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Forschungsprojekte im Überblick
2015

Kuratorium für Forschung und Technik
der Zellstoff- und Papierindustrie im VDP e. V.

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Verband Deutscher Papierfabriken e.V.

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Kuratorium für Forschung und Technik
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Inhaltsverzeichnis

VORWORT

Das Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V. stellt Ihnen die aktuelle Übersicht über Forschungsprojekte in den Themenbereichen Zellstoff und Papier für das Jahr 2015 vor.

Neben Arbeiten, die aus Mitteln des Kuratoriums gefördert werden, finden Sie zahlreiche weitere Projektbeschreibungen, die die Forschungsinstitute der Papierindustrie zur Kenntnis bringen wollen. Es sind Projekte von Instituten, die sich im Cluster Paper and Fibre (CPF) vernetzt haben, um die Innovationskraft der Papier-Wertschöpfungskett zu stärken. Zahlreiche Projekte erhalten öffentliche Förderung des BMWi im Rahmen der Industriellen Gemeinschaftsforschung oder aus anderen nationalen und europäischen Förderprogrammen.

Folgende Institute stellen in der diesjährigen Ausgabe Beiträge aus ihrer Forschungsarbeit vor:

- Papiertechnische Stiftung (PTS), München und Heidenau
- Technische Universität Darmstadt
    - Fachgebiet Papierfabrikation und Mechanische Verfahrenstechnik (PMV)
    - Makromolekulare Chemie und Papierchemie (MAP)
- Technische Universität Dresden
    - Professur für Papiertechnik
- Hochschule München
    - Verfahrenstechnik Papier und Verpackung

Wir danken den Forschungsinstituten für die Erstellung der Vielzahl von Kurzbeschreibungen.

Diese Broschüre wurde zusammengestellt mit dem Ziel, den Geschäftsführungen und insbesondere den mit Forschung und Entwicklung befassten Mitarbeitern unserer Mitgliedsunternehmen einen kompakten Überblick über die Forschungsergebnisse und laufenden Untersuchungen, die für die Papierindustrie von Interesse sind, zu vermitteln. Firmen, die detailliertere Informationen wünschen, können direkt mit dem bearbeitenden Forschungsinstitut Kontakt aufnehmen. Ansprechpartner sind in der Kopfzeile jeder Projektbeschreibung benannt.

Für interessierte Firmen besteht jederzeit die Möglichkeit, bei Projekten, die über das Kuratorium für Forschung und Technik gefördert werden, in projektbegleitenden Ausschüssen mitzuarbeiten. Unternehmen können direkt an den entstehenden Forschungsergebnissen partizipieren und diese auch mitgestalten. Anmeldemöglichkeit zum projektbegleitenden Ausschuss besteht auch über die Mitgliederseiten (Extranet) des VDP:

https://www.vdp-online.de/de/extranet/startseite-extranet/neue-infor-projekte.html

In der Forschungsübersicht 2015 wurden Kurzbeschreibungen von insgesamt 89 Forschungsvorhaben erfasst und nach Forschungsgebieten geordnet. Am Ende der Broschüre finden Sie ein Schlagwortverzeichnis und eine Themenliste, die das Auffinden bestimmter thematischer Schwerpunkte ermöglichen.

Die Forschungsübersicht 2015 steht auch auf CD-ROM zur Verfügung. Wenn Sie Themen zu einem bestimmten Forschungsgebiet suchen, gelangen Sie durch Anklicken der gewünschten Zeile im Inhaltsverzeichnis auf die erste Seite des betreffenden Forschungsgebietes. Über das Themenverzeichnis am Ende können Sie alle enthaltenen Einzelthemen durchsehen und direkt das Projekt anklicken. Ein Schlagwortverzeichnis führt zu den Schlagworten der einzelnen Projektbeschreibungen.

Wir senden Ihnen gerne weitere Exemplare der Forschungsübersicht und der CD-ROM. Bitte wenden Sie sich an die VDP-Forschungsförderung e.kloss@vdp-online.de.

Die Forschungsübersichten stehen ebenfalls im Extranet des VDP bereit unter:

https://www.vdp-online.de/de/extranet/startseite-extranet/forschungsuebersichten.html

PRODUKT-ZIELE

Forschungsgebiet
Rohstoffe

Holz
Landwirtschaftliche Nutzpflanzen
Altpapier
Füllstoffe, Pigmente
Chemische Additive

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Research area: Product aims

Raw materials // Wood

Key words:

recovered wood, upgrading recycling, wood value chain, reverse logistic model, environmental impacts

TITLE:
Cascading Recovered Wood (CaReWood)

Background/Problem area

Wood products at the end of a life cycle are invariably chipped into particles. The two main end-uses for the recovered wood (RW) are particleboard manufactures and energy generation. The CaReWood consortium considers it a waste to grind all the wood into particles, because many of the wood products contain relatively large dimension timbers of originally good quality that would have a higher value than particles if their dimensions were maintained during recycling. The CaReWood project will develop and evaluate techniques for converting large dimension RW into new, large dimension solid wood products to complement the solid wood currently used in the furniture, interior fitting and construction sectors.

The CaReWood consortium believes that the world's forests will not be able to adequately provide enough primary wood for the growing global resource demands without a significant improvement in resource efficiency of the whole value chain. The CaReWood project will significantly improve resource efficiency by demonstrating the potential of creating at least one additional life cycle for solid wood products.

Objectives/Research results

The overall objective of this project is to introduce an up-grading concept for recovered solid timber as a source of clean and reliable secondary wooden products for the European industry. Such a concept will further strengthen the market competitiveness and the sustainability of wood based products. The CaReWood project will develop a business model for cascade use of wood recovered from building renovation and demolition, the furniture sector and the packaging and transport industries. The scientific and technological objectives of CaReWood include:

- present authoritative forecasts of volumes and qualities of post-consumer and post-industrial RW;
- design guidelines to facilitate future reuse;
- develop software supported reverse logistic models for recovery of wood;
- develop, demonstrate and evaluate the feasibility of up-grading solid RW technologies;
- adopt certification and labelling criteria to cascaded wood;
- evaluate the environmental impacts and socio-economic viability of wood cascading.

Successful up-scaling and application of the CaReWood principles by the target industries will result in:

- New and viable business opportunities (in Europe and worldwide);
- Mitigation of climate change by longer storage of captured carbon in wooden materials;
- Safeguarding of resources in the biosphere;
- Higher societal acceptance of renewable raw materials and recycled products by public authorities and customers;
- Higher valorisation of LCA of wood products results, namely of the carbon footprint of recycled wood in the technosphere.

Application/Economic benefits

The idea behind CaReWood is to look for opportunities to have a first step of recycling allowing a re-use of the material at the same stage of quality at least as for its first use, by keeping the largest possible dimensions in order to open new possibilities of end-uses.

From an environmental point of view, the increased recycling of recovered wood can be seen as a positive evolution because this increases the total volume of CO_2 stored in solid wood many years and longer periods as before.

The results of this project were disseminated and exploited to different industrial branches in different way, either directly to the companies in conferences, symposia and on fairs.

Period of time: 01.06.2014 – 31.05.2017

Remarks

The RTD project CaReWood is funded by German Federal Ministry of Food and Agriculture (**BMEL),** ERA-NET WOOD-WISDOM-NET+, a network of European Funding Agencies (4th Joint Call - 2013), and coordinated by Technische Universität München, Lehrstuhl für Holzwissenschaft (TUM) Germany, in cooperation with leading European paper research institutes PTS, Germany; WKI, Germany; AAL, Finland; SRBTP, France; FCBA, France; ESB, France; BOKU, Austria; IAM, Slovenia), and 7 industrial partners: Abelium d.o.o, M SORA d.d., Slovenia; RTT Steinert, Schumann-Analytics GmbH, Olympus Deutschland GmbH, LSA – Laser Analytical Systems & Automation GmbH, Germany; Vanek Tischlerei und Reparatur, Austria; Fédération Française du Bâtiment – Charpente-Menuiserie-Parquets, France.

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Research area: Product aims

Raw materials // Arable crops

Key words:

subcritical water extraction, food additives, non-wood raw materials

TITLE:
Subcritical water as a green solvent for extraction of plants

Background/Problem area

The use of subcritical water as a solvent allows current extraction processes that are based on problematic chemicals like acids, bases or organic solvents to be replaced. Indeed, when the water is heated above 100°C and maintained in a liquid state under pressure, the polarity can decrease significantly. Valuable chemicals can be extracted from vegetal material and hemicellulose can be partly hydrolysed. Two types of extract substances are expected to provide substantial added value: antioxidant substances to be used as additives in food or as ingredients in cosmetics, and antimicrobial substances for preserving food and cosmetics.

Paper manufacturers have been encountering skyrocketing fibre raw material prices, paralleled by increasing competition for wood fibre feedstock. Alternative fibre sources are needed to re-gain a competitive edge. The key concept of this project is to investigate the implementation of Subcritical Water Extraction (SWE) in synergy with paper manufacturing.

Objectives/Research results

Objective of the project was to develop an integrated process chain to add value to agricultural by-products, produce “green” valuable bioactive additives for the food and cosmetics sectors and at the same time feedstock for the paper industry to replace costly fibre raw materials. Subcritical water extraction is at its core.

Based on criteria like availability, competitive uses, suitability and paper-technological potential, the four most promising materials were selected from a group of 29 agricultural and food residues like stalks, hulls, skins and oil extraction residues: oat hulls, apple pomace, barley straw and corn straw.

First extraction tests were made on a lab scale for the exploration of favourable conditions. The optimisation was carried out on a pilot scale. Optimum extraction conditions included solvent recirculation, nitrogen atmosphere and a temperature range of 140 – 160 °C.

Active substances in the extracts included organic acids, polyphenols, and other specific substances. Polyphenols and catechins are antioxidants which are interesting for food and cosmetic application due to their capacity of reducing oxidation of the final product. Fresh extracts were effective as antimicrobials and antioxidants. The antimicrobial activity decays with time. Extracts can be applied where antimicrobial efficacy against S.aureus and E.coli is needed, eg. bio-cosmetics and fresh organic food products.

The extracted materials are capable of replacing part of the conventional fibrous raw materials used for papermaking. They are suitable for papermaking after refining or milling, but must be further optimised in terms of drainability and process water pollution for industrial implementation. Compared to recycled fibres, the use of up to 40 % straw after extraction at 160 °C for 60 min led to higher tensile strength levels in handsheets. However, these extraction conditions also lead to by-products in the extracts that are incompatible with food sector applications.

These by-products can be avoided by extracting in more gentle conditions. Extracted straw or oat hulls gave less tensile strength when replacing part of the recycled fibre pulp in papermaking, but led to considerably higher volume and bending stiffness. This makes them particularly suitable for paperboard production, especially for the middle layers of multiply board.

Integrating an extraction plant on-site at a paper mill proved to be an advantage for the implementation.

Application/Economic benefits

It could be demonstrated that the process chain developed in this project generates significant profit potential. The new technology links agriculture with food, cosmetics and papermaking industries, thus opening up attractive new business areas for start-up firms and established SMEs in these sectors.

The results represent a unique approach to add value to vegetal residues. By its coupled approach and the total material use it goes far beyond existing approaches of biomass use.

Period of time: 01.01.2013 – 30.04.2015

Remarks

The RDT project IGF CORNET 82 EBG is carried out in cooperation with CELABOR, Belgium, and the West Pomeranian University of Technology, Poland. It is funded by the German Federal Ministry for Economic Affairs and Energy (BMWi), Narodowe Centrum Badań i Rozwoju, Poland, and Service public de Wallonie (SPW). www.cornet-subwex.eu

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Research area: Product aims

Raw materials // Arable crops

Key words:

non-wood raw materials, classification, characterisation, processing

TITLE:

Development of a provision of services for an efficient assessment of alternative paper raw materials and for the preparation of technical-economical utilisation concepts

Background/Problem area

Paper manufacturers are facing increasing raw material prices for pulp and paper production. This leads to a decreasing profitability of paper production. The input of so far not used raw materials predominantly from the agricultural sector is an option that was not assessed very intensively until now. Expensive fibre raw materials based on wood are able to be partly replaced in several product segments. At the same time, the use of residues from other sectors leads to an increased sustainability of paper production. Furthermore first results in this field of research show, that with some raw materials, also technological properties of the targeted products can be improved.

Objectives/Research results

The project aims at the development of a systematic methodology as a core element of a provision of services to asses alternative raw materials for papermaking in a target-oriented and cost efficient way.

In the project progression raw materials were classified according to their origin and especially according to their characteristics. A basic differentiation between fiber-like and filler-like materials led to individual pretreatment and characterization strategies for different types of biomass.

Characterisation methods were tested on representative raw materials. Characteristics such as surface charge and particle size and chemical composition were determined. The raw materials were then used to partly replace fibre raw materials in laboratory sheets. Furthermore the influence of pretreatment conditions on paper properties was examined.

During further progress of the project, impacts of the raw materials on the papermaking process were investigated. Furthermore methodologies for the assessment of the legal and economic status of the new paper products will be generated.

Application/Economic benefits

The developed provision of services aims at two groups of customers. On the one hand, there are raw materials suppliers, who are looking for new application routes of their products. On the other hand, there are paper manufacturers who are looking for alternative raw materials to use in their paper. The development of a more efficient methodology to assess possible raw materials regarding their papermaking potential leads to a faster and more economical way to decide which raw materials are suitable to be used for a certain product or vice versa.

Period of time: 01.11.2013 – 31.10.2015

Remarks

The RTD IK-MF130097 is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Research area: Product aims

Raw materials // Paper for Recycling

Key words:

paper for recycling, modelling, dry sorting concepts

TITLE:
Developing tools to design plant concepts for the dry sorting of papers for recycling with new product aims

Background/Problem area

European demand and manufacturing structures for graphic and packaging papers have changed significantly in recent years. Graphic papers have been suffering a steady decline in both consumption and production volumes, whereas packaging papers and boards have remained at a consistently high level. Against this background, the consumption and key quality requirements of papers for recycling can be expected to shift from graphic mass papers to packaging production in future. However, the packaging sector's growing demand for high-quality paper for recycling is opposed by qualitative changes in paper products such as increasing shares of material composites, highly ash-containing papers etc. as well as by the fact that the technologies and operating regimes of sorting plants have been designed exclusively for the quality demands of the fractions used in graphic paper production (grade 1.11). These trends and the growing need for plant concepts that enable the economical operation of dry sorting systems have given rise to a research project aimed at studying the production of raw materials for packaging mills by dry sorting papers for recycling from household collections.

Objectives/Research results

Aim of the research project is the development of tools that can be used to derive new sorting concepts for household collections mainly in order to obtain papers for recycling for packaging paper and board production.

The new sorting concepts are intended to offer to packaging paper manufacturers a possibility to reduce process and quality problems that result from the growing shares of non-paper materials, ash and short fibres in the paper for recycling.

The project work involves a detailed stocktaking of the separating characteristics and utility values of the paper products that occur in relevant amounts in PfR from household collections as well as the sorting methods including their separation behaviour that exist both currently and in the near future. Another focus of the work is the preparation and development of a software-assisted tool for selectively choosing sorting procedures (selection tool) and for the utility value-oriented and economic evaluation of sorting concepts (simulation tool).

It was elaborated that the focus in sorting packaging paper for recycling lies in sorting the paper products according to the pulp composition – besides separating the non-paper materials – such as:

- separating highly ash-containing paper products to enhance the pulp characteristics that impart volume and strength, or
- separating kraft-containing packaging to obtain secondary fibre pulp with great strength potential.

Based on economic feasibility studies, it was able to be demonstrated that an essential prerequisite for an economically viable sorting concept lies in tapping the maximum synergy potential between dry PfR sorting and PfR treatment in a paper mill and in the efficient separation and profitable utilisation of the contaminants that can be separated out by dry sorting processes. The design and economic evaluation of the process for producing and using the new packaging paper for recycling quality take place under the framework conditions of a reference region. This provides the waste management industry and the paper industry with practical decision-making tools for implementing such a concept.

Application/Economic benefits

The systematic sorting of papers for recycling to obtain qualities suitable for packaging paper production is a new technological and economic concept for dry sorting plants. It enables packaging paper producers to reduce quality problems caused by growing shares of surface-finished packages in paper for recycling as well as by the further closure of packaging cycles. Basically, the new process concepts are intended to provide the following technological and economic benefits to operators of automated sorting plants as well as producers of packaging paper and board:

- Reliable processing and lower treatment cost of pulps for packaging paper and board production due to lower shares of non-paper components in grades 1.02 and 1.04 (obtained by dry sorting)
- Long-term profitability of sorting plants by winning packaging production as principal market for superior grades of papers for recycling

Period of time: 01.01.2014 – 31.12.2015

Remarks

Research project IK-MF130043 is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Forschungsgebiet: Produkt-Ziele

Rohstoffe // Altpapier

Schlagworte:

Altpapier, Altpapiersortierung, Sortieranlage, Simulation

Topic:
Modelling and Systematic Assessment of Recovered Paper Sorting Systems

Background/Problem Area:

Paper for recycling is an important raw material for the European paper industry. The quality of recovered paper can be influenced and improved by sorting. The sorting process separates the recovered paper into various fractions and removes unwanted components.

The dominant sorting process for recovered paper is manual sorting. But automated processes are employed as well. They include for example screening and optical recognition combined with automatic removal by means of compressed air jets.

Objective/Research Result:

One objective of this project is to develop a simulation software for recovered paper sorting plants. The software should be based on models of processes used in recovered paper sorting and should enable the user to simulate and evaluate various scenarios of sorting plants. From this objective the following main work packages can be built:

- modelling the important sorting processes for recovered paper,
- determining model parameters and verifying of the modelling in industrial sorting plants,
- developing (semi-)automated measuring methods to collect the relevant data of an adequate number of recovered paper samples.

The second objective is to simulate and compare typical and new sorting plants.

All objectives of the project were reached. An automatic measuring system was constructed to speed up the data collection. It uses dynamic scales and image analysis to measure the particle size distribution, the particle shape distribution and the composition of samples of recovered paper.

Samples of recovered paper were collected in five industrial sorting plants and analyzed with the automatic measuring system. The data was used to model the processes coarse screening, fine screening, Paperspike treatment, optical sorting and manual sorting. The modelling showed, that the coarse screening is well suited to separate big pieces of corrugated board from other components of recovered paper. The mean mass ration of corrugated board in the coarse fraction is about 90 %. Optical sorting is also well suited to remove corrugated board (removal rate between 60 and 85 %), but its drawback is, that it also removes a significant amount of graphic papers (removal rate between 10 and 30 %). The investigated Paperspike machine removes about 50 % of the corrugated board and nearly no graphic papers. All of the modelled processes, even the manual sorting, have problems with the removal of gray or brown cardboard.

Simulations of two sorting plants proved the suitability of the developed simulation software. On the one hand the simulations correlate satisfactorily with measured data. On the other hand the software offers the possibility to evaluate the potential of modifications in the plant design. For one plant it could be shown that reducing the mesh size of the fine screen from 18 x 10 cm² to 7 x 12 cm² could raise the output of the sorted graphic paper for deinking from 60 to 64 % without a decline of the quality.

Application/Economic Benefits:

The simulation software developed in this project can directly be used by designers and operators to evaluate and improve the potential and efficiency of recovered paper sorting plants. Data obtained in industrial sorting plants during this project can also be used to evaluate sorting plants.

By applying the results of this project presumably higher recovered paper qualities can be achieved. This could offer the possibility to reduce or save processes in the stock preparation of paper mills that work with recovered paper.

Project Period: 01.08.2012 – 31.07.2015

Remarks:

The project IGF 17496 N of the research association Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V. is funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Forschungsgebiet: Produkt-Ziele

Rohstoffe // Altpapier

Schlagworte:

Altpapier, Massenbilanzen, Materialflüsse, Import/Export verpackter Produkte

Topic:
Indirect Material Flow of Paper and Board in Germany

Background/Problem Area:

Recovered paper is the most important fibre raw material resource for paper production in Germany. The VDP issues the “Annual Report Paper” that contains a fibre flow chart for recovered paper in Germany. In this diagram the mass balance including the recovered paper, produced paper and virgin fibres is shown. The data presented in this mass balance is the basis for the calculation of important key numbers as the recovered paper utilization rate and recycling rates. Unfortunately, not all streams of recovered paper and paper products are considered sufficiently in this diagram. This is especially true for:

- Foreign trade: packaging materials from imported or exported packaged goods, especially transport and secondary packaging.
- Paper and cardboard in non paper/cardboard products, especially paper in technical applications like insulation material or flower pots. These papers are used in other industries or leave the mass balance and are therefore not available for recycling.
- Non-paper additives for paper products (printing ink, glue, starch in corrugated board, staples, ...).
- The amount of virgin pulp and non-fibrous materials and the amount of unsold returns.
- The amount of long lasting products, recovered paper that is not ascertainable, non-collectable recovered paper at end-user.

It is assumed that the planned modifications will lead to an increased amount of available recovered paper and also theoretical paper consumption, especially due to the indirect import/export of paper/cardboard as packaging materials for goods. Because these material flows are partly unknown and/or not captured in the statistics, there is no information on the composition of the packaging material. This information is important for the balance of the product groups packaging paper and technical papers.

Objective/Research Result:

The described work is aimed to improve the reliability of the mass balances of both paper and recovered paper. The expertise of the working group “Recovered Paper Availability" of the VDP Technical Committee on recovered paper will be included in this project. One important point is to collect additional data for the import/export of packaged goods. Additionally, the data and assumptions that are used for the statistics today are questioned, checked for plausibility and if necessary new methods/values for the assumption and data collection are proposed. A stakeholder analysis is conducted to investigate the influence of these new methods and data collection on the different actors of the circular flow economy. Also the new data should be more transparent than the ones of today. Potential options for actions and conflicts will be identified as well.

Application/Economic Benefits:

The paper industry and also other industries that use recovered paper have a crucial interest in the amount of potentially available recovered paper. This project will aim to identify which amount of recovered paper is potentially still unused and could be exploited with a better recovering system.

Project Period: 01.05.2014 – 30.04.2015

Remarks:

The research project INFOR 180 is being funded by Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V. and performed in cooperation between PTS and PMV.

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Rohstoffe // Altpapier

Schlagworte:

Zerfaserung, Wassereinsparung, Stoffaufbereitung, stoffliche Verwertung, Ressourceneinsparung

Thema:
Trockenzerfaserung – Ein alternatives Verfahren für die energieeffizientere Zerfaserung von Altpapier

Ausgangssituation/Problemstellung

Der Teilprozess der Zerfaserung steht zu Beginn einer jeden altpapierbasierenden Produktionskette. Aufgrund der heute überragenden Bedeutung von Altpapier, das mit einem Anteil von ca. 61 % und insgesamt über 16 Millionen Tonnen/Jahr den mit Abstand wichtigsten Rohstoff der deutschen Papierindustrie darstellt, wird die Forderung nach einer umweltverträglichen, ressourcenschonenden und energieeffizienteren Zerfaserung des Ausgangsstoffes deutlich unterstrichen. Bisher erfolgte die Zerfaserung, also die Zerkleinerung des Papiergefüges in Einzelfasern, unter Zuhilfenahme von Wasser und geeigneten Chemikalien in diskontinuierlich arbeitenden Pulpern oder in kontinuierlich betriebenen Auflösetrommeln. Eine energetische Betrachtung der Zerfaserung offenbarte allerdings eine erhebliche Differenz zwischen dem Energieeinsatz nach dem Stand der Technik und dem theoretisch minimalen Energiebedarf für diese Aufgabe.

Ein Hauptgrund für diese schlechte Energiebilanz sind vor allem die bisher benötigten Wassermengen, welche zusätzlich bewegt und gepumpt werden müssen. Um den Zerfaserungsprozess wesentlich energieeffizienter zu gestalten, muss demnach nach Technologien gesucht werden, bei denen die Zerfaserung bei deutlich höheren Stoffdichten und einem verbesserten Energieeintrag durchgeführt werden kann. Einen denkbaren Lösungsansatz stellt die mechanisch-trockene Zerfaserung des Altpapiers dar.

Forschungsziel/Forschungsergebnis

Im Ergebnis des Projekts konnte ein Verfahren zur trockenen Zerfaserung von Altpapier entwickelt werden. Die Technologie beruht dabei auf der Grundlage einer mechanischen Luftstromfeinprallmühle, in der die Zerfaserung auf den durch hochturbulente Luftströmungen herbeigeführten Kollisionen mit Einbauten bzw. den Apparatewänden beruht. Durch das Zusammenwirken von Prallbeanspruchungen an einer Körperfläche und einer Druck-Scher-Beanspruchung im Mahlspalt, kombiniert mit einer Beanspruchung innerhalb einer rotierenden turbulenten Strömung, wird der zugeführte Ausgangsstoff zerkleinert.

Zahlreiche Zerfaserungsversuche von Altpapier (Zeitungen und Magazine) haben bestätigt, dass es mittels Trockenzerfaserung möglich ist, das Fasergefüge gänzlich ohne Zugabe von Wasser zu zerlegen und dabei eine Faserqualität zu erreichen, bei der die gewonnen Einzelfasern für die herkömmliche Weiterverarbeitung geeignet sind. Allerdings konnte der Energiebedarf der nicht optimierten Trockenzerfaserung bisher nicht unter das Niveau der herkömmlichen Nasszerfaserung gesenkt werden. Auch hinsichtlich der Faserqualität bestehen noch Defizite, da die Trockenzerfaserung im Vergleich zum schonenden Nassprozess zu einer Defibrillierung und Faserkürzung führt, wodurch die Faserflexibilität eingeschränkt wird und der trocken aufbereitete Faserstoff ein geringeres Festigkeitspotenzial aufweist. Der hohe Energiebedarf resultiert u. a. auch daraus, dass der Zerfaserungswiderstand – und somit auch der Energiebedarf – mit dem Trockengehalt des Papierprodukts korreliert. Optimierungsversuche mit befeuchtetem Zeitungsdruckpapier haben jedoch gezeigt, dass die mit der Befeuchtung verbundene Schwächung des Papiergefüges auch zu einer Reduzierung des Energiebedarfs und einer Verbesserung der Faserqualität beiträgt. Weitere Optimierungspotenziale zur Energieeinsparung und Qualitätsverbesserung konnten im Projektverlauf aufgezeigt werden.

Weiterführende Versuche zur Trockenzerfaserung zeigten jedoch auch, dass nicht nur die gängigen Altpapiersorten in Einzelfasern zerlegt werden können, sondern auch schwer zu zerfasernde Produkte wie Hülsen, Trennpapiere, Verbundmaterialien wie Getränkekartons oder nassfeste Filterpapiere. Dies eröffnet die Möglichkeit, neue und teilweise noch nicht genutzte Rohstoffquellen für die Papierproduktion zu erschließen und somit hochwertige, bisher nicht nutzbare Fasern dem Wertstoff-Kreislauf zurückzuführen.

Darüber hinaus legt die Trockenzerfaserung den Grundstein weiterführende Prozesse innerhalb der Stoffaufbereitung ebenfalls ohne Wasserzugabe zu gestalten. Geht man noch einen Schritt weiter und skizziert einen nahezu trockenen Produktionsprozess für die Herstellung von Papier und Karton, so würden sich erhebliche Einsparpotenziale ergeben, welche vermutlich mit keinem Nassprozess erreicht werden könnten. Entsprechende Forschungsarbeiten auf diesem Gebiet stehen allerdings erst am Anfang.

Anwendungen/Wirtschaftliche Bedeutung

Mit dem hier dargestellten Konzept der Trockenzerfaserung ist es möglich, schwer rezyklierbare Papierprodukte deutlich effizienter aufzubereiten als mit konventionellen Nassverfahren. Darüber hinaus bietet die Trockenzerfaserung die Chance, hochnassfeste Produkte und Spezialpapiere, welche bisher entsorgt werden mussten, als Rohstoffquelle zu erschließen und dem Altpapierkreislauf wieder zuzuführen. Insbesondere vor dem Hintergrund sich verknappender und verteuernder Rohstoffe ist dies für die Industrie eine attraktive Technologie, um die Rohstoffkosten zu reduzieren und die Versorgungssicherheit bei den Rohstoffen zu erhöhen.

Bearbeitungszeitraum: 01.04.2013 – 31.05.2015

Bemerkungen

Das ZIM-Projekt KF 2418616SL2 wird über die AiF Projekt GmbH vom Bundesministerium für Wirtschaft und Energie (BMWi) aufgrund eines Beschlusses des Deutschen Bundestages gefördert. Das Projekt wird in Kooperation mit der Mahltechnik Görgens GmbH bearbeitet.

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Research area: Product aims

Raw materials // Fillers, pigments, chemical additives

Key words:

coating, cellulose nano-colloids, synthesis, properties, barrier, surface energy, mineral oil

TITLE:
New barrier layers based on cellulose nano-colloids

Background/Problem area

In many areas in the functional finishing of paper, barrier layers constitute an important basis for the performance of a wide range of paper grades. Nowadays, coating materials (plastics, metal laminates, etc.) are often used that are difficult to recycle. Often used are also barrier materials that cannot be used in all fields of application (e.g. in contact with foodstuffs) to create barriers, e.g. for water vapour, fats or gases (oxygen, mineral oils, etc.) owing to substances they contain. Barriers of "regenerative raw materials" frequently suffer from the disadvantage that they are either very expensive or they do not perform adequately when compared to the afore-cited materials. Initial studies undertaken by the MAP Chair at Dresden Technical University have given rise to novel, cellulose-based, hydrophobic nano-colloids that are ideally suited for coating paper and selectively adjusting surface properties.

Objectives/Research results

The objective of the research project is to study the barrier properties of paper coatings comprised of hydrophobic cellulose nano-colloids, and to derive from this information whether or not these coatings would be a "sustainable" alternative for conventionally used barrier layers.

The studies shall focus on properties such as water vapour transmission and the ability of prevent the transfer of mineral oils. Whereas the cellulose nano-colloids were produced and applied to model papers at Dresden Technical University (MAP), the barrier properties of these novel coatings are to be studied and understood at PTS. Another objective is to evaluate a variety of different application processes in the light of the barrier properties that result. The latter is to be investigated in particular dependent on temperature, since the morphology of the films changes at 70° C, thus changing the barrier properties as well – thus allowing them to be "thermally switched" in the event of a successful outcome. Last but not least, the recyclability of the barrier layers is to be investigated.

The project is designed in such a way that the work will be subsequently continued in the form of a publicly funded project (e.g. IGF).

Proceeding from microfibrillated cellulose, a variety of different cellulose esters were created with saturated fatty acids. Using a special procedure (nanoprecipitation in an aqueous solution), colloid cellulose ester particles could be obtained with average diameters of 100 – 200 nm. The particles were characterised based on their chemical and thermal properties and then applied to paper surfaces and other substrate surfaces using different application methods (spray process, screening). The films are only a few microns thick and exhibit very interesting properties in contact with aqueous solutions: the surfaces show superhydrophobic properties at temperatures less than approx. 60° C. This can be traced back to the particular nature of the films and thus the associated roughness on the nanometre and micron scales. At temperatures greater than approx. 60° C, the colloids fuse to form a compact layer that continues to possess hydrophobic properties.

The surfaces were characterised in respect to their homogeneity, morphology and chemical composition. The next steps will be as follows: to better understand the barrier properties of these films that are of utmost importance, to evaluate the different application methods with a view to their possible technological use, and finally to derive the relationships that exist between the film structure and the film properties.

Application/Economic benefits

Barrier layers based on regenerative raw materials can be an alternative to existing systems for a number of applications in the packaging and specialty paper sectors. The raw materials required to produce the nano-colloids (cellulose and fatty acids) are 100 % regenerative. The proposed approach thus aims to develop "sustainable" solutions for novel barrier layers.

Period of time: 01.01.2015 – 31.12.2015

Remarks

RTD project INFOR 185 is being funded by Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V. and is being conducted in cooperation with Institute of Macromolecular Chemistry and Paper Chemistry (MAP) at Dresden Technical University.

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Forschungsgebiet: Produkt-Ziele

Rohstoffe // Chemische Additive

Schlagworte:

Leimung, ASA, AKD, Leimungsrevision, Leimungsmechanistik, Leimungsmittel-Lokalisation

Thema:
Ressourcenschonung durch Leimungsoptimierung bei der Herstellung von Papier und Karton

Ausgangssituation/Problemstellung

Die Anforderungen an Papier steigen stetig an. Immer schneller laufende Weiterverarbeitungsmaschinen mit kleiner werdenden Toleranzen sowie steigende Ansprüche der Verbraucher lassen Schwankungen während des Papierherstellungsprozesses und der Verarbeitung kaum noch zu. Daher müssen in einer großtechnischen Anlage alle Prozessschritte möglichst schnell, optimal, verlustfrei und effizient ablaufen, um dadurch einen stabilen Maschinenlauf garantieren zu können. Einer der wichtigsten Prozessschritte der Wertschöpfungskette bei vielen Papiersorten, wie Kopier-, Massendruck- oder Schreibpapier, ist die Leimung. Auch beim Streichen von Papier, im Verpackungsbereich und bei einigen Spezialpapieren spielt die Leimung für Fragen der Verarbeitung, Bedruckbarkeit und der Hydrophobierung eine große Rolle. Da sie sehr kostenintensiv ist, muss sie möglichst reproduzierbar, schwankungsfrei und dauerhaft verlaufen.

Die heute weltweit am häufigsten eingesetzten Leimungschemikalien sind, neben dem traditionellen Harzleim sowie den Polymerleimungsmitteln für den Oberflächenauftrag, die Reaktivleimungsmitttel AKD (Alkylketendimer) und ASA (Alkenylbernsteinsäureanhydrid). Die Prinzipien der Entfaltung ihrer Leimungswirkung beruhen auf einer Modellvorstellung, nach der sich kovalente Bindungen mit OH-Gruppen der Cellulose ausbilden. Dabei stellt der Blattverbund von Cellulosefasern vor der Leimung ein hochporöses und hydrophiles Netzwerk dar, welches durch eine hohe Zahl an OH- und Carboxylgruppen Wasser sehr schnell aufsaugen kann. Das Resultat bei Wasserkontakt ist eine unerwünschte Faserquellung und ein damit einhergehender Festigkeits- und Strukturverlust. Um dieses physikalisch-chemische Phänomen zu vermeiden, müssen Oberfläche und Poren des Netzwerks hydrophobiert werden. Leimungsmittel bewirken eine Oberflächen- und Tiefenhydrophobierung des Fasernetzwerks. Dadurch kann Wasser nicht bzw. nur sehr langsam, in das feinporige Blattgefüge eindringen. So ist eine höhere Resistenz gegen Quellung und den einhergehenden Festigkeits- und Strukturverlust gegeben.

Forschungsziel

Mit den im Projekt gewonnenen Kenntnissen über die Leimungsmechanismen der beiden größten Neutralleimungsmittel AKD und ASA soll deren großindustrieller Verbrauch drastisch reduziert werden. Im Rahmen des Projektes soll zum einen untersucht werden, warum teilweise über 80 % der eingesetzten Leimungsmittelmengen nicht zum gewünschten hydrophobierenden Effekt beitragen und zum anderen soll daraus abgeleitet werden, wie durch Aktivierung der verwendeten Chemikalien deren Verbrauch deutlich reduziert werden kann. Angestrebt sind dabei Reduzierungen von über 50 %. Diese drastische Reduzierung soll durch eine empirisch ausgearbeitete optimale Kombination von Prozess- und Leimungsparametern erreicht werden. So soll neben einer verbesserten Leimungswirkung auch andere Papiereigenschaften wir Porosität oder Festigkeitswerte positiv beeinflusst werden. Zusätzlich wird eine Stabilisierung des Produktionsprozesses erhofft, da durch geringeren Leimungsmitteleinsatz auch die mit der Leimungsmitteldosierung verbundenen Wechselwirkungen minimiert werden.

Bisherige Ergebnisse

Bisher durchgeführte weitläufige Versuche im Bereich der Wechselwirkungen mit Prozessparametern und Prozessadditiven, sowie die Entwicklung einer neuen Lokalisationsmethode für ASA im Blattverbund, haben gezeigt, dass die Papierleimung erheblich äußeren Einflüssen unterliegt. Diese sind in der Lage, das Ergebnis der Leimung mit bis zu Faktor drei positiv, wie auch negativ zu beeinflussen. Speziell fallen unter die Gruppe der stark wechselwirkenden Faktoren der pH-Wert, die Emulgierparameter, sowie die die Leimungsmittel-Fixierung. Weitere Versuche sollen ergeben, wie diese Faktoren kanalisiert werden können um lediglich die positiv beeinflussenden Wechselwirkungen zu nutzen. Die Ergebnisse haben zudem bekräftigt, dass die chemischen, wie physikalischen Mechanismen, welche hinter der Ausbildung der Leimungswirkung stehen, nicht oder nur zu einem sehr geringen Anteil auf der Ausbildung kovalenter Bindungen zwischen den Leimungsmitteln und der Zellulose bestehen. Vielmehr scheint die Leimungswirkung ein reines Ergebnis der physikalischen Verteilung des Leimungsmittels und vor allem dessen Ausrichtung im Blattverbund zu sein.

Anwendungen/Wirtschaftliche Bedeutung

ASA (Alkenylbernsteinsäureanhydrid) und AKD (Alkylketendimer) machen heute gemeinsam gut zwei Drittel des weltweiten Verbrauchs der Leimungsmittel bezogen auf Papier und Karton aus. Zu Ihrer Anwendung als kostengünstige Leimungsmittel in Gegenwart von $CaCO_3$ und Altpapier gibt es keine großindustrielle Alternative. Dies bedeutet, dass nur kleine Reduzierungen der Leimungsmittelmengen mit großen Einsparungsmöglichkeiten verbunden sind. So werden nicht nur primär die Kosten für die Beschaffung und Applikation der Leimungsmittel sinken, sondern auch jene, welche mit den Folgen der übermäßigen Leimungsmitteldosierung und den damit verbundenen Wechselwirkungen in Zusammenhang stehen.

Bearbeitungszeitraum: 01.04.2013 –-31.12.2015

Bemerkungen

Bundesministerium für Wirtschaft und Energie

Das IGF-Vorhaben 17577 N der Forschungsvereinigung Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V., Adenauerallee 55, 53113 Bonn wurde über die AiF im Rahmen des Programms zur Förderung der Industriellen Gemeinschaftsforschung (IGF) vom Bundesministerium für Wirtschaft und Energie aufgrund eines Beschlusses des Deutschen Bundestages gefördert.

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Forschungsgebiet: Produkt-Ziele
Rohstoffe // Chemische Additive

Schlagworte:
Nassfestigkeit, Vernetzer, photoreaktive Polymere

Thema:
Photoreaktive Polymeradditive für den Einsatz in der Papierfabrikation als neuartige Nassfestmittel und Streichfarbenvernetzer

Ausgangssituation/Problemstellung

Es gibt eine Vielzahl an Papiersorten, die ausreichend Festigkeit im feuchten oder nassen Zustand in Verarbeitungs- oder Gebrauchsprozessen bewahren müssen. Hierbei kommen zurzeit u.a. Polyamidoamin-Epichlorhydrin Harze, Melamin- und Harnstoff-Formaldehydharze und untergeordnet die Glyoxal Harze zum Einsatz, die alle gemeinsam haben, dass die Ausbildung der chemischen Bindungen zwischen Harz und Faser thermisch erfolgt. Neben thermischen Verfahren kann man sich aber auch andere, z. B. photochemische Verfahren vorstellen, um funktionale Polymere mit Fasern im Papiervlies (oder Komponenten des Papierstrichs) chemisch zu vernetzen. Benzophenon ist als Photoinitiator für Polymerisationsreaktionen, u. a. auch in Druckfarben, schon länger bekannt. Neben der Möglichkeit, Polymerisationen zu initiieren, werden Benzophenone aber auch als Photovernetzer (z. B. in der Biomedizin und Biologie) eingesetzt. Hier wirkt Benzophenon nicht als Photoinitiator sondern abstrahiert u. a. aliphatische Protonen (u. a. aus Proteinen) und rekombiniert dann mit den resultierenden Kohlenstoffradikalen im Aliphat. Implementiert man solche Gruppen in Polymere, so kann man diese so hergestellten photoreaktiven Polymere alsVernetzer in Faservliesen einsetzen und eine chemische Vernetzung von Papierfasern durch eine einfache Belichtungsreaktion initiieren. Die Verwendung von photovernetzenden Additiven bringt den Vorteil, dass man die chemische Vernetzung unabhängig von den auf einer Papiermaschine gewählten Prozessparametern insbesondere auch in Gegenwart von Restfeuchten durchführen kann.

Forschungsziel/Forschungsergebnis

Ziel des Forschungsvorhabens ist es, photochemisch reaktive Polymeradditive herzustellen, die als alternative funktionelle Papieradditive (neuartige Nassfestmittel und Streichfarbenvernetzer) eingesetzt werden können. Das Projekt, welches durch das BMWi gefördert wird, ist ein Gemeinschaftsprojekt der TU Darmstadt und der Hochschule München (HM). Die Arbeiten an der Technische Universität Darmstadt umfassen u. a. die Synthese und Charakterisierung verschiedener Polymeradditive, die im Rahmen von Laborversuchen an der TU Darmstadt, aber auch in einem ersten halbtechnischen Maßstab an der Forschungsstelle 2 (HM) auf der VPM eingesetzt wurden. Es wurden verschiedene Faserstoffe, deren Mahlung, Füllstoffe und Additive auf ihren Einfluss auf die Wirksamkeit der neuartigen Nassverfestiger getestet. Es zeigte sich u. a., dass auf gebleichte Zellstoffe ein höherer Einfluss (relative Nassfestigkeit ~ 14 %) ausgeübt werden kann als auf ungebleichte Zellstoffe (relative Nassfestigkeit ca. 11 %). Der Einsatz von Füllstoffen reduziert sowohl die Trocken- als auch die Nassfestigkeit; jedoch zeigt von den untersuchten Füllstoffen nur Titandioxid einen negativen Einfluss auf die Wirksamkeit der neuen photoreaktiven Additive. Bei Letzterem wird sehr wahrscheinlich die Photovernetzung im Blattgefüge gestört, da das Pigment selbst UV Licht absorbiert und damit die Effizienz der Photoreaktion negativ beeinflusst wird. Ein erster Versuch an der VPM zeigte, dass die nassverfestigende Wirkung der Polymere im Papier auch im halbtechnischen Maßstab nachgewiesen werden kann − in Maschinenrichtung wurden 12 % relative Nassfestigkeit gemessen. Man muss aber beachten, dass die Einsatzmengen der Polymere limitiert sind, da diese eine Verschiebung des Zeta-Potenzials in den positiven Bereich und damit eine Verschiebung der Ladungsverhältnisse bewirken können. Zum Einsatz der photoreaktiven Polymere als Vernetzer in Streichfarben werden zur Zeit verschiedene Analyseverfahren angewandt sowie Streichversuche mit anschließenden Druckversuchen an der Forschungsstelle 2 durchgeführt.

Anwendungen/Wirtschaftliche Bedeutung

Von den Forschungsergebnissen können sowohl Papierhersteller und -verarbeiter, Unternehmen der chemischen Industrie als auch Anlagenbauer profitieren. Durch den Einsatz der neuartigen Polymeradditive soll es möglich sein, eine Nassverfestigung unabhängig von den Prozessbedingungen einzustellen. Durch diese Entkoppelung der Einstellung der Nassfestigkeit vom eigentlichen Papierherstellungsprozess wird es z. B. auch kleineren Papierverarbeitern möglich, die Nassfestigkeit der Papiere im Nachgang zur Papiererzeugung gezielt einzustellen. Kleinen und mittelständischen Unternehmen innerhalb der chemischen Industrie (Zulieferer) eröffnet sich die Möglichkeit, ihr Portfolio im Bereich effizienterer Nassfestmittel zu erweitern. Hier können auch kleinere Chargen an taylor-made Produkten zum Einsatz kommen, die von kmU aus dem chemischen Zulieferbereich synthetisiert werden. Für Unternehmen, die z. B. UV-Lampen oder UV-Offsetdruckanlagen produzieren ergeben sich Potenziale zum Absatz ihrer Produkte in einem für sie neuen Industriezweig. Mit dem Einbau der Lichtquellen in die vorhandenen Maschinen (Papiermaschine, Umroller, Rollen- oder Querschneider,…) können auch direkt kleinere Anlagenbauer angesprochen werden.

Bearbeitungszeitraum: 01.11.2013 − 30.04.2016

Bemerkungen

Bundesministerium für Wirtschaft und Energie

Das IGF-Vorhaben 17919 N der Forschungsvereinigung Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V., Adenauerallee 55, 53113 Bonn wurde über die AiF im Rahmen des Programms zur Förderung der Industriellen Gemeinschaftsforschung (IGF) vom Bundesministerium für Wirtschaft und Energie aufgrund eines Beschlusses des Deutschen Bundestages gefördert.

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Research area: Product aims

Raw materials // Chemical additives

Key words:

starch, surface application, arabinoxylan, film press, viscosity

TITLE:
Xylan containing starch formulations for the surface sizing of paper

Background/Problem area

The surface application of starch is a well-established method for increasing paper strength. In surface sizing, a solution of degraded starch is applied to the paper by a size press or film press. The trend towards ever-faster, more powerful paper machines and the pressure to achieve energy savings explain why increasingly size presses have been replaced by film presses. This allows the application of starch solutions with high solid concentrations. However, starch application with high solid concentrations also means a high degradation of the starch solution in order to achieve a workable viscosity to allow penetration into the paper. High starch degradation in turn means a great loss of paper strength.

Joint analysis by TITK and UH showed a significant reduction in viscosity as a result of the addition of a small amount of arabinoxylan containing products to starch solutions without degradation the molar mass.

Objectives/Research results

The objective of the project is utilise materially unused arabinoxylan containing by-products of the starch process to reduce viscosity to enable surface sizing.

The project is being carried out by the research institutes TITK, UH and PTS. The cooperation partners are representatives from the starch industry, food industry, chemical industry, paper and corrugated board industry and mechanical and plant engineering fields.

The aim of the research institutes is to systematically study the interactions between the addition of arabinoxylan to the starch solution and the reducing effect of viscosity and the delayed retrogradation tendency. Based on these results, the best arabinoxylan containing starch formulation will be found, and the jet cooking process for starch degradation will be optimized for surface sizing. The studies have included chemically modified xylan products (mainly cationically modified). It is expected that the use of cationically modified arabinoxylan products by recycling this surface sized papers will cause less starch to be replaced and hence lower chemical oxygen demand (cod) values of the waste water.

Application/Economic benefits

The benefits are:

- utilisation of material residues recovered from the starch process, which so far have only been in limited amounts; market expansion through xylan containing starch products (starch industry, chemical industry, food industry)
- efficient starch surface sizing, reduction of cod by recycling the modified xylan containing sizing papers (paper industry)
- opening-up new avenues of packaging design (corrugated board industry)
- industry access to the xylan extraction process; know-how expansion for quality assessment of starch solutions for the paper industry (mechanical and plant engineering)

Period of time: 01.04.2015 – 31.03.2017

Remarks

The RTD project IGF 18714 BG is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

PRODUKT-ZIELE

Forschungsgebiet
Papier, Karton und Pappe

Graphische Papiere
Verpackungspapiere und -karton
Technische Spezialpapiere

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Research area: Product aims

Paper, paperboard and board //
Graphic and packaging papers

Key words:

paper curl, flatness deviation, fibre orientation, stiffness distribution, z-direction profile, TSO/TSI, sheet splitting

TITLE:
Paper curl and flatness deviation due to stiffness and fibre orientation distributions in paper thickness direction

Background/Problem area

Two sidedness of paper structures is a well-known phenomenon mainly influenced by the sheet forming process. In particular the one-sided dewatering may result in an inhomogeneous structure in paper thickness direction affecting shares of fillers, fines, fibre types, fibre length, formation and fibre orientation within the different fibre network layers. The resulting structure profile leads to different properties of top and down side with regard to surface roughness, fluid penetration behaviour, optical and mechanical properties and especially also to flatness deviations e.g. curl. Quite a number of measures are available to control the two sidedness in the wet end and drying section or during sizing, coating or calendering. Nevertheless problems concerning flatness behaviour occur again and again and are assumed to be significantly influenced by the stiffness and fibre orientation distribution in thickness direction. Unfavourably the measuring devices that are available for paper mills and paper converters are only able to determine an integral value of parameters like stiffness and fibre orientation for the whole paper, thus a detailed analysis of quality profiles in thickness direction is not possible.

Objectives/Research results

The project aims at an improved ability to control the flatness behaviour of paper by means of an optimized stiffness and fibre orientation profile in paper thickness direction. For this purpose a new method involving sheet splitting is to be developed. Sheet splitting using a laminating foil can be easily performed and was already studied in several projects. Therefore the new method can be easily transferred to the paper mill labs later on. By applying an uncomplicated additional procedure the user would be able to determine not only integral values of stiffness and fibre orientation but also the distribution of these parameters in paper thickness direction using a commercial TSO/TSI tester. Based on a set of selected paper grades and samples the correlation of these characteristics to the observed flatness behaviour will be studied and demonstrated intensively also by the use of a finite-element model.

During the project three work packages are to be carried out

- Measuring method development
- Application on systematically selected paper products
- Model based assessment of flatness behaviour

Application/Economic benefits

Paper flatness behaviour and paper curl in particular are important characteristics of the paper product quality. It was confirmed by current literature articles and a survey of the ZELLCHEMING technical sub-committee for online sensor technology that this issue has high significance for manufacturers of graphic and packaging papers but also of some specialty paper grades. Flatness deviations appear when paper is cut into sheets, but also during the subsequent steps of folding, creasing, or die cutting internal stresses may be released and lead to paper curl if maybe fibre orientation and stiffness are not adjusted properly. Processes as printing and copying involve unequal moistening or drying of the top and down side and subsequent dimensional changes. In-depth knowledge on how to adjust two sidedness of paper properly may improve the runnability of paper products in these cases significantly. Thus economic effects are to be expected from better product quality, improved productivity during converting and less production wastage.

Period of time: 01.05.2015 – 30.06.2016

Remarks

The Project INFOR 191 is being funded by Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V. and carried out jointly with the Chair of Paper Technology and Mechanical Process Engineering PMV at TU Darmstadt.

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Research area: Product aims

Paper, paperboard and board // Graphic papers

Key words:

microrobotics, fibre bond strength measurement, fibre bond and network modelling, paper strength improvement, grammage reduction

TITLE:
Enhancement of Fiber and Bond Strength Properties for Creating Added Value in Paper Products (PowerBonds)

Background/Problem area

Significant research efforts have been undertaken in recent years to reduce energy and raw material consumption in paper making while maintaining the constant mechanical and optical properties. In this respect, reducing grammage (the basis weight) of the paper products at a given thickness, in other words decreasing paper density, is a potential area for improvement. A reduction in paper grammage offers means for cutting paper and board manufacturing costs and ensuring production sustainability.

There are many known challenges associated with the grammage reduction. In printing papers, the web stiffness and the strength reduce with a decrease of grammage. Another problem in the grammage reduction is the loss of opacity influencing the visual perception of printed products. To maintain sufficiently high opacity, the amount of pulp fines and mineral fillers need to be increased in the paper furnish. Some of these particles can reduce the number of effective bonds in the sheet and therefore, decrease the strength even further. The largest challenge, however, is that the role of the strength itself in the paper performance in end-use applications is not well understood.

Objectives/Research results

Understanding the importance of strength and taking steps towards reducing the grammage based on this understanding therefore is the primary goal in this project. To achieve the projects aim the project partners combine microscopic characterization tools, novel experimental techniques working at a microscale, simulation tools and advanced pulp-processing technology in order to address the outstanding challenge of understanding the paper strength and its role in paper making. Furthermore a detailed particle level modelling approach is used to capture the very nature of the paper – the stochastic network structure – and to support the materials design by exploring a much greater parameter space than pilot machines can provide. Innovative characterization tools are used to reveal the details of fibres, fibre bonding and the structure of paper. The advanced experimental tools, such as nano and micro-tomography, AFM and ESEM, and micro- and nanorobotic technologies enable the fibre scientists to characterize mechanical and morphological properties of fibres and fibre bonds. In addition to the efforts in developing new models and characterization tools, the project aims to improve the fibre strength and bonding capabilities using novel mechanical and chemical fibre modifications.

Application/Economic benefits

This project aims at *new products* by improving the strength and bonding capabilities of fibres. As the improved strength and bonding capabilities of fibres will allow the reduction of fibrous raw material use and starch consumption, and increase in the filler content while still ensuring an excellent performance of paper products, costs can be reduced.

Furthermore, an increase in paper strength has a huge influence on the productivity as well as on the profitability of paper mills. One paper break in a paper machine causes 20 – 60 minutes downtime and costs from 6.000 € and above. It is not unusual to see some paper machines suffering from 6 – 9 breaks a day. Thus, a reduction of web breaks increases the output of a production line, reduces the consumption of raw material and energy and improves the paper quality due to a lower variability. Due to large production volumes, saving of only 10 € per ton by resolving the runnability issue for high-end graphics paper translates into 4 millions € profit for a medium size paper machine having a 400.000 ton annual capacity. In a pressroom, on the other hand, the cost of a single break sums up to a lower value (about 1.500 €) but yet the accumulated cost of all the breaks is still immensely high.

Increasing the bonding strength in fibre-based materials will also help to overcome intrinsic mechanical weaknesses in comparison to other, less sustainable, materials. This approach has to be performed by ensuring in parallel the printability and the optical properties of papers. Paper and board have an overall lighter footprint on the environment, better consumer perception, and are on the long term more sustainable, being based on renewable resources, while competing materials are fossil-based.

Period of time: 01.02.2012 – 31.01.2015

Remarks

The research project PowerBonds (WoodWisdom-Net, 3rd Joint Call – 2010) is being funded by the European Commission and coordinated by Tampere University of Technology (TUT, Finland) in cooperation with leading European research institutes for paper technology and microrobotics (Abo Akademi University, Finland; Graz University of Technology, Austria; Grenoble INP-LPG2, France; OFFIS Institute for Information Technology, Germany; PTS, Germany; Royal Institute of Technology, Sweden; VTT Technical Research Centre of Finland) and 8 industrial partners: INNOWEP GmbH, Germany; Munksjö Arches SAS, France; Papeteries Emin Leydier, France; Sappi Finland Oy; Stora Enso Deutschland GmbH; Stora Enso AB, Sweden; UPM-Kymmene, Finland; De Nederlandsche Bank (DNB), the Netherlands.

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Research area: Product aims

Paper, paperboard and board // Graphic papers

Key words:

inkjet printing, drying, modelling

TITLE:
Developing a simulation tool to characterize the drying behaviour of papers in high-speed inkjet presses

Background/Problem area

The importance of inkjet printing has grown steadily in recent years, which is owed not only to the high flexibility offered by digital printing, but also to technical improvements enabling higher machine speeds and print heads covering the full web width. Inkjet printing is therefore an increasingly attractive option also for areas previously reserved for flexographic or offset methods. Modern high-speed inkjet presses can be expected to produce several hundred pages of high-quality prints per minute on a multitude of substrates. Compared to conventional methods, the liquid volumes that must be absorbed by the paper and dried off ahead of the first idler roller to prevent ink set-off on machine components are much greater here. Drying is therefore already used in high-speed inkjet presses today, and will become ever more important the higher the printing speeds. A deeper understanding of the mechanisms involved in this process would help improve the design and print quality of high-speed inkjet presses – in terms of both economic results (energy and process efficiency) and product quality. For this purpose, the thermal properties of papers, coat layers, the various ink layers applied during printing as well as their resulting layer structures must be known.

Objectives/Research results

Aim of the project is to model the drying behaviour of papers and coat layers during printing. As a prerequisite, the thermal properties of papers and coatings must be understood and represented in models. Next step is the characterisation of drying properties, i.e. temperature and moisture distributions in the paper, during drying in the press. The envisaged final result is models forecasting theoretical optimisation options for the drying behaviour of papers and paper coatings in the press.

Application/Economic benefits

The heat transfer through paper plays an important part in both the production and many applications of coated papers, for example finishing or printing. In printing, the paper is heated to remove the moisture introduced by the process, i.e. a significant share of the absolute energy consumption for printing is spent on drying. Estimates suggest, however, that only around 2 % of the drying energy is actually used for solvent evaporation, most of it is lost by heating the paper and various coat layers. Due to its high energy costs, drying offers vast potential for optimisation in terms of energy efficiency. The economic benefits of the project therefore result from two effects: energy savings due to higher energy and drying efficiency achieved by optimised paper characteristics and drying parameters, and improved product quality and productivity/runnability during printing due to fewer web breaks and paper jams. Moreover, papers with optimised drying properties will open up new market opportunities for paper producers in this highly competitive segment.

Project period: 01.01.2014 – 31.12.2015

Remarks

The RTD project IK VF 130037 is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Research area: Product aims

Paper, paperboard and board // Graphic papers

Key words:

inkjet printing

TITLE:
Assessing the suitability of papers for high speed inkjet printing

Background/Problem area

The influences on print results in High Speed Inkjet printing (HSI printing) (paper, ink, typographical parameters et al.) are highly complex, and so is their metrological and visual assessment. This complexity is the reason why it has not been possible to date to reliably predict HSI print results based on paper characteristics, ink data and typographical parameters.

To solve this issue, paper producers and printers as well as their suppliers are pursuing different paths: One is the more detailed and typographically relevant characterisation of printing papers; another the simulation of industrial print processes on laboratory scale. Both options have not yet been exhausted. Focus of this project is the typographical simulation of HSI printing on lab scale and the complex analysis and evaluation of print results.

Objectives/Research results

Aim of the research project is the development of a method to determine the suitability of different papers for HSI printing as well as the corresponding classification of commercial inkjet papers.

A laboratory printing station was assembled featuring two industrial print heads (OCE/KYOCERA) in the first stage of development and enabling printing speeds of up to 100 m/min as well as ink configurations (K, C) up to 200 %. Four printing plates were developed to evaluate the print result in terms of

- print density and chromaticity coordinates
- ink penetration (wipe test)
- mottling/ print unevenness
- streakiness
- share of missing dots or light areas
- wicking and bleeding characteristics.

The methods have already been used to assess the print quality of 21 papers from the quality groups uncoated papers with and without inkjet optimisation, pigmented inkjet papers and coated inkjet papers. The printing station will be equipped with two additional print heads and optimised to enable four-color printing tests. The development of additional printing plates and evaluation methods is under way.

Application/Economic benefits

The HSI printing test station and evaluation method developed in the project will benefit paper producers, printing press and ink manufacturers, additive producers, printers and instrument manufacturers. The envisaged technical and economic benefits will mainly result from:

- reduced development efforts of paper manufacturers
- easier and more reproducible paper evaluations to determine the suitability for inkjet printing
- fast and systematic improvements of printability properties
- cost and time savings for end users.

Project period: 01.07.2014 – 30.06.2016

Remarks

The RTD project IK MF 130147 is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Research area: Product aims

Paper, paperboard and board // Graphic papers

Key words:

inkjet printing

TITLE:
Developing a method to assess the printability of papers in water-based inkjet printing

Background/Problem area

The widespread use of trial-and-error methods to design coated and uncoated surfaces or select suitable substrates leads to high costs and prolonged developments. The printability of substrates can only be assessed with absolute certainty by costly and time-consuming test prints made on pilot or even industrial presses. In spite of the steadily growing importance of inkjet printing, there are still no technically mature measurement techniques to assess the penetration behaviour. Indirect methods are inaccurate and can only provide averages of more or less extensive areas. Near-practical counter prints and single-drop analyses by means of a high-speed camera are the most sophisticated and informative methods available today. A fast, inexpensive and easy-to-use forecasting method to assess the principal suitability and resulting print quality of substrates in inkjet printing is still lacking.

Near-practical counter prints provide qualitative information about specific printing issues (e.g. Datamatrix codes on cartonboard), but their results could not be generalized so far. Penetration measurements by means of a high-speed camera characterize the penetration behaviour with adequate reliability because they determine the penetration speed of single drops. However, it is still difficult to draw conclusions about the print quality actually achievable because the latter also depends on the distribution and fixation of printing inks in the coat layer or paper structure. This deficit may be overcome when the method is developed further to analyse the penetration of multiple ink drops and drop sequences. Combined with powerful existing measurements, the new method could make it possible to reliably assess the suitability of papers for inkjet printing.

Objectives/Research results

Aim of the project is to develop a fast, reliable and objective method to evaluate the suitability of papers for inkjet printing. An evaluation method that considers the results of specific measurements (high-speed camera, Datamatrix tester), test prints and, if possible, model calculations will enable fast paper classifications in terms of inkjet printability. A camera test bench will be developed further to use its results for the improvement and optimisation of existing base models for penetration characteristics. The project contributes to a strategic goal of long-term PTS research: developing modular simulation tools to improve the printability of paper. The modelling methods and tools required for this will be developed step by step in the form of modules. They must be complemented by measurement techniques capable of providing the data and data quality needed for modelling. The measurement technology developed in research project IK-VF 100010 and penetration models obtained in various earlier projects will be improved here.

Application/Economic benefits

The results will be of interest to the entire value chain of the packages and coated graphic papers investigated in the project, including:

- paper and board producers (cartonboard; corrugating stock; coated graphic papers)
- converters (printers)
- machine builders (printing press manufacturers)

The results are expected to bring the following main technical and economic benefits:

- reduced development effort of paper producers (more efficient laboratory tests and pilot trials)
- fewer costly and time-consuming pilot-and full-scale printing trials
- faster and target-oriented improvement of printability characteristics through systematic raw material selection and optimisation
- cost and time savings for printers due to the use of substrates with optimised printability characteristics (fewer misprints)
- cost and time savings for printers due to higher flexibility in connection with hybrid printing papers.

Project period: 01.09.2013 – 31.08.2015

Remarks

The RTD project IK MF 130044 is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Forschungsgebiet: Produkt-Ziele

Papier, Karton und Pappe // Graphische Papiere

Schlagworte:

Ressourceneffizienz, Altpapier, Papierkette, Prozess-simulation, Lebenszyklusanalyse, Nebenprodukte, Multi-Produktfabrik

Topic:
Tools for Monitoring and Assessing Resource-Efficiency in the Value Chain of Process Industries (REFFIBRE)

Background/Problem Area:

Paper and board are unique products being both the end products as well as the main raw materials for the next cycle; thereby creating a circular economy. In order to ensure long term profitability, the industry needs to focus on resource efficiency and creating innovative products and additional value out of the streams discarded from the main production line due to resource efficiency reasons.

Currently, the impact of product or process development in the paper mill can to some extent be determined for energy or material efficiency within the mill itself. However, the current tools are not able to incorporate impacts of novel innovations that make the total value chain (or circle) more resource efficient. The impact on e. g. the energy use outside of the paper mill or reduced quality in recycling needs to be considered and optimized.

Objectives/Research Results:

The main aim of this project is to develop tools and knowledge needed for the eco-design of resource efficient paper and packaging material production chains. Industrial applications investigated in this project are based on paper for recycling and waste fractions from the processing. In addition to paper as the main outcome of paper industry processes also so called "by-products" are in focus of the project. The main scientific and technical objectives of the project are:

- Development of methodologies and models for environmental and economic assessments (life cycle assessment and techno-economic analysis of the value chains).
- Development of methodologies and tools for eco-designed paper production (paper production design models).
- Development of process modelling tools and innovative analytical tools to control production in multi-product mill concept (physical process models, analytical tools and novel by-products).
- Integrate and validate tools to the practical guide for decision makers and control systems for multi-production units (multi-product mill concept cases). The validation will be based on several demonstrators carried out by three industrial partners taking part in the project.

Application/Economic Benefits:

These results will contribute to the European objective for reducing greenhouse gas emissions by 80 % until 2050 compared to the level of 1990. The results of this project will help to create conditions that will enable complete value chains of paper and board industry, converting industry and end users, to

- decrease their overall waste production and improve resource efficiency,
- increase competitiveness and
- approve with a standardised way that the final impact on the environment is reduced.

Project Period: 01.11.2013 – 31.10.2016

Remarks

The research project REFFIBRE is being funded by the European Commission (Seventh Framework Programme) and co-ordinated by VTT Technical Research Centre of Finland in cooperation with 4 European research institutes for paper technology (Technische Universität Darmstadt, Germany; Papiertechnische Stiftung, Germany; Instituto Tecnologico del Embalaje,Transporte y Logistica (ITENE), Spain; Bumaga BV, The Netherlands), the Confederation of European Paper Industries (CEPI) and 4 industrial partners (S.C. Vrancart S.A. Adjud, Romania; Alucha SL, Spain; Papierfabrik Utzenstorf AG, Switzerland; Holmen AB, Sweden).

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Forschungsgebiet: Produkt-Ziele

Papier, Karton und Pappe // Verpackungspapiere und -karton

Schlagworte:

Planlage, z-Richtung, Biegesteifigkeit, Elastizitätsmodul, Faserorientierung

Topic:
Flatness and Curling due to Stiffness Distribution in z-Direction

Background/Problem Area:

Two-sideness is a well known problem in paper manufacturing resulting from dewatering unevenness in the wet section and different drying conditions of top und wire side in the drying section. This may result in curling problems. Some reasons of curling are known, and there are possibilities to react. However, an unevenness of the stiffness properties in thickness direction of the formed web may be assumed but hasn't been evaluated yet.

Objective/Research Result:

The new approach is to use sheet splitting by polymer foils and to examine the obtained layers in order to get information about the distribution of fibre orientation in z-direction. The layers may also be examined according to the stiffness distribution.

During developing this new measuring method single ply as well as multiple ply papers shall be analyzed. As multiple ply papers are manufactured with separate headboxes, parameters during web forming can be monitored to support or to neglect the results obtained after sheet splitting. To be successful in this objective the influence of the polymer foil must be eliminated.

Any results have to be compared with papers of high and low flatness. Doing this hopefully leads to more understanding of curl results and more possibilities for prevention.

Finally the results shall be used to predict curl behaviour with mathematical modelling.

Application/Economic Benefits:

Box board and corrugated board use paper grades that often have to deal with curling problems. But office paper or printing papers (especially sheeted paper) are faced with this phenomenon too. Knowing more about curling reasons and getting more instruments to act against it help to optimize the papermachine output. The results of this project shall help the manufacturer to avoid broke and complaints.

Project Period: 01.05.2015 – 30.04.2016

Remarks:

The research project INFOR 191 is being funded by Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V. and Vereinigung Pack- und Wellpappenpapiere (VPWP) and performed in cooperation between PTS and PMV.

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Forschungsgebiet: Produkt-Ziele

Papier, Karton, Pappe // Verpackungspapiere und -karton

Schlagworte:

Zellulose, Nachwachsende Rohstoffe, Verpackungen

Thema:
Funktionelle Schichten aus streichfähiger Zellulose

Ausgangssituation/Problemstellung

Moderne Verpackungskonzepte müssen nicht nur umweltverträglich, biologisch abbaubar oder rezyklierbar sondern auch möglichst flexibel sein und große Freiräume hinsichtlich der Individualisierung des Packmittels aufweisen. Außerdem sollen moderne Packstoffe auch oft hohe Anforderungen an Festigkeits- und Umformeigenschaften erfüllen. Kunststoffverpackungen haben dabei gegenüber Verpackungskonzepten aus zellulosebasierten Materialen oft den Vorteil der Dichtheit gegenüber Flüssigkeiten, Gasen, Fetten und Mineralölen. Diese Tatsache erschwert gegenwärtig die Verbreitung zellulosebasierter Verpackungen im Lebensmittelbereich. Um konkurrenzfähige Verpackungskonzepte aus Zellulose einzusetzen, müssen diese zwingend mit Barriereeigenschaften ausgerüstet werden und auch modernen Anforderungen in Bezug auf Design und Produktpräsentation genügen.

Forschungsziel/Forschungsergebnis

Das Ziel des Projekts ist die Entwicklung von streichfähigen, transparenten Additiven für die Herstellung von Verpackungsmaterialien mit Barriereeigenschaften gegenüber Mineralölen, Fetten, Flüssigkeiten und Gasen aus nachwachsenden, zellulosebasierten Rohstoffen. Als Applikationsstrategie soll das Streichen von nano- bzw. mikroskaligen Zellulosesuspensionen vorzugsweise ohne Zusatz von Chemikalien bzw. chemischen Additiven entwickelt werden. Durch Modifikation bzw. eine spezielle Behandlung der Zellulose müssen die Streichfähigkeit und anschließende plastische Verformbarkeit erreicht werden. Das soll durch extreme Mahlung (Fibrillierung) und ggf. durch Zugabe von geeigneten biologischen Hilfsstoffen (z. B. Stärke) geschehen. Möglicherweise ist dazu eine chemische oder enzymatische Modifikation der Fasern zur Verbesserung der Applikation oder Barrierewirkung notwendig.

Anwendungen/Wirtschaftliche Bedeutung

Vor dem Hintergrund der aktuellen umweltpolitischen Zielsetzungen können im Falle der erwarteten positiven Projektergebnisse erhebliche Impulse für die Verbesserung der Marktposition und der Einsatzmöglichkeiten zellulosebasierter Verpackungskonzepte generiert werden. Fortschritte auf diesem Gebiet sind das erklärte Ziel der Papierindustrie und Gegenstand in jüngerer Zeit intensiv forcierter Forschungsaktivitäten. Durch die Ausrüstung mit Barriereeigenschaften werden für zellulosebasierte, nachwachsende Faserstoffe neuartige Einsatzbereiche erschlossen und damit ein Beitrag zur Ressourcenschonung und zur Kreislaufwirtschaft, d. h. der stofflichen Verwertung von Biomasse geleistet.

Bearbeitungszeitraum: 01.04.2014 – 31.03.2016

Bemerkungen

Das ZIM-Projekt KF 2418623WZ3 wird über die AiF Projekt GmbH vom Bundesministerium für Wirtschaft und Energie (BMWi) aufgrund eines Beschlusses des Deutschen Bundestages gefördert. Das Projekt wird in Kooperation mit der Papierfabrik Schoellershammer Heinr. Aug. Schoeller Söhne GmbH & Co. KG bearbeitet.

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Research area: product aims

Paper, paperboard and board //
Packaging papers and paperboard

Key words:

release, non-sticky, emptying

Title:
Microfolding of paper surfaces coated with VUV/UV-curable materials to obtain specific surface properties

Background/Problem area

There are various reasons why residues of the packed good should not or only minimally adhere to the emptied package:

- They can be contaminants leading to problems in disposal and recycling operations.
- They can necessitate additional cleaning or special treatment steps ahead of recycling leading to higher costs and resource consumption.
- The possibility of complete emptying makes packed products more attractive to customers (good value for money).

Aim is to develop paper or paper composite-based packaging materials with novel surface properties minimizing the adherence of packed goods. The project work is carried out jointly by PTS and the company IOT GmbH.

Objectives/Research results

The goal of complete emptying is to be achieved by the microfolding of package surfaces. The company IOT GmbH will develop excimer formulations for folding; PTS will develop the pre-coat and adjust the technology. Both VUV and UV techniques will be used. The following results have already been achieved by the project partners:

- Design and installation of a test system for the microfolding of paper surfaces
- Microfolding pre-tests of various varnishes on different primer layers (pure binder – feasibility) under varying conditions
- Reduction of variables for microfolding as first technological technology adjustment
- Development of a measurement and evaluation procedure for microfolds, adjustment of the method and definition of parameters describing the folding result.

Application/Economic benefits

Aim of the joint project is to develop packaging materials based on paper/paper composites that can be treated by excimer technology to obtain micro-structured surface finishes minimizing the adherence of viscous or pasty packed goods. The envisaged materials offer the following economic advantages to manufacturers, filling companies and consumers:

- Greater variety of package designs due to better adjustment of package sizes to packed goods,
- Reduced filling quantities through more complete emptying of packages,
- Better value for money because consumers can get more product from the package,
- No expensive special recycling channels necessary – packages can be recycled by conventional methods,
- Lower resource consumption and cost of cleaning, disposal and recycling processes for used packages,
- Reduced environmental pollution by residues of the packed goods.

Project period: 01.11.2014 – 31.10.2016

Remarks

The RTD project ZIM-KF 203 792 0SL4 is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi) and is carried out in collaboration with IOT GmbH, Leipzig.

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Research area: Product aims

Paper, paperboard and board //
Packaging papers and paperboard

Key words:

mechanical properties, material parameters, experimental mechanics, load-bearing capacity, numerical simulation, computational mechanics, constitutive law, flow rule

TITLE:
Material parameters for the efficient evaluation of the mechanical properties of multilayer materials and the subsequent design of adapted products

Background/Problem area

In the context of lightweight construction, semi-finished products, especially resource-efficient and recyclable multilayer materials, continue to grow in importance. In order to achieve specific properties, thin layers with low stiffness are often integrated into the lamination. The various materials resulting from paper technological production can often meet many requirements for chemical resistance, stiffness, strength and creep strength in a laminate or sandwich, but must be able to be characterized adequately, especially in mechanical terms, so that they can be included in the design process. There is a lack of measuring procedures, however, designed to determine the required material parameters in constitutive laws as part of a continuum mechanical approach. Here a particular challenge is to overcome stability problems of the thin sample material associated with its relatively low stiffness and, at the same time, to resolve the problems associated with thermal and hygroscopic properties and inhomogeneity. The measuring procedures that exist in the paper sector are only suitable for comparison amongst themselves in trade.

Objectives/Research results

Based on the example of paperboard in the sense of a semi-finished product, measurement techniques affiliated with calculation rules were developed for the optimal design of paper-composite cross sections that are generally usable and available as design tools in the development of adapted or new products from multilayer composites; for example, to determine the out-of-plane shear behaviour a shear test equipment for use in universal testing machine was constructed and buildt.

For this general purpose, tension, compression, shear and strike-off tests has been made, as well as optical deformation analyses with regard to local mechanical stresses and cross direction strain. For instance, an indirect measure procedure to determine the elastic in-plane shear modulus was successfully developed on the base of common tension tests and a computational mechanical theory.

Moreover, in particular the existing in-house laboratory standard measuring procedures for paper, which in some cases operate with fairly complex mechanical stress states, have been identified as a suitable complement to basic experiments in answering questions of workability with the help of reconstruction methods using mechanical modeling in reverse engineering. In order to provide a compact but adequate basis for numerical simulations, the approach is based on identifying important parameters in adapted simplified constitutive laws for paper in a methodical material modeling framework. Fundamental statements about the suitability of starting materials, concerning the properties of the individual layers, are made in creasing folding boxboard, as a complex processing operation.

The differentiation of tension and compression flow rules, which is important for constitutive laws for natural fiber materials without any matrix, was implemented together with a modified associated yield surface with tension/compression-dependent linear isotropic hardening for the explicit solution method with a rapid rear-projection process, at the accessible interface of the LS-Dyna finite element software as the user defined material in the FORTRAN programming source code.

Application/Economic benefits

The requirements related to the design and construction of lightweight structures are currently – and to an even greater extent will be in future – the key driver to the development of high technologies along the entire chain of production processes of flat materials. Especially in the paper sector, the link between the production of a new fiber material and its use in innovative products often fails since the semi-finished products that emerge from paper manufacturing technology are still too infrequently understood as engineering materials. The building and construction industry as well as the mechanical engineering sector need materials which can be produced over a large area in a short time.

A significant improvement for the marketability of paper-like materials can be achieved by adapting the characterization in terms of their mechanical, chemical and other properties to the requirements for structural design in context with the verification of load-bearing capacity, long-term durability and verification of suitability and serviceability. The necessary parameters that are measured on the finished paper itself should be taken into account in a selective production process and can also be used to assess converting processes.

Period of time: 01.08.2012 – 31.03.2015

Remarks

The RTD project IK-VF 120017 being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Research area: Product aims

Paper, paperboard and board //
Packaging papers and paperboard

Key words:

hydrogel, paper coating, self-climatizing packaging, humidity adjustment

TITLE:
Self-climatizing Packaging based on Paper Coating containing Hydrogels

Background/Problem area

Besides being decoration, packaging mainly serves to protect products. To achieve this, several concepts such as water or oxygen barrier systems to avoid deterioration of commodities are pursued. In addition, some products have to be stored at especially adjustable humidity in order to preserve their optimal practical value. Actual demands of the market prove clear needs to adjust the air moisture in packaging and to be able to maintain it constant regardless of external conditions like temperature or humidity fluctuations. Today, autonomously working systems which meet these requirements are not known yet, which opens a need for research having a wide spectrum of application possibilities. Hydrogels are able to absorb and release water due to their hydrophilic polymer network structure. Once being made an active paper coating component, hydrogels offer the theoretical possibility of adjusting the humidity in packaging. Hydrogels can absorb liquids up to a hundred times their own weight, which makes them an indispensable auxiliary material for sanitary products with the further ability not to release the absorbed liquids under pressure.

Objectives/Research results

The aim of this project is to develop packaging material which offers the possibility of binding water in such a way that it will be released/absorbed at low/high internal moisture, thus providing a humidity self-regulating packaging.

In this project folding boxboard will be modified by a coating which contains hydrogels as active components. Besides the development of the coating formulations, the project comprises measurements of thermodynamic parameters of hydrogels concerning the absorption and the release of water (e.g. swelling degree, sorption kinetics). Hydrogels with and without a lower critical solution temperature (LCST) have been studied. Hydrogels with LCST (under which a phase transition and release of the expanding agent takes place) are thermosensitive.

Important results achieved until now as a function of temperature and relative humidity are:

- Study of swelling behaviour of different commercial hydrogels without LCST in water and air,
- Determination of the swelling degree in water and air,
- Study of the swelling and de-swelling behaviour in varying climatic conditions,
- Influence of hydrogel particle size on swelling degree,
- Reproducibility tests and swelling kinetics,
- Development of hydrogel containing coatings on folding boxboard samples with and without additional hygroscopic components,
- Evaluation of the coating (surface) properties,
- Proof of concept of reversible water vapour sorption under different climatic conditions,
- Quantitative evaluation regarding the water sorption capacity of different hydrogel coatings and comparison of sorption kinetics,
- Application-specific tests of the functionalized paper board samples concerning their processing properties.

Application/Economic benefits

As a result of this research project specifications will be formulated for improved package surfaces enabling humidity self-regulating properties. These changes should lead to new possibilities in packaging as well as to more versatile and innovative applications of packaging.

Until now it has not been possible to regulate selectively the moisture content inside the packaging which leads to the assumption that this project will arouse great market interest.

The project results can be expected to benefit mainly small and medium sized enterprises in the packaging industry.

Period of time: 01.09.2013 – 31.08.2015

Remarks

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Research area: Product aims

Paper, paperboard and board //
Packaging papers and paperboard

Key words:

migration, phthalates, food contact materials made of paper and board, legal requirements

TITLE:
Reduction of the migration of phthalates from packaging materials made of recycled board into food

Background/Problem area

Phthalates are critical substances, which are ubiquist present in the environment and daily life products. Many of them are known to cause serious health effects on humans. Therefore many regulations and restrictions are defined in chemical, environment and food law. It is supposed to get even more phthalates restrictions in the near future.

Migration from paper and board food contact materials made of recycled paper is a concern for food safety. To respect legal requirements such as good manufacturing practise, paper and board manufacturers and producers have to know their relevant contaminant sources and actions to reduce migration which could endanger human health or bring about an unacceptable change in the composition of the food. Beside mineral oil phthalates are one of the most abundant contamination known to migrate from recycled paper and board into packed food. Sources for certain phthalates may be raw materials, chemical additives, production aids, printing inks, varnishes or adhesives.

Options to reduce the migration of phthalates are firstly careful selection of raw materials by using only unprinted, non-glued and/or virgin fibres. Secondly a reduction within the processing of paper and board may be an option. By heating or washing steps the content of volatile phthalates could be reduced to a certain extent. The third option is the use of functional barriers on the board or additional inner packaging, which is not attractive due to high costs and additional machinery.

Objectives/Research results

The objective of this project is the reduction of phthalate migration from packaging materials made of recycled board into food based on identification of all sources and quantification of phthalate input streams as well as of the phthalate migration. After successful implementation of the analytics of phthalates for many different matrices (paper and board, water, additives) in order to identify additional origins of phthalates beside already known sources such as dispersion adhesives and such as impurities of additives and production aids first paper and board samples were taken in a paper mill and in a paper converting company. For the amount of additives, printing inks and adhesives and processing aids a screening method using GC-MS was developed to determine the impact of these excipients to the packaging material. In these samples DIBP, DBP, DEHP and BBP were detected. Especially BBP was found in almost every printing ink at low concentration levels between 10 and 20 µg/kg sample. Plastic containers of sampled additives were examined by ATR-IR and the results showed that they are a nonrelevant source for phthalate contamination. Apart from already known migrating phthalates (Diisobutylphthalate, Dibutylphthalate, Di(ethyl-hexyl)phthalate) the content of futher phthalates and their abundance in raw materials and production aids were checked. Therefore the whole production chain and material throughput starting from raw materials, water circulation, chemical additives and production aids up to the final paper and board products were sampled and analysed by GC-MS. Phthalates are identified in almost every sample, but a wide range of concentration levels was observed. The analysis of phthalates in packaging materials from recycled fibres sold on the German market showed that DIBP, DBP, DEHP and BBP are the most abundant phthalate compounds. Other phthalates like DOP or the high molecular DINP and DPHP were found in several paper and board samples. DEHP levels varied between 2 and 12 mg/kg, BBP between not detected and 0,5 mg/kg board. The most significant differences were observed for DIBP and DBP. Especially DIBP varied between 1 and 30 mg/kg board. The migration potential of high and low contaminated paper and board products for food contact was tested with food simulants Tenax® and Ethanol (50 % (v/v)). Especially DIBP, as a volatile and low molecular substance, again demonstrated to be a criticalmigrant for food packaged in paper and board of recycled fibres. Itcould exceed the special migration limit of 0,3 mg/kg food for DIBP resp. sum of DBP+DiBP). After identifying the relevant migrating phthalates the possibility of reducing their content within the production process (waste water, deinking, heating…) and a mass balance within the value chain could be estimated. The main sources as well as possibilities for action will be reported.

Application/Economic benefits

This study aims to deliver a overview on the phthalate occurrence in material streams of paper mills and paper manufacturers with the intention of reducing the phthalates within the paper making process. This investment yields food contact materials with low phthalate content. Knowing the phthalate sources and possibilities of reduction yields paper and board products with low phthalate contents, which respect to nowadays and future legislative requirements . These products of high quality are supposed to be effective in advertising and thus provide an economic advantage on the P&B market.

Period of time: 01.01.2014 – 31.12.2015

Remarks

The RTD project IK MF130082 is being funded by German Federal Ministry for Economic Affairs and Energy BMWi.

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Research area: Product aims

Paper, paperboard and board //
Packaging papers and paperboard

Key words:

coating, barrier properties, mineral oil, phthalates, Benzophenone, pigments, tortuosity

TITLE:
Improving the action of barrier coatings for undesirable substances by the effective use of inorganic pigments and suitable binders

Background/Problem area

Secondary fibre paper and paperboard for food packaging contain traces of undesirable substances that are introduced primarily via the printing inks, varnishes, adhesives, chemical additives or the like. Some of these undesirable substances can migrated directly or indirectly into the foodstuffs via the gas phase. As the mineral oil contents that have been the subject of year-long intensive discussions indicate, quantities that are viewed critically by authorities and the general public can be reached very quickly.

Irrespective of legal regulations, the German paper industry has a great interest in reducing health risks to consumers. Paper for recycling, however, is an essential raw material for the production of food packaging paper and board. Of the approx. 9 million tonnes of packaging made from paper, paperboard and board, approx. 2.3 million tonnes of food packaging are made based on paper for recycling in Germany. It would be fatal both economically and ecologically in particular for smaller papermaking and paper converting plants if this source of raw materials could no longer be used for food packaging.

Objectives/Research results

The project objective is to prevent the migration of undesirable substances via the gas phase by means of efficient, pigment-containing coatings, and in this way contribute to protecting the paper for recycling loop. The substances that migrate via the gas phase include mineral oil, a currently closely followed issue, as well as phthalate plasticisers and benzophenone. These substances are the focus of this project. Up to now, pigment-containing coatings have been studied as to their capability to reduce mineral oil migration is isolated cases only. Relevant possibilities for reducing phthalate and benzophenone migration, however, have not been investigated at all.

The following hypotheses are to be examined within the framework of the project objectives and work schedule:

Hypothesis 1: By carefully matching the type, the property and the quantity of the pigment as well as the polarity and the free volume of the polymeric coating agent, the tortuosity effect can be utilised to selectively improve the barrier effect of pigment-containing coatings for the three substance classes mentioned above. This will make a concept for efficient and cost-effective barrier coatings possible.

Hypothesis 2: The concept for realising cost-effective formulations can be further developed in such a way that it will meet the high demands in practice, including adequate long-term effect of the barrier properties, food law suitability, no disruption of recyclability as well as practice-oriented applicability and processing capabilities.

Within the scope of the project, improved testing procedures will be developed that will allow the barrier effect of coatings to be evaluated over longer periods of time.

The project began with the characterisation and provision of the starting materials (polymeric barrier agents, pigments and substrates). At the same time, the basic components for the analytical work were provided, and a testing procedure was developed to evaluate the barrier effect of coatings on paper. This work was then followed by studies on the effects of the individual starting materials, alone and in combination with one another.

Application/Economic benefits

The use of pigments in barrier coatings is intended to save polymeric coating agents, thus cutting costs. Assuming the polymeric coating agent costs 4 €/kg (dry) and 20 % of it is replaced by a pigment (approx. 0.4 €/kg) in the coating, the result will be a cost savings of 18 % in the starting materials due to the volume effect alone. If the thickness of the coating can then be reduced by one-third due to the tortuosity effect, this would add up to a cost savings of approx. 50 %. Against the background of growing statutory regulations that also include the application of barrier coatings, a competitive edge will be achieved in future for the sectors affected.

Period of time: 01.04.2015 – 31.03.2017

Remarks

The RTD project IGF 18656 is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi) and is being conducted by PTS-PTI, Munich, and PTS-IZP, Heidenau.

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Research area: Product aims

Paper, paperboard and board/
Packaging papers and paperboard

Key words:

food packaging, permselectivity to oxygen and carbon dioxide, bio-polymer coating, plastic material

TITLE:
Food packaging materials with oxygen/carbon dioxide selective permeability

Background/Problem area

The European Union is the fifth largest fruit and vegetable producer, with about 8.3 % of the global production, but also the leading fruit and vegetable importer. Further, the market of „freshcut" products (freshly cut fruits and vegetables) and fresh, individually portioned cheese is strongly growing, but an effective packaging solution for this type of food is not available. Nowadays, micro- and nano-perforated plastic films are used for food packaging. They do not allow packaging under modified atmosphere, which is necessary to prolong the shelf-life of the product. Also materials with high barrier properties are used as packaging material. The respiration of the fruit, vegetable or cheese is not considered and the MAP in the high barrier materials is modified by the respiratory activity of the produce, with a risk of anoxia of the foodstuff after a while. Neither of these materials is optimised for produces that need to breathe, such as vegetables, fruits, and certain kinds of cheese.

Objective/Research results

This project aims to develop a packaging material with oxygen/carbon dioxide selective permeability for the packaging of fresh produce. The project will target produce such as fresh cut fruits mix and vegetables mix, and "camembert type" cheeses, and aim to improve the shelf-life of these breathing produce by regulating the gas exchanges and therefore the oxygen and carbon dioxide permeabilities of the packaging materials.

The materials used in the project will be biobased and/or recyclable, in order to develop sustainable packaging solutions: on the one hand, paper coated with a permselective film; on the other, materials made entirely of polymers (multilayer and compounds).

The project will be roughly divided into three phases. In the first step different materials will be screened according to their permeability to oxygen and carbon dioxide. The materials will be modified by adding different additives (e.g. cyclodextrines, bentonite, zeolithes and silica). In parallel, a numerical model to calculate the optimal atmosphere of the packed pruducts will be developed and this model will be verified and optimised by two case studies. In phase two, two packages, one coated cartonboard based and one plastic based package will be produced according to the material study and the computer simulations. With the help of shelf life tests and permeation measurements the model will be verified. In a profitability study the price of the best package including production cost will be compared with actual package solutions on the market.

To the present day we have been very successful in setting up a mathematical model, which describes the gas permeation through the package, the respiration of the product and the change of the headspace atmosphere with the help of mathematical equations. We were able to gain knowledge on metabolism parameter and respiration data of fresh, convenience and sensitive food products and to implement these data in the model.

We have acquired extensive knowledge on formulation of aqueous biopolymer dispersions for cardboard coating and on the influence of pigments on permeation behaviour of oxygen and carbon dioxide in such biopolymer coatings. We have gathered valuable experience in the preparation of binary blends, the tuning of the blend permeability for oxygen and carbon dioxide due to blend composition and in the preparation of multilayer plastic films. The permeability of oxygen and carbon dioxide through the biopolymer coatings could not be measured on cardboard, but on BOPP foil. The permeation values for oxygen and carbon dioxide in biopolymer-additive coatings on BOPP foil are very promising, but have to be further improved. The bilayer coating shows a too low permeability for oxygen and carbon dioxide. At the current state we try to increase the permeability of these coatings further with plasticizing agents and work on suitable precaotings that also the oxygen and carbon dioxide permeability of these coatings is measureable using cardboard as substrate. In the case of plastic blends we are on a good way to get a material with a relative high permeability for oxygen and carbon dioxide and suitable permselectivity for such an EMAP packaging. Furthermore, we were able to modify zeolites, but we have to improve further the properties of the zeolites.

Application/Economic benefits

The development of concepts for packaging with selective permeable materials will target several market sectors. It is very important for paper coating and plastic (synthetic and biopolymers) industry, but also for the packaging supplier and food retailers. The project obviously aims at targeting the needs of all the concerned market sectors, i.e. the entire food and packaging value chain. Once the concepts for new packaging materials have been developed, paper and plastic packaging manufacturers and suppliers will be able to propose new, improved packaging materials to their customers; food producers will get better packaging and therefore improve the shelf-life of their products and thus their cost-effectiveness; chemical manufacturers will have new uses for their materials, and finally food retailers will reduce waste by marketing products with a better shelf-life.

However, the project itself is still in the pre-competitive stage. Its goals are not to introduce new packaging to the market directly, but to provide the companies from the whole value chain with knowledge and concepts.

Period of time: 01.05.2014 – 30.04.2016

Remarks

The RTD project CORNET 118 EN is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi) and carried out in cooperation with the Fraunhofer Institute for Process Engineering and Packaging IVV and Fraunhofer Institute for Structural Durability and System Reliability LBF.

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Research area: Product aims

Paper, paperboard and board/
Packaging papers and paperboard

Key words:

food packaging, fibre based thermo-formable packaging, bio-polymer coating, barrier functionalities for moisture and oxygen, antimicrobial coating

TITLE:

Active polyvalent packaging based on environmentally friendly fibre material with thermo-formable properties to extend shelf-life of fresh food for the reduction of waste

Background/Problem area

The society as a whole is confronted with important losses in particular at the end of the value- and distribution chain in food and packaging. This is partly due to an insufficient shelf-life of fresh food in small packaging units. Another important cause is consumer behaviour, which will not be covered in this project. In addition to the economic losses in fresh food and corresponding packaging materials, this creates a massive environmental impact. Wasted food has to be dealt within suitable treatment units. Apart from the food-waste issue, this market generates large amounts of used packaging. Used materials are mostly based on non-renewable resources. Resulting waste has to be handled in specific treatment units, mainly incineration with energy recovery and controlled gaseous emissions. This entails high costs for municipalities, i.e. eventually for the consumer.

The market of fresh food in ever smaller packing units is constantly rising. This stresses the need for urgent solutions. The variety of demands from customers calls for tailor-made and small volume applications, which are typically the market for SMEs. It is expected that the SME sector will benefit most of this project. Any solution reducing waste and environmental impact of this waste is welcome. Pragmatically, such improvements could be brought by:

- Longer shelf-life packaging solutions for fresh food (reduction of food waste and of packaging materials)
- Use of renewable and compostable packaging materials, reducing environmental impact and pressure on resource supply of end-of-life packages

Objectives/Research results

This project aims to develop a novel fibre-based thermo-formable packaging material for the production of compostable trays for fresh food packaging. Further development steps will include barrier functionalities for moisture and oxygen impermeability optimised for thermo-processing and also antimicrobial coatings, both intended to preserve the freshness and edibility of the packaging good and thus extending the shelf-life. Additionally, a bio-based barrier topfilm with antimicrobial properties will be developed, which is sealable on the fibre-based tray. The total packaging concept is recyclable and compostable. To achieve these goals, the project is divided into 3 phases: I) material development, II) material assessment and III) tray/topfilm demonstration. In the latter phase, the performance of the developed packaging material will be evaluated for different fresh food products, both in lab-scale and on industrial scale.

We have startet with the parallel development of the individual materials for the tray packaging. In WP 2 tests were performed to functionalize the cellulose fibres to create thermo-formable fibre-based material. Likewise, in WP 3 polymers for the ductile barrier coating were characterised according to their ability to thermoforming and their impermeability of oxygen and water vapour. In WP 4 we have started with the development of antimicrobial coatings following different approaches with focus on food-contact approved materials. The target bacteria were selected according to the demonstration case, the shelf-life extension of fresh meat. In WP5 suitable foils based on biopolymers were selected and will be coated to guarantee sealability of the tray.

Application/Economic benefits

The novel packaging material for trays will open new markets for SMEs for producers of packaging materials and also fresh food. It is expected that this new packaging solution will penetrate the market through the “green thinking” upper middle class, probably around 10 % of the market in the participating countries (Germany, Belgium and Poland), and then reach the main stream of users. The target group of this project are firstly food producing companies, which can broaden their market through the extension of shelf-life of fresh food products and through the biobased and compostable nature of the material aiming amongst others to bio-shops. Secondly, packaging producers can also valorise the project results through different routes: producing paper with extra functionality and offering compostable and biobased alternatives to existing crude-oil based packaging solutions. Thirdly, different developed technologies within this project can be applied in other sectors in order to integrate barrier or antimicrobial coatings on different substrates e.g. processing equipment. The project results will not be immediately suitable for the introduction of new packaging products to the market. Instead, the project delivers valuable knowledge on a new concept for an eco-friendly packaging material for trays and topfilms. This will support SMEs in the mentioned sector to create innovative outlets and new jobs.

Period of time: 01.05.2015 – 30.04.2017

Remarks

The RTD project IGF 142 EBG is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Research area: Product aims

Paper, paperboard and board //
Packaging papers and paperboard

Key words:

food packaging, barrier for mineral oil, starch coating

TITLE:
Development of barrier concepts for recycled paper against mineral oil based on starch coatings

Background/Problem area

The papermaking industry is confronted with seriously mineral oil problems. Recycled paper for food packaging contains traces of mineral oil which can diffuse in undesirably large amounts into the packaged food. The primary source of the mineral oil is the printing ink. Generally speaking, there are three options for solving this problem. Firstly, elimination of the source by using fresh fibres or using printing ink without mineral oil. This is a very problematic approach, because the inks do not only have to be forbidden in Germany but even all over the world. A more expensive way is to clean recycled fibres. An enormous amount of research is going on in this field but there is still a need for improvements to achieve satisfactory results. At this point, the most efficient and feasible option is a migration barrier for mineral oil between the packaging paper and the food. At the beginning, PET bags were proposed between board and food to obstruct mineral oil migration. In addition, some synthetic polymers with good barrier properties have already been found such as PA, PLA, PLMA and PVOH. It was observed in preliminary studies that starch and modified starch coatings also show a good barrier effect for mineral oil. The properties of starch and modified starch used for barrier coatings are investigated further in the scope of this project.

Objectives/Research results

The objective of this project is to develop an efficient and economic mineral oil barrier based on starch or modified starch coatings for paper food packaging. As first step native starches with different amylose/amylopectin ratios and modified starches with different modifications and degree of degradation were tested according to their barrier properties against mineral oil. In general, it was found that starch or modified starch coatings are very brittle. Different plasticizers were added to improve film flexibility and reduce embrittlement. Glycerol, urea and polyvinylalcohol were found as good plasitzicer for starch coatings. The most effective plasticizer combination for modified starches and native starches was a combination of glycerol and polyvinylalcohol.

In the next step pigments (calcium carbonate and kaoline) were added to decrease the costs of the barrier coating while obtaining the barrier effect against mineral oil. The effectivity depends on the different starches, but it is possible to decrease the costs of the barrier coating with pigments by obtaining more or less the same barrier effectivity.

It was found that the hold out of the testliner and carton board for the starch coating is too low and this was improved by developing a pigment based precoating. The combination of precoating weight and barrier coating weight with the best barrier properties was evaluated.

In trials it was shown that these starch formulations can be applied with a lab curtain coater on cardboard and on testliner. In experiments performed on the pilot coater "Vestra", it was shown, that coating on industrial level is possible with these precoatings and starch based formulations. Also the limits stated by the third draft of the BMEL Mineral Oil Regulation dated on 24th July 2014 for the accepted amount of migrated mineral oil can be fullfiled. It was demonstrated, that there is no difference in using a bend blade or a curtain coater as coating aggregat. It was also shown that these coatings are recyclable. The breaking of the coating during the folding or creasing process cannot be reduced completely.

Application/Economic benefits

A very important advantage of biopolymer coatings compared to synthetic polymer coatings is the low costs involved. They can cut the price of starch coatings more or less by half compared to the commercial synthetic polymer coatings. Furthermore, most of the modified starch or starch coatings are compatible for use in food packaging. Therefore, this study aims at introducing new possible starch applications, preferably in SMEs in the packaging and paper industry. This type of coating shows little or no water vapour barrier which is also very important because some foods require a steady moisture exchange with the environment. Further, starch is a biopolymer and as such is biodegradable. This is a very important advantage for environmental issues. In addition, starch is already being used in the papermaking industry and presents no recyclability problems. The research on this topic is not only useful for the paper industry and food packaging industry. It can also be transferred as an application to other industrial fields, e.g. mechanical engineering for lubricant coatings and fuel tanks and in the chemical industry for the transport of mineral oil products. Another application would be the environmental engineering for oil barriers or protection from mineral oil exhalation.

Period of time: 01.02.2013 – 30.04.2015

Remarks

The research project IGF 17676 N is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Research area: Product aims

Paper, paperboard and board //
Packaging papers and paperboard

Key words:

packaging, paper, cardboard, green, ecological, recycled, confectionary waste, hazelnut shells, cocoa bean skins, replacement of virgin fibres

TITLE:
ECO°PAPER: Production of paper and cardboard packaging based on the use of confectionary production waste, in partial replacement of virgin cellulose

Background/Problem area

The increase in the cost of virgin paper, driven by a combination of market pull and the limited size of the European supply, requires technological innovative solutions that are able to reduce the dependence on standard fibre materials and provide a larger offer on the European market while limiting the use of forest resources. At the same time, it has to ensure food industry safety and quality standards. In the best case, it also reduces production costs.

Objectives/Research results

The project aimes at the creation of a more economical and ecologically friendly packaging solution for confectionary goods. For that purpose confectionary waste, specifically hazelnut shells and cocoa bean skins, from the production of confectionary goods is pre-treated by a dry-milling process and then added to the middle layer of a triplex folding box board. There it acts as a partial replacement for standard cellulosic fibres. Hence, the waste materials are upcycled as raw materials for board production and not being treated as waste anymore which leads to a more sustainable and more economical packaging.

Industrial trials with ground hazelnut shells at the board mill in fine-tuned recipes were very successful. Thus the scale-up and technical implementation of the concept of adding ground hazelnut shells to cartonboard while safeguarding processability and product quality proofed to be viable. A 10 % addition rate in the middle layer was optimum under the present conditions. The feasibility of adding ground cocoa bean skins to paperboard was confirmed on an industrial scale as well; though the cocoa bean skin addition was assessed as not sufficiently advantageous under the present conditions.

Application/Economic benefits

The key deliverable of the project is the definition of an efficient, sustainable and reliable industrial production process of paper and cardboard products incorporating in their recipes process waste originated from the confectionary industry. The process will be fully replicable in smaller production entities as the novel recipes require minor capital investment in technology. Industrial experience and knowhow will be the key to guarantee a rapid roll out into the European market. When the roll out is completed and by absorbing the estimated available waste materials within Europe, this will result into a market potential of 1.5 million tons of paper products made with the novel recipes.

The proposed solution finds its main targets in the food industry seeking to optimize its value chain through the use of production waste, consequently decreasing the costs related to packaging and waste management. Secondary targets are the paper mills and converters interested in diversifying their offer and thus introduce into their production systems the novel recipes by setting or adjusting their equipment to handle the different physical and mechanical properties.

Period of time: 15.07.2012 – 14.07.2015

Remarks

The RTD project ECO°PAPER has received funding by Eco-innovation Initiative of the European Union. It is being performed together with Ferrero s.p.a., Alba (Italy) and Stora Enso Packaging Boards, Barcelona (Spain).

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Research area: Product aims

Paper, paperboard and board // Packaging papers and paperboard

Key words:

tamper verification, thermochromic print, folding box for pharmaceuticals

TITLE:
Tamper-proof hot melt bonding for folding pharmaceutical boxes

Background/Problem area

According to an EU customs report from 2012, medicinal products make up 24 % of all counterfeit or pirated goods, thus representing the largest product category of counterfeit goods discovered crossing the EU's external borders. These products can reach patients not only through illegal routes, but even via established delivery chains. The existing Directive 2001/83/EG was amended to counteract this growing threat. Attempted tampering will now be detected by safety features provided on the pharmaceutical packaging. One of the features is intended to make it possible to make the unauthorised access to the respective pharmaceutical product visible. This offers the consumer a nontamper guarantee. An important approach in this context is the hot melt bonding of the sealing flaps during the packaging process. This allows the folding box to be opened by a heated blade or using ovens and the contents to be selectively manipulated without leaving any discernible traces. Such a major weakness of the pharmaceutical box can also be exploited for large-scale manipulation.

Objectives/Research results

The objective of this project is to develop thermochromic dye formulations that are easily identifiable by the consumer for use with tamper-proof hot melt bonds for pharmaceutical boxes. To this end, a thermosensitive dye will be used that indicates renewed heating by undergoing a corresponding colour change. The indicator should be low-priced on the one hand and, on the other, be able to integrate into the process of manufacturing folding boxes so that any unauthorised, undetectable attempt to manipulate the contents of the pharmaceutical box can be prevented.

In an initial development stage, suitable thermosensitive dyes and application processes were chosen and evaluated. In consultation with one of the project partners, three suitable irreversible, thermochromic dye systems were chosen and their relevant physical properties characterised.

Appropriate color formulations were prepared based on the selected dye systems and validated for several application processes. Among the techniques evaluated the most suitable one was the spray method.

Another issue that was evaluated in the framework of the project was the positioning of the thermochromic counterfeit indicator on the folding box. Results demonstrate that an indirect application of the Hot-Melt bond on the folding box board, equipped with the counterfeit indicator, yielded the best results. Applying such processing methods prevented unwanted thermally induced color change during packaging process.

Trials on an industrial-scale demonstrated that the industrial integration of the counterfeit indicator is generally possible. Evaluation of folding box boards produced during the trials unequivocally showed the functionality of the indicator, preventing unwanted access to the folding box board for pharmaceutical products.

Application/Economic benefits

First and foremost, it is the manufacturers of folding boxes for the pharmaceutical sector as well as the pharmaceutical companies themselves who benefit directly from these results. In summary, the scheduled project objectives make a significant contribution to the innovative capacity of these Bavarian-based sectors. In addition, companies involved in the added value chain for the planned manipulation indicator will of course also profit from the results of the research project. These companies include on the one hand the manufacturers of thermochromic dyes, since they can expand their product application portfolio. On the other hand, they also include companies involved in the technical implementation of the counterfeiting evidence. They can expect to profit from additional business segments of their technical products, since the corresponding facilities will have to be upgraded. The maximum benefits from the project results, however, will ultimately be derived by the end consumers, since they will be able to tell from a simple colour indicator that the medicine they have purchased is the original.

Period of time: 01.02.2014 – 31.01.2015

Remarks

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Research area: Product aims

Paper, paperboard and board //
Packaging paper and paperboard

Key words:

pulsed laser machining, non-impact process, laser additives

Title:
ALasKa – Developing a process for the economical use of pulsed laser technology in machining paper and paperboard

Background/Problem

At present, there is a clear trend towards individual products in the paper and packaging industries. Circulations with personalized packaging are on the rise. In addition, the development of new high-tech materials such as microwave paperboard is an ongoing process. In order to address the new developments, high requirements are being placed on the machining processes for paper-based products:

- The further development of “non-impact processes”, i.e. the least possible material change or damage as a result of mechanical or thermal action during the process of machining paper, paperboard and board
- More degrees of freedom for producing design elements due to very fine and delicate structural sizes and high-quality cut edges
- The setting of predefined depths of ablation in machining paper as an additional design possibility for producing haptic features
- Fast and flexible machining

The afore-cited requirements can already be met in some instances using current CO_2 laser procedures, although the changes to the material during the machining process are considerable due to thermal and/or mechanical action. There is therefore an acute need for research designed to minimise the deficits mentioned above. On the one hand, it is important to optimise and further develop laser technologies for paper machining and, on the other hand, to upgrade the paper or board material especially for laser machining in such a way that optimum machining possibilities are given.

Research objective/Research results

The objective of this project is to develop a process for individual product design for the machining of paper and paperboard by means of pulsed laser beam systems. For a selective examination of the machining of paper using pulsed laser beams, the physical interaction mechanisms that occur during machining must first of all be analysed and understood. On this basis, the laser parameters can be adapted on the one hand and, on the other, the paper can be upgraded with additives so that damage to the material due to thermal input or mechanical action (e.g. by gas pressure) is minimised. An important parameter in the context of laser technology is the impact of pulse duration, since this variable correlates with the thermal energy input.

The process of machining paper by means of pulsed laser beams is to be sustainably improved by the addition of special additives. The important parameters in this respect are the concentration of the additive and the distributions in the composite material. By evaluating and weighting the various factors contributing to the machining result, the relationships between the laser parameters and the composition of the paper substrate contributing to the technical results can be understood. For lab trials different additives were already examined, e.g. kaolin, acrylonitrile butadiene styrene binders and special laser pigments. All additives showed a good processability. Furthermore different commercial available paper and cardboard substrates were chosen and examined to reveal interactions between paper components and laser radiation.

Furthermore, the necessary flexibility requirements for a non-impact paper machining technology will be fulfilled as well. Improvements are to be expected compared to previous classical machining procedures such as shorter change-over times during batch changes, reduced tool wear or reduced material consumption due to optimised laser parameters and/or the use of laser additives. A comparison made within the scope of the project between high-tech laser and high-tech paper for the chosen applications allows a cost-benefit analysis to be made and serves as decision-making support in designing an economical process.

Application/Economic benefits

New and especially more flexible machining procedures are of immense importance for the papermaking industry in Germany which consists of small and medium-size enterprises having little research and development capacities of their own. This allows them to maintain and improve their competitiveness. Smaller businesses in particular are specialised in individualised products with small product batches. It is of essential importance in this context to be able to change batches quickly and flexibly. Other competitive advantages result for the manufacturers of pulsed beam sources as well as special-purpose machines for the laser machining of paper. The sales potential is very high in this case, since short-pulsed CO_2 lasers have still experienced very little use in industrial applications until now. In the design and marketing sector, the results from this project will lay the groundwork for new ideas and developments regarding design possibilities for packaging (e.g. haptic elements), thus generating innovative marketing strategies.

Period of time: 01.12.2014 – 30.11.2016

Remarks:

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Research area: Product aims

Paper, paperboard and board // Technical speciality papers

Key words:

organic synthetic fibres, binding fibre, core-sheath, high-temperature fibers, matrix fibers

TITLE:
The application potential of Organic synthetic fibers in regard of product optimisation and development of innovative paper products

Background/Problem area

Searching for new products with high value added, the paper industry has been focusing to an ever greater extent on the fringes of the textile sector as well as the film and foil industries in which it is of the utmost important to selectively adjust the specific properties of the products. The material paper constitutes a flexible material base for supplementary products in the areas of light-weight construction, functional packaging and fiber composites. Synthetic organic fibers are a promising tool for expanding the potential properties of technical specialty paper in respect of strength, convertibility and resistance to chemical attack.

Objectives/Research results

In addition to classical paper fibers, there is also a constantly expanding range of synthetic special-purpose pulps that can significantly improve the performance of paper as a material. The studies are intended to focus on bonding fibres, fibrids, and fibers based on biopolymers and functionalized fiber types, all of which are to be evaluated with respect to their morphology, applicability in wet processing and their property spectra. Based on the results, recommendations can then be made for product development and system optimization. The objective is a practice-oriented property mapping of synthetic organic fibers as far as their impact and processability in wet processing are concerned. The focus will be placed on those fibers that, until now, have typically not been used or only rarely used in the papermaking process.

Suitable fibers will be proposed, selected and, if need be, provided by the project partners. In addition to the manufacturer's details, the fibers will undergo supplementary examination regarding morphology and suspensibility, and initial sheet formation trials will be conducted using the Rapid Köthen sheet former. Based on these preliminary trials, several types of fibers are to be used for trials concerning the combination with reinforcing fibers like carbon, basalt or glass und functional fillers. Also further processing steps as forming (fluting), thermal molding and impregnation will be tested with selected recipes. The results are intended to provide recommendations for the use of synthetic fibers for a variety of different approaches in product optimization and product development.

Application/Economic benefits

This study will give an overview about applicable organic synthetic fibers available on the market. Handling of the fibers will be described as well as possible approaches for tailored product properties achievable, e.g. mechanical strength, haptics, moisture adsorption, elasticity, etc. Also it will give an overview about producers and prices.

Period of time: 01.10.2014 – 30.09.2015

Remarks

The Project INFOR 187 is funded by Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V.

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Research area: Product aims

Paper, paperboard and board // Technical speciality papers

Key words:

future, retropolation

TITLE:
"Fibre & Paper 2030" – the foresight project of an industry sector

Background/Problem area

Current trends demonstrate that in the future, paper will not be limited to well established printing and writing functionalities. Innovative paper based solutions will be available for new applications as construction material for houses or furniture, lightweight actuators for robotic systems and revolutionary components for advanced automotive and aerospace constructions.

The aim of the project "Fibre & Paper 2030" was the development of application areas and the analysis of future requirements for paper based materials. Resource efficiency from production and usage up to recycling will be an important part of future sustainability. The sum of insights created will generate new business opportunities for the whole paper industry to develop novel and attractive markets. According to the team motto "Doing the thinkable instead of thinking the doable", the project started with a time travel to a future vision of 2050. This was a prerequisite for the team discussions in the way to the joint identification of future needs and new requirements.

In a second step the project team works on a retro-perspective view on the period to 2030, to check potential pathways into the future, and to verify how the collected ideas can be transferred into future products, services and business models.

Objectives/Research results

The objective of the future-oriented project entitled "Fibre & Paper 2030: Shaping a sustainable future" was to take a look into the future of materials and the sector of the entire paper value chain. A core team made up of 18 representatives from interbranch organisations and several companies have been working on this groundbreaking project during the 15 months of the project period.

Eight true-to-life fields of action, known as thematic areas, were defined for contemplation: Living & Working, Nutrition, Health & Hygiene, Mobility, Information/Communication/Education/Learning, Logistics, Future towns & Architecture as well as General boundary conditions. This scenario framework was then defined more precisely based on 106 selected premises – assumptions derived from future studies in numerous sectors.

A total of 103 participants from a variety of sectors and subject areas initially developed just under 1500 concrete proposals in six idea workshops. Once these proposals had been consolidated, there was a corpus totalling 640 business ideas, of which 375 were classified as being closely associated with paper. They could theoretically be put into practice in the paper value chain now on the basis of current know-how. Of the remaining proposals, 265 were regarded as being unrelated to paper, although they are attractive based on a clearly justified need, while the contributions of future paper have yet to be clarified or developed by research work.

The result is a wealth of interesting and informative project results which was presented for the first time at ZELLCHEMING 2015. At the same time, broad-based communication on this future project, important for the entire paper value chain, will be disseminated through a comprehensive brochure and a separate website at www.faser-papier-2030.de.

Application/Economic benefits

- Determine future impulses, innovations and new business models for lightweight and composite materials on the road to 2030
- Identify and analyze future customer needs and expected requirements as well as new application areas for paper based materials
- Develop a consistent foresight for the innovation potential of the whole industry and its value chains
- Initiate research projects enabling the development of attractive future markets
- Foster interdisciplinary cooperation between organizations and enterprises to prepare for new profitable business opportunities

Period of time: 01.01.2014 – 15.03.2015

Remarks

Research project "Fibre & Paper 2030" is being funded by Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V.

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Research area: Product aims

Paper, paperboard and board // Technical speciality papers

Key words:

polish agent carrier, polish paper, speciality paper, crêpe paper

TITLE:
Development of polish agent carrier and adaptive finishing aids

Background/Problem area

Polishing rings and polishing wheels made from various cotton fabrics have a wide range of applications. They are used by "aggressive" pre-polishing up to line-free final polishing. Typical materials for conventionally produced polishing rings are various cotton-based fabrics. The fabrics differ depending on the application requirements, e.g. in terms of grammage, softness, flexibility and possibly their finish. Currently, about 10 to 15 different cotton fabrics are used as trimming materials for polishing rings and wheels in the manufacture of polishing agent carriers. Publicly available information indicates that the fabrics differ mainly in the following parameters:

- Strength with respect to static and dynamic force
- Absorbing capacity for liquid and pasty materials
- Flexibility and elasticity
- "hardness" or abrasiveness, respectively

As a result of an expert assessment, the material paper was included in a pre-selection for a number of different reasons. The advantages of paper for this application are the following:

- Good formation
- Compared to woven and non-woven fabrics, a randomly oriented fibre arrangement despite the preferred orientation of the fibres
- The possibility for homogeneously mixing fibres of various morphology and function into the final paper product
- Good wettability when pastes and emulsions are used

Typical polish agent carriers are polish rings and polish wheels consisting of a central support material of metal or paperboard and fan-shaped or flat polish elements.

Objectives/Research results

The project aim is to implement in a cost-efficient way as many of the functional properties of conventional textile trimming materials for polishing tools as possible by using a newly developed specialty paper as the polish agent carrier. The necessary functionality of polish agent carrier is high mechanical strength with long-lasting dynamic stress, absorption, storage, and transportation capacities for polish agents as well as resistance to thermal stress.

Another aim is to gather the specification values of the papers to be developed which are geared to the requirements of the material to be treated and the surface properties of the workpieces and their shape.

According to current knowledge, the development of a sustainable concept for polishing papers requires application technology oriented research and development work to address the following priority issues:

- Fiber selection and specific mechanical preparation of the fibrous materials,
- Screening and selection of functional additives for adjusting the required strength, wetting and sorption properties,
- Implementation of abrasive substances in the paper structure without adversely affecting other functional properties.

An essential factor for the success of the project is to create opportunities to test whether the solutions that were developed on the pilot scale can be scaled up to the industrial scale.

In initial studies, different fibers and functional additives were selected, prepared in different ways and then evaluated for their suitability as a base material for polishing paper.

Application/Economic benefits

Compared to polish agent carriers made from fabrics, there are hopes of achieving advantages, in particular regarding costs, additional features and polishing results. It is expected that users of the technology developed in this R&D project will be able to achieve a competitive advantage. An increase in sales is expected since the polishing tools produced are less expensive than competitive products and give rise to correspondingly faster and enhanced results in the initial tests. This will open up new markets in Germany, the US and China.

Period of time: 01.04.2015 – 31.03.2017

Remarks

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Research area: Product aims

Paper, paperboard and board // Technical specialty papers

Key words:

pyroelectricity, catalysis, antimicrobial, oxidation, environmental technology, filters

TITLE:
Finishing paper with pyroelectric coatings

Background/Problem area

Against a background of increasing environmental pollution as well as climate change and increasing depletion of resources, a rapidly growing global interest in green technologies has been observed in the past few years. The paper industry as well has been working on innovative developments aimed at offering environmentally friendly, sustainable, resource-efficient products for a wide variety of applications.

In the course of the research project, paper is to be finished with pyroelectric properties. In so doing, the charge exchange of the pyroelectric crystals with the environment is to be implemented in a selective and beneficial manner. The potential of the paper finished with this property to be employed in technical applications is to be examined and demonstrated.

Objectives/Research results

Important results are:

- Coating colors with pyroelectric pigments could be formulated, which are applicable using standard paper coating processes.
- In addition, these functional materials could be also successfully applied on paper using a novel method: by means of the flocking process.
- The coating colors have been investigated regarding their pyroelectric activity. For this purpose a special procedure using a fluorescent dye has been adopted to these materials.
- The pyroelectric activity of the used pigments is not affected by binders or other standard components of coating colors. Minor temperature changes (2 K) are already sufficient for the functionality.
- The proof of a distinct antimicrobial effect of coated papers was possible, as well as after application of the new method by flocking the pigments.
- The oxidative abilities of the pyroelectric pigments do not affect negatively the mechanical properties and stability of the papers and coatings before and after their defined ageing.

Application/Economic benefits

Conceivable applications include, inter alia, the sectors of air and effluent treatment, water treatment, filter systems and air conditioning systems, medical and microbiological working environments or even security features on packaging.

The utilization of pyroelectric substances in such technical applications is both resource-efficient and energy-savings. Creating charges on the crystal surfaces is a catalytic process which recurs with every temperature change, without consuming the substance itself. Energy savings is possible because no separate heat/cold source, current source, light source or radiation source is required. The required temperature changes can be produced by natural fluctuations as well as selectively exploiting induced heat/cold flows from other processes.

Period of time: 01.05.2013 – 30.04.2015

Remarks

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Research area: Product aims

Paper, paperboard and board // technical speciality papers

Key words:

fire resistant coating, nacre, protective coating

TITLE:
Self-assembly of large-scale nacre mimetic hybrid films

Background/Problem area

A flame retardant finishing of surfaces is essential to prevent fires and limit the damage of person and property. A wide variety of flame retardant coatings exists, but their components may contain heavy metals, or may release toxic gases formed by halogen compounds during the combustion process. The flame retardant sector is currently undergoing a radical change, since current agents are ecologically unsound and must be replaced by non-toxic materials in the future. Particular challenging is the development of safe, cost-effective alternatives, which can be applied easily. The development of environmentally friendly flame barrier layers which prevent a complete penetration of flames and enable a thermal insulation of the materials behind the protective layer provides a wide variety of applications. An ecologically promising approach arises from the construction of films of a regular silicate/polymer multilayer system. The established ways to build such layers are not eligible to be used in paper applications for economic reasons as well as due to poor mechanical stability and optical transparency. Using so-called nacre mimetics enables for the first time the creation of core-shell layered silicate platelets with polymer binders immobilized on the inorganic component via self-assembly, using specific polymer/silicate interactions. The arrangement of components to "brick and mortar" structure as generally found in biogenic mollusc shells occurs at ambient conditions and allows the production of thin coatings in continuous roll-to-roll manufacturing processes.

Objectives/Research results

The project is aimed at the development of a well-adhering, flexible and environmentally friendly intumescent flame and heat barrier coating for paper products. Polymer-coated layered silicates shall be produced which can be organized from an aqueous dispersion to a nacre-analog brickwork forming a porous ceramic material during combustion protecting the substrate from fire/heat exposure. Polymer/layered silicate dispersions exhibiting high solids content shall be prepared in this context. The dispersions are composed of a polymer which enables the production of a flexible coating in combination with an appropriate silicate. A further aspect which is where focus is set on is to ensure the printability of the flame-retardant material by an additional multi-layer coating without affecting the intumescence level. As a first step, suitable base paper substrates were screened and selected according to the criteria dimensional stability and coating adhesion. Secondly, polymer-/layered silicate dispersions were produced with focus on workability of the produced coating colors. As inorganic components, several commercially available silicates were investigated. For the polymeric part of the dispersions different binders, typically used for coating colors were used and investigated. The solids content and the viscosity of the coating colours produced, was found to be strongly dependent on the pigment used. Maximum solids contents in the range of approx. 20 % were achieved using mixtures of Kaolin and Nanoclay. The dispersions with varying polymer content were applied to the paper and resulted in homogeneous coatings. The coated samples were characterized by various methods, including scanning electron micrographs of surface and cross section. The micrographs showed a good orientation of the pigment platelets on the surface of the paper. The flammability of the pre-coated base paper could be significantly reduced in many cases using coat weights of approximately 10 g/m2 per side. The printability with offset printers could be drastically improved, applying an additional top-coating, without affecting the fire retardant properties.

Application/Economic benefits

So far no method exits for the production of comparable coatings showing similar multifunctional material properties (light construction, mechanical stability, low gas permeability, high transparency) together with economically and ecologically sound produced flame barrier layers. The combination of manufacturing and material properties makes the newly developed material particularly attractive and competitive in comparison to other established materials. The development of cost effective, innovative, ecologically sound flame barrier materials serves to a global, rapidly growing market in the paper sector where not only the prevention of damages by fire, but also the reduction of insurance premiums creates additional motivation for the use of new products. The combination of bio-inspiration (nacre) and environmentally friendly method offers additional image advantages for SMEs involved in the marketing of fire preventing products. In addition to the end user, companies from a variety of industries in the value chain – in the sectors fibre and additive manufacturing, machine construction or coating of of paper-based products – may profit. These SMEs benefit by expanding of their product portfolio, thereby strengthening the market position in the (inter)national competition.

Period of time: 01.08.2012 – 31.01.2015

Remarks

The RTD IGF 17502 N was funded by German Federal Ministry for Economic Affairs and Energy (BMWi) and carried out in cooperation with the institute for Interactive Materials Research of RWTH Aachen (DWI).

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Research area: Product aims

Paper, paperboard and board // technical speciality papers

Key words:

colour coating, foamed coatings

TITLE:
Frothing up of cavity structures of coating layers

Background/Problem area

Paper as a documentation and information medium is of global importance. This is due especially to high-quality, coated papers. The high demands on optical properties such as the whiteness and opacity of the graphic papers are accompanied by the trend towards reducing grammage to keep transportation costs as low as possible. Coating paper is the only way to maintain these optical properties whilst simultaneously reducing paper weight. Coated papers must have good printability for classical printing processes (offset or gravure printing) and also for non-impact printing processes of increasing importance such as inkjet or laser printing. At the same time, mechanical properties like paper rigidity or tear propagation work which should be maintained or even improved are of importance for subsequent processes.

The development of voluminous cavity structures containing coating on paper would therefore be an important measure in reducing raw material costs, obtained in the form of a coating with the same coat thickness compared with a standard coated paper, but with a reduced amount of colour applied with little or no effects on downstream processes.

Foam applications are already being used in many other industrial applications. The majority of these applications are using physically generated foams which have some disadvantages like bubble size to be attained or an uneven and wide range of bubble size distribution.

Objectives/Research results

Until today, no reasonable way has been found to apply a thin and at the same time evenly distributed foam, which is characterised by small bubble size.

The target of the research project will therefore be to create very small cavities generated via chemical reaction releasing gaseous products thus causing the formation of said cavities aimed at a low specific gravity of the coating. The project focuses on reducing the specific coat mass, whilst at the same time increasing the opacity and generation of interfaces by numerous very small and evenly distributed small bubbles in the coating.

The variations of foamed coatings to be investigated and used in the application of colour coating of the project are produced either by acidic-base reaction of carbonates or by polyurethane foam production. Protein foams are also of interest as a research objective but will be combined with the chemical reaction of carbonates with acidic components due to the fact that protein foams can only be generated either physically or by the additional use of chemical gas releasing reactions for example as previously mentioned. Several specific questions must be addressed in conjunction with the foam generating process, foam stabilization, application and possible side reactions with the paper surface during application.

In-depth studies into the gas producing reaction of carbonates with acidic salt solutions together with the incorporation of the chemical reaction into the colour formulation process have been conducted giving indications as to how to produce foamed pigment coatings. Furthermore, different coating procedures and coating layer orders have been made and examined by REM and mercury porosimetry. For the polyurethane process, the foam was applied in different thicknesses and formulations including various foaming properties. In addition, several coating techniques were used. Also a semi-continous coating was conducted on a pilot coater.

Finally the processability such as printability or folding stability of the foamed coatings was evaluated.

Application/Economic benefits

An application of foamed colour coatings opens up the possibility of weight reduction with unaltered mechanical properties in various paper and cardboard inserts.

Due to the expected results, different markets may yield benefits in different forms beginning with chemical suppliers, paper producers, and finally with paper or cardboard users. Production costs will be reduced as less material will be used. Chemical suppliers will have an opportunity to launch addition product in the paper producing market. Printing shops will benefit from improved optical performance and at the same time from reduced weight.

Period of time: 01.01.2013 – 31.03.2015

Remarks

The RTD project IGF17635 BG is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Research area: Product aims

Paper, paperboard and board // technical speciality papers

Key words:

printed electronics, electrical functionality, paper testing, print quality, durability, ageing

TITLE:
Influence of ageing processes on the mechanical surface properties of functional layers in printed electronics based on paper

Background/Problem area

Flexible substrates like paper or film materials that are also suitable for roll-to-roll processing are becoming ever more important in the field of printed electronics. Compared to other substrate materials for printed electronics, paper is highly attractive in terms of price and raw material availability and thus in direct competition with plastic films. Disadvantages of paper like roughness, absorbency of the surface, dimensional stability and gas permeability are no longer an issue because they have been investigated and continue to be optimised by several research projects.

Many products in the field of printed electronics are designed for longer lifetimes (solar modules, various sensors, loudspeaker systems).

To analyse the long-term stability of these components, which depends on the stability of their individual functional layers, no standard simulation and evaluation system is currently available that is capable of describing the influences of stresses, loads and ageing processes on the mechanical surface strength and, thus performance of thin printed electronic layers in these systems.

Objectives/Research results

The aim of the project is to monitor and ensure the functionality of high-quality printed electronics on paper after their exposure to various factors of natural, artificial, physical and chemical ageing processes and loads.

It has been demonstrated, that papers designed for printing can serve as a basis for certain long lasting printed electronic products, if basic quality requirements are met. Specialised coating formulations have been developed in order to enhance surface characteristics. These coatings qualify the examined paper substrates for resistivity applications as e.g. realised in humidity sensors and beyond. Tolerable loads from mechanical, climate and irradiation stress have been determined to qualify the examined substrates for graduated applications of printed electronics.

In order to be able to forecast the performance of paper substrates in printed electronics applications, a number of test methods have been assessed. These include test of surface as well as bulk properties. It has been shown, that a good evaluation can be obtained by the combination of standard paper tests and more sophisticated test methods, such as optical topography measurement.

Application/Economic benefits

Forecasts predict enormous growth for products of printed electronics. Having been a niche market with a volume of just 1.9 billion dollars in 2010, their global market volume is expected to reach 55 billion dollars by 2020.

Printed electronics are intended to replace a wide range of conventional electronic components based on silicon or other materials. This provides the basis for cost-effective mass production. Analysts of IDTechEx are forecasting a steadily growing market for flexible and printed solar cells and sensors in coming years. In the field of sensor production, printing will even gradually supersede other manufacturing methods. This could mean enormous windfall profits for specialty paper producers, printers who are currently experiencing a period of recession due to declining jobs especially in gravure and offset printing, but also manufacturers and converters of products based on printed electronics.

Period of time: 01.05.2013 – 30.10.2015

Remarks

The RTD project IGF 17773 BR is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi) and carried out jointly with the ”Institute for Print- and Media Technology of Chemnitz University of Technology [pmTUC]”.

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Research area: Product aims

Paper, paperboard and board // Technical speciality papers

Key words:

electromagnetic compatibility, absorption and reflection of microwave radiation

TITLE:
Functional specialty papers for shielding electromagnetic radiation

Background/Problem area

In the last few decades, people have been exposed to increasing amounts of electromagnetic radiation, above all in the microwave range. Alternating electromagnetic fields with frequencies in the range of 300 MHz to 300 GHz are usually identified as "microwaves". Microwaves are used in a broad range of common devices, e.g. a wireless LAN operates at 2.4 GHz or 5 GHz, respectively, Bluetooth and microwave ovens both operate at 2.4 GHz, or radar-based parking sensors operate at 24 GHz. These are just a few examples, but they prove the widespread use of this type of radiation.

In Germany, the 26th Regulation for implementing the Federal Immission Control Act (Regulation on Electromagnetic Fields – 26th BImSchV) includes requirements intended to protect the general public from the harmful environmental effects of electromagnetic fields or for electromagnetic compatibility, respectively.

In addition, a survey carried out by the European Commission reinforces the need to find an adequate solution for these problems. The survey showed that 46 % of the interviewees are worried about possible risks to health from electromagnetic fields

Objectives/Research results

The aim of the research project is to develop a technical specialty paper which is capable of attenuating high frequency electromagnetic radiation, thus offering an opportunity to comply with the limit values of the regulation on electromagnetic fields (26th BImSchV). This objective is to be achieved by a thin, highly reflective undercoat, based on sol-gel materials and conductive pigments which inhibit the transmission of electromagnetic radiation as well as an absorptive top layer which reduces the radiation. Furthermore, a suitable application procedure for applying the coating colour will be developed. In order to increase the absorption of the pigments, plate-like reflecting pigments are implemented to supplement the absorbing pigments which lead to multiple undirected, diffuse reflections. As a consequence, the path of the electromagnetic radiation through this layer is increased significantly and the absorptivity of the active pigments is enhanced. Different metallic materials of various shapes could be dispersed in conventional binders like PVA and Styrene-Acrylate. Furthermore, these metal-based colours could be coated on a base paper by using common application methods like a laboratory rod.

It was also possible to disperse absorbing pigments like carbonyl iron, ferrites or absorbing metals, into calcium carbonate based coating colors. These coating colors could be coated using conventional laboratory rods. Furthermore metal pigments could be incorporated into conventional coating colors, too. Thereafter both types of pigments will be combined in a single absorbing coating layer. In the end the reflective and the absorbing layers will be combined in an two layer coating system.

Application/Economic benefits

Based on the knowledge acquired, small companies are given the chance to use new materials for new products, thereby producing such new products. Small paper producers in particular can benefit from this project because of their small paper machines with small working widths and minor production units. They will be able to manufacture such high-tech papers batch-wise in small quantities. These companies will be able to establish new high-tech products on the market, which protects existing jobs and helps create new jobs.

An analysis of the estimated costs shows that this type of coating qualifies as an economic alternative to traditional products whose costs range between 15 €/m² and 40 €/m². Since the costs of lamination are twice as high as the costs of varnishing, it is appropriate to establish a varnish with metal pigments as a benchmark for the project. Since sol-gel materials are also used as binding agents, and their prices are significantly lower than those of metal pigments, their prices can be regarded as the upper limit of the costs.

In addition, those companies that produce carbon allotropes or ferrites, further processing companies can tap into new markets and expand the range of their products or services.

Period of time: 01.02.2014 – 31.01.2016

Remarks

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Research area: Product aims

Paper, paperboard and board // Technical specialty papers

Key words:

papery material, folded and honeycomb sandwich cores, buckling resistance, simulation

TITLE:
Analysis and simulation of mechanical properties for the development of adapted papery materials for folded and honeycomb sandwich cores

Background/Problem area

Sandwich designs are particularly suitable for structural applications requiring high bending stiffness in combination with low weight. Sandwich designs are used in the aerospace and automotive, machine construction and engineering or building sectors, among others.

Sandwich structures are usually comprised of two thin, very stiff and strong top or outer layers surrounding a thick, comparatively low-weight and soft middle layer, the so-called sandwich core. The latter may be made of quasi-homogeneous materials (e.g. wood, foam) or discrete supporting structures (e.g. honeycomb or fold cores). Compared to honeycomb cores, homogeneous cores provide lower mechanical weight-related strength levels. Owing to their structural potential, honeycomb and folded cores are thus at the forefront of attention. The most frequent defect when using folded cores under pressure or axial loads acting vertically to the core plane is the buckling of individual core walls. Due to the materials used, the wall thickness of folded cores is small compared to their other dimensions. This results in a low buckling resistance of the core walls, which makes buckling the main failure type of folded cores. To be able to optimise the buckling resistance of folded cores made of papery materials, the corresponding systematic, theoretical and metrological knowledge needs to be improved.

Objectives/Research results

The aim of the project is to develop a suitable papery material and complement the systematic/theoretical and metrological fundamentals needed for characterising the mechanical properties of paper and papery materials for applications in the field of lightweight construction. This is intended to fill major gaps in the present knowledge about the design, manufacturing and converting processes involved and to provide the basis for the load- and application-specific selection, manufacture, simulation and adaptation of paper materials for lightweight sandwich cores.

One part of this project is devoted to developing adapted papery materials for core structures, the non-combustibility on the one hand and the mechanical properties on the other hand being the focus for improving the buckling resistance of the core structure as far as the requirements are concerned. Initial material options were produced on a laboratory scale in a pulp screening. In addition to the type of pulps, fillers were also used to influence the micro structure (expand the volume) and thus bending stiffness. In addition, initial trials for producing a multi-layer material were conducted. At the same time, the metrological procedures for determining the material data required for simulation were further developed. This made it possible to make improvements, modifications and new developments for shear and compression testing. A variety of handsheets were subjected to the corresponding tests and promising options identified. Initial work on the development and implementation of a suitable material model were carried out. As far as the development is concerned, the material model according to Mäkelä und Sörens was selected which was then adapted by modifying the distortion body and by adding a modification of the reloading behaviour.

Application/Economic benefits

A papery core material with improved mechanical properties will enable many new applications, being suitable for a multitude of innovative products in the field of lightweight sandwich structures. The new or improved measurement methods developed in the project will be the basis for further application-oriented developments. The material model developed by means of the experimental results will significantly enhance the accuracy of numerical simulation models for the behaviour of sandwich structures comprising innovative cores. The simulation methods will enable their potential users to design new innovative structures and products much faster and, because of the reduced need for expensive experimental studies, at lower cost. The project results will help reduce the development and manufacturing times for products based on sandwich design and innovative core structures. The findings will be used to derive recommendations for improving the manufacture and economic efficiency of these products, thus increasing the competitiveness of SME in the specialty paper and paper converting sectors and of companies using the new core materials.

Project period: 01.06.2014 – 31.05.2016

Remarks

The RTD project IGF 18256 BG is being funded by German Federal Ministry of Economic Affairs and Energy (BMWi) and carried out in cooperation with the Institute of Aerospace Engineering of TU Dresden.

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Research area: Product aims

Paper, paperboard and board // Technical speciality papers

Key words:

highly filled papers, functional papers, convertability

TITLE:
Use of strength-increasing special components to control the formability of highly filled fibre-based materials

Background/Problem area

Results of previous research projects have proven the importance of the formability of highly filled fibre-based materials. They have shown that functionalized materials suitable for a multitude of application sectors could be developed and produced with the variable, economically priced paper manufacturing process. The use of functionalized composite materials in the practice affords converting to three-dimensional structures to be able to integrate them into the constructions specified by the particular applications. The formability of highly filled functional materials is impaired by the reduction of their structural strength due to their low fibre content, resulting in problems with the necessary converting processes (e. g. corrugation, creasing and folding) by increased numbers of breaks and delaminations. These defects are impairing the market access necessary for a broader application of the novel materials.

Research activities are required therefore to avoid failures of highly filled fibre-based materals during their production and converting processes, to stabilize the materials against delamination caused by tensile stress in z-direction (e. g. during the expansion of honeycomb structures) and to provide a sufficicient stability for the material transport processes in production and converting machines (runability). The developed measures have also to be assessed regarding their economic efficiency (raw material, operating and energy expenses) in a holistic approach.

Objectives/Research results

Aim of the research project is the control of the converting properties of highly filled fibre-based materials by the systematic construction of a fibre framework optimized regarding morphology and bonding properties ("hierarchic fibre network"), imitating naturally occuring fractal structures with optimal strength and surface properties. The measures shall provide functionalized materials which are uncritical during converting (especially creasing and folding processes) and which can be manufactured using conventional paper-specific installations, i. e. paper machines and corrugating plants.

For the reinforcement of the fibre structure, low amounts of suitable fortification components shall be used together with the formation of additional fibre-fibre-bonds to optimally use the existing fibre framework. Cellulose-based, synthetic and mineral fibres will be used in combination with special binding components, e. g. thermoplastic fibres to construct the "hierarchic fibre network".

Additional measures will be necessary to adapt the different production process steps for implementing the newly-developed custom-tailored microstructure. Basic prerequisite in the development work is the transferability to conventional installations of the paper industry without additional investments. Additionally, only components will be used which are ecologically uncritical.

Application/Economic benefits

The project results shall enable the production and converting of cost-efficient functionalized materials with innovative properties on conventional paper machines and corrugating plants, providing them for a broad range of applications, especially in the sectors of lightweight construction materials and adsorptive filtration. Key industrial innovation is the use of cellulose-based fibres together with synthetic binding components hitherto used only in sectors outside the paper industry (e.g. in the production of polymers, concrete or nonwovens).

Small and medium enterprises of the paper industry will be enabled to use their present installations for the manufacture and converting of functionalized speciality materials intended for novel end products. Being able to flexibly manufacture and convert manageable amounts of speciality papers in their relatively small plants, SME can optimally use the potential of the novel functionalized materials after adaptation to their specific installations. New market segments, especially in the sectors of lightweight construction materials and in filtration applications, will be opened for SME from the paper industry, enabling them to expand their product portfolio and to secure their capacity utilization.

Period of time: 01.06.2015 – 31.05.2017

Remarks

The RTD project IGF18584 BG is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Research area: Product aims

Paper, paperboard and board // Technical speciality papers

Key words:

drapability, semi-finished product, hydroentanglement, organo-sheet material

TITLE:
3-D-formable wet-laid media

Background/Problem area

During the previous IGF Project 401 ZN "Development of a wet-laid process for producing directional carbon fibre prepregs made of C-fibre recyclates for use in tool construction, among other fields" it was seen that the papermaking process is an effective processing route for short cut recycled carbon fibers. It was also seen that 3-D-formability of the wet-laid media (so-called drapability) was insufficient for use in 3-D-structural elements.

Drapability of fibrous media can be increased using longer, flexible (crimped) fibers, multi-layered structures and by using tailor-made binding resins. From textile media it is also known that drapability correlates to the float stitch of the textile. Based on this, it should be investigated if it is possible to improve drapability by influencing the number and position of fiber-fiber-binding points via Hydroentaglement of the wet-laid. The pilot paper machine was equipped with a spunlace-device directly on the forming board, were high-pressure water jet can be applied to the still wet media. Complementary to this recipe of the wet-laid media will be optimized concerning binding fibers, fiber length, fiber diameter and so one - overall aim is to achieve a drapable semi-finished product useful for structural components.

Objectives/Research results

There are two main development routes relating to the commonly used composite materials: Composites with duroplastic matrices (e. g. epoxy) and composites with thermoplastic matrices ("organo-sheet"material, e. g. with PA6-matrix). For both materials recipes will be developed in lab-scale, investigating the processing properties (impregnation and pressing behavior) of the media. Epoxy resins will be used to represent duroplastic matrices, fibrous polyamide 6 will be used representing thermoplastic matrices.

Not more than two recipes per route will be used afterwards for upscaling trials on the pilot paper machine. There also will be started the first trials concerning hydroentanglement of the media. Variable parameters are: diameter of the jet nozzles, jet pressure and dwell. Influences on drapability will be measured by LCC via picture frame test and double sinus stamping test. It was agreed to work with basalt fibers representing reinforcing fibers in general, and to do confirmative trials at the end of the developments with glass fibers and carbon fibers.

So far, several basalt fibers were tested concerning processing in wet state and sheet formation. Market research concerning available PA6-fibers is ongoing.

Application/Economic benefits

Paper-based organic-sheet media will be the initial point of a lower-cost composite in existing applications as well as in new applications in which this material had been too expensive so far. As the papermaking process is flexible with regard to thickness of the media and mixing with thermoplastic components, it is likely possible to manufacture an organic-sheet-material in a one-step-process and to avoid an additional impregnation step. The papermaking process is inexpensive (4 €/kg) compared to textile engineering (20 €/kg) and also has a higher production rate. Furthermore, overall costs can be minimized using recycled reinforcing fibers instead of virgin fibers.

Period of time: 01.04.2015 – 31.03.2017

Remarks

The research project IGF 18697 was funded by German Federal Ministry for Economic Affairs and Energy (BMWi) and carried out in cooperation with the LCC (Institute for Carbon Composites, TUM).

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Research area: Product aims

Paper, paperboard and board // Technical speciality papers

Key words:

semi-finished product, recycled fibres, carbon-composite, organo-sheet material

TITLE:
Fiber-length-optipimized recycling prozess for manufacturing of carbonfiber-multilayered-organo-sheets with high surface quality

Background/Problem area

Carbon fiber composites are commonly used for high-end applications in aerospace technology, top-level competitive sport and to an increasing extent in the automotive industry. Finished carbon fibre composites (woven and non-woven fabrics encouraged with organic matrix) are cut to size during the production of composite components. The cuttings that are produced during the process range at present between 10 % and 20 % and remain largely unused. Depending on the complexity of the component, as much as 50 % cuttings may accumulate. Carbon fibers are produced in energy-intensive processes and should be considered as valuable raw-material. Therefore it is of particular importance to selectively recycle material in the process chain in order to reduce process-related waste.

Objectives/Research results

The project is aimed at the development of a recycling-process-chain in lab-scale, which allows reutilization of 97 % recycled Carbon Fibers (rCF) to a multi-layered composite material. The present state of material efficiency for recovery from rCF is approximately 70 %, that rate is insufficient considering the requirement of the EU Directive 2000/53 / EC on end-of -life components in the automotive industry. That leads to the following scientific and technological research objectives: Process chain with two paths on a laboratory scale for recycling RCF with an overall efficiency of 97 %; Modified opening and cleaning process of excretion short carbon fibers in the length range 6-18 mm smaller; Process for fiber gentle aerodynamic web formation from rCF and thermoplastic fibers with uniform mixing for quasi-isotropic RCF mixed fabrics; Recipe for RCF mixed fabrics with high mechanical resistance; Technically , economically and environmentally optimized paper composition and process parameters for the production of carbon paper from the secluded rCF; Development and production of a new multi-layer composite material with isotropic material properties as a material for use as a steel sheet alternative; knowledge about the relationship between the fiber characteristics , the production process and the final products produced; Mechanical characteristics of developed multilayer structure for component design.

So far, PTS received first samples of short-cut rCF, which needs to be characterized by SEM to evaluate surface quality, the amount of fiber fragment and respirable dust. Next step will be to investigate the behavior of the fibers in wet state and while mixing with thermoplastic fibers like polyamide etc.

Application/Economic benefits

On the one hand, paper-based organic-sheet media will be the initial point of a lower-cost composite in existing applications as well as in new applications in which this material had been too expensive so far. On the other hand, it provides a solution for, until now, insufficient waste management in carbon composite process units. As the papermaking process is flexible with regard to thickness of the media and mixing with thermoplastic components, it is likely possible to manufacture an organic-sheet-material in a one-step-process and to avoid an additional impregnation step. The papermaking process is inexpensive (4 €/kg) compared to textile engineering (20 €/kg) and also has a higher production rate. Furthermore, overall costs can be minimized using recycled carbon fibres instead of virgin fibres.

Period of time: 01.04.2015 – 31.03.2017

Remarks

The research project IGF 18717 was funded by German Federal Ministry for Economic Affairs and Energy (BMWi) and carried out in cooperation with the ITA of RWTH Aachen and the LCC (Institute for Carbon Composites, TUM).

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Research area: Product aims

Paper, paperboard and board // Technical speciality papers

Key words:

binder, starch, mottling, surface analytical methods

TITLE:
Starch in the top coat – printability

Background/Problem area

Binders in coating colors are used to connect pigments to themselves and to the base paper, so that the dissolution of the coating does not occur during the production and processing. Latex and starches are used as binders to control coating colour rheology, water retention and to modify paper stiffness and strength.

A still major obstacle to an increased dosage of starches as the (co-)-binder in paper coatings is the reduction of surface non-uniformity (mottling). Mottling is an uneven, cloudy expression of a printing image on the paper surface. "Backtrap-mottling" appears in most printing processes, partially due to uneven penetration and back-splitting behavior of the printing ink on paper – especially on coated paper. Fogginess becomes visible. The printing colour penetrates unevenly in some cases due to an uneven distribution of the binder and pigments in the coating. 42 % of all complaints for sheetfed papers are due to mottling according to a study published for sheet offset printing in 2006.

In this project, modified starch products will be developed as a co-binder for specific applications in the topcoat, which show a crucial lower tendency to mottle than traditional starch binder systems for paper coatings.

Objectives/Research results

There is a multitude of publications dealing with the migration of latex and starch binders and their influence on mottling. In addition to a detailed scientific study, surface analytical methods will be investigated for a baseline study of printing non-uniformity. One of the ambitions is to demonstrate the individual component distributions in the x-,y- and z-dimensions of the paper and the coated surface. The use of AFM and TOF-SIMS is intended to broaden knowledge on surface and cross-sectional studies. In addition, the use of Raman-spectroscopy is planned.

By understanding the interactions between modified starch and latex binders and their effect on mottling in greater detail, newly developed modified starches starch should be prepared and be evaluated further. The new derivatives produced will be characterized based on their compatibility with conventional coating color components. Suitable coating formulations will be scaled-up to pilot scale with the ultimate aim of industrial use.

In addition to the required mottling reducing properties, the influence on machine settings, coating colour rheology and drying velocities will be investigated as well.

Application/Economic benefits

The economic and technical applications also play a central role in this research project. Since starch is a renewable and natural raw material, a successful project will contribute to conserving finite fossil resources. Besides the advantages in the processability of the paper, the greater use of starch in paper coatings can potentially contribute to a better recyclability and promote the development of innovative starch products.

Its cost advantage compared to synthetic products can be passed on along the entire value chain beginning with starch manufacturers and ending with producers of paper and board materials and supplier industries.

Period of time: 01.07.2013 – 31.12.2015

Remarks

Research project FNR-506 is being funded by German Federal Ministry of Food, Agriculture and Consumer Protection (BMELV).

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Research area: Product aims

Paper, paperboard and board // Technical speciality papers

Key words:

additives, PCC, MFC, strength

TITLE:
Production of nanocomposites of cellulose and precipitated $CaCO_3$ for the strength control of paper

Background/Problem area

The strength enhancement potential of PCC nanocellulose composites is undisputed. The procedures used, however, hardly allow for industrial use. This is due to the following factors:

MFC availability still does not exist despite the announced commissioning of as many as 15 pilot-scale plants worldwide. The technologies of homogenisation using high-pressure homogenizers or grinders are not designed for large capacities or are no longer economically attractive due to chemical pre-treatment.

The production of PCC compounds analogous to SUBRAMANIAN can only occur at solids contents of 4 – 5 %, since the homogenizers will otherwise clog. Hence, the homogeneous precipitation of $CaCO_3$ in the aqueous phase predominates in the reaction, and thus the high specific surface area of the MFC is only insufficiently exploited.

Economically speaking, the share of more than 50 % nano/microfibrillated cellulose in the SUBRAMANIAN compounds is much too high to actually be implemented.

Studies have demonstrated that only 20 – 40 % of the PCC was able to be taken up irreversibly. This is at least more than what was possible with GCC compounds in the extruder, although it does show that controlling precipitation onto the fibrillar structures is difficult. The precipitation and the reaction preferably occur in the aqueous phase at a stock consistency of 3 – 5 %.

Objectives/Research results

Based on the current state of scientific research, the idea behind this project is the fact that the alkaline conditions that occur in the chemical precipitation of $CaCO_3$ can be utilised to improve MFC production in an extruder and, at the same time, to precipitate PCC onto the highly specific surface area of fibre wall nanostructures.

The strength values of paper are to be enhanced and the raw material costs in production are to be cut due to the use of these novel PCC cellulose nanocomposites. Such novel filler composites are suitable for producing innovative products. For this it is necessary, however, that the production of such PCC cellulose nanocomposites can take place under industrially utilizable conditions.

The objective of this project is therefore to develop a novel process for precipitating $CaCO_3$ onto nanostructures of the cellulosic fibre wall in the high consistency range in an extruder.

There is a pressing need for an application in papermaking and the development of the properties of PCC cellulose nanocomposites in respect of:

the retention and filler distribution in paper

the impact on paper strength and

the impact on the surfaces and structural properties that ensure processing in printing and packaging operations.

Initial trials were devoted to studying a basis for comparison involving different pulps, preparing the pulps by adding lime milk and studying the influence of pH on mechanical degradation in the extruder. The following parameters were varied in the extruder: screw geometry, mixing ratio of pulp to lime milk, throughput, speed, dwell time. The degradation behaviour and properties of the pulps differ significantly at varying reaction conditions in the extruder. After evaluation of this basis for comparison, it was determined which pulps and which settings are required to produce MFC in the extruder. Trials are now underway using these prepared pulps and subjecting them to a flow of CO_2.

Application/Economic benefits

With the development of an innovative procedure for precipitating $CaCO_3$ onto nanostructures on the cellulosic fibre wall in the high consistency range in an extruder, it should be possible to cut costs in the production of filler-containing graphic and packaging paper.

Period of time: 01.11.2014 – 31.10.2016

Remarks

The RTD project IK-MF140082 is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

PRODUKT-ZIELE

Forschungsgebiet
Endprodukte aus Papier, Karton und Pappe

Druckprodukte
Schachtelprodukte
Wellprodukte
Sonstige

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Research area: Product aims

End products made of paper, paperboard and board // Print products

Key words:

Offset, printing, cardboard, folding, creasing, adhesion, cracking, dynamic-mechanical performance, varnish, lacquer

TITLE:
Adhesive and cohesive behavior of the ink and varnish layers during folding of UV-varnished cardboards

Background/Problem area

Due to high demands on printing quality, appearance and haptics folding box carton is mainly printed by offset printing using high amounts of printing inks and at least one lacquer coating. In such way printed folding boxes show significant processing failures at creasing and folding after printing, in particular if UV curing varnishes have been used. This leads to cracking and white areas in the folding groove. The reason for this kind of defects has not yet been sufficiently clarified.

Objectives/Research results

In addition to non-optimized folding and creasing parameters the following causes for spalling of ink, lacquer or coating could be stated:

- Poor adhesion of lacquer on ink or ink on substrate
- Inappropriate curing parameters or dependence on degree of crosslinking
- Different expansion behavior of coating, ink and lacquer during further processing
- Different hardness and viscoelasticity of the layers

For the theses listed above no adequate and systematic research has been carried out so far, so this project addresses the specified context. To describe the forces (cohesion and adhesion) in printing inks and coatings resulting in failures when creased and folded various methods are used to investigate the dynamic mechanical performance of the printed cardboard, such as DSC and DMA, IR spectroscopy for detecting the degree of crosslinking, Nano indentation for measuring the hardness of the layers. The aim of the project is to predict the suitability of folding box cartons for a certain print job and reveal possible limitations for these prediction.

Application/Economic benefits

The project intends to clarify the reasons for poor adhesion of UV printed and lacquered prints when being creased. Recommendations shall be given on which parameters the printers and converters should pay attention when choosing folding box carton, printing inks and UV varnishes in order to avoid adhesion problems in the folding zone. The quality of the printed and converted folding boxes will increase significantly, delivery times can be guaranteed and customer needs will be met.

The project results can be expected to benefit mainly small and medium sized enterprises in the packaging industry, particularly print shops and converters, but will also help board suppliers to develop folding box carton with good ink and varnish adhesion properties.

Period of time: 01.01.2014 – 30.06.2016

Remarks

The RTD project IK-MF 130039 is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Research area: Product aims

End products made of paper, paperboard and board // Print products

Key words:

abrasion test, method development, abrasion testers, reproducibility, comparability, influences

TITLE:
Phenomena of printing ink cohesion and standardised evaluation options

Background/Problem area

Abrasion wear is very disturbing and constitutes a serious quality defect especially in high-grade print products. Printers must often use material combinations for which no information is available, which increases the risk of abrasion defects in subsequent converting steps or during use of their print products. This problem could be overcome by a deeper understanding of the various material influences on print product abrasion and the future availability of more detailed information on the material parameters relevant to abrasion.

Objectives/Research results

New models describing the causes of reduced abrasion resistance in sheet offset print products will be tested and verified. The reproducibility and inter-laboratory comparability of the established abrasion test method will be investigated in detail and improved if necessary. Another aim is to create the basis for extending the scope of the ISO standard "Determination of abrasion resistance of photographic images" to industrial print production.

The overall intensity of print product abrasion is assumed to be influenced by various material parameters. These were investigated separately: Printing inks were procured and tested to determine their wax content and the degree of intermolecular cross-linking of ink binders in printed ink films. Sample papers were procured and tested on surface topography, pore volume and surface elasticity. Based on the results, papers were selected for further studies and the production of typical sheet offset test prints. The test prints will be analytically characterised to document changes occurring in the paper during printing. This will be followed by studies on abrasion resistance using different abrasion testers and test conditions.

Application/Economic benefits

The project is intended to create the basis for a multi-parameter analysis of the material influences on abrasion test results. This will help to reliably avoid abrasion defects in industrial print production, and – by enabling printers to obtain information about a practically manageable number of paper and printing ink parameters from the corresponding manufacturers – make printing jobs significantly more stable and reliable in future.

The envisaged improvements in the ISO test method will make its test results more comparable; and the inclusion of abrasion testers commonly used in Europe in ISO 18947 will make it easier to communicate its results on a worldwide scale.

Project period: 01.06.2014 – 31.03.2016

Remarks

The RTD project IGF 18234 BG is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Research area: Product aims

End products made of paper, paperboard and board // Carton products

Key words:

hydroforming, formability, formable paper, formable board, cardboard

TITLE:
Controlling the shear deformation capability of paper and board enhancing its formability (Steuerung der Schubverformbarkeit und Lagenverschiebbarkeit von Papier und Karton zur Verbesserung der Umformbarkeit)

Background/Problem area

Increasing volume of cargo and the aim to present goods in a more and more appealing manner result in a rising demand for three-dimensionally shaped packaging solutions. These products can be manufactured by forming of natural fibre based based, plane, semi-finished products, such as cardboard. Forming capabilities of cardboard improved by progress in mechanical engineering in the last few years. Still the material inherent properties set narrow limits to its formability. Paper plates and carton board trays of minor height are state of the art products. Beakers or cups cannot be manufactured by forming (hydroforming, cupping, molding) so far.

The cooperation partners (PMV Darmstadt , PTS Heidenau) agree that shear deformation capability of cardboard is a key factor for controlling formability. Cardboard usually is a multi-layered material. By connecting single layers flexible its tendency to break during forming should decrease and wrinkling should happen more homogeneously.

Objectives/Research results

The project aims to improve formability of cardboard introducing flexible layers into the sheet structure, primarily between the layers. In order to manufacture three-dimensional formed and further more complex formed packagings. This new cardboard shall offer a lower risk of breaking, unwanted wrinkling and improved processing properties.

Thermoplastics polymers like waxes, poly-vinylalcohol and poly-caprolactone or mineralic lubricants like talcum and clay shall assure flexible connections between cardboard layers and single fibres as well as suitable friction properties at cardboards surface.

Application/Economic benefits

Industrial processors of cardboard and plastics profit from the development of a new, formable, semifinished cardboard. Its all-purpose formability shall provoke the development of new natural fibre based, three-dimsionally formed end-produts. These packaging innovations shall strengthen the market position of small and medium enterprises.

Period of time: 01.06.2015 – 31.06.2016

Remarks

The RTD project IGF18030 BG is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi) and carried out in cooperation with the TU Darmstadt the chair for papertechnology and mechanical process engineering.

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Forschungsgebiet: Produkt-Ziele

Endprodukte aus Papier, Karton und Pappe // Schachtelprodukte

Schlagworte:

Mineralölbarrieren, Barrierebeschichtungen, Rezyklierbarkeit

Topic:
Assessment of Barrier Coated Paper and Board Product Recyclability

Background/Problem Area:

The mineral oil migration from packaging papers into foodstuffs is still under intensive discussion. Hence, toxicologists ask for the application of barrier coatings preventing any organic substances from migrating into foodstuffs. Those barrier coatings could even be applicable to fresh fibre boxboards in order to avoid cross contamination from secondary packaging used for transport purposes. However, it is not clear whether an intensive use of barrier coatings could negatively affect the recycling process since no generally accepted method for the assessment of recyclability of barrier coated papers exists. The method used most often is the PTS-Method RH 021-97 "Kennzeichnung der Rezyklierbarkeit von Packmitteln aus Papier, Karton und Pappe sowie von graphischen Druckerzeugnissen" which focuses on the evaluation of re-pulpability, the content of non-paper components, and the presence of optical inhomogeneities and sticky particles using the so called “sheet adhesion test”. The accumulation of colloidal and solved components of barrier coatings in narrowly closed water circuits is not being considered. Particularly in regard of increasing use of barrier coatings such an accumulation must be assumed. To that extend the development of a new method is essential.

Objective/Research Result:

The objective of this research project is to develop a laboratory method for the simulation and modelling of accumulation processes in narrowly closed paper machine water circuits caused by colloidal and solved substances. To this end, barrier coated papers and board will be disintegrated in a low consistency pulper at 45 °C and 4 % consistency and after be dewatered in a laboratory centrifuge. The obtained process water will then be used for disintegration of another batch of papers with similar coating. This procedure will be repeated until the amount of colloidal and solved substances reaches a stable level. A guide parameter could be the chemical oxygen demand (COD), the salt load, the solids content, the ash content, etc.

To evaluate the behaviour of barrier coatings during the recycling process several test methods will then be applied to the enriched process water. Possible test are for example the micro-sticky content according to PMV or the content of extractable components. The results will be compared to the process water after the first dewatering step. The difference will be the measure for accumulation.

In addition to process water, also pulp properties according to PTS-Method RH 021-97 will be determined. Furthermore, strength properties of laboratory handsheets made from pulped paper products with and without barriers will be measured. Finally, the obtained data will be used to evaluate assessment criteria for the recyclability of coated papers.

For this project two reference products and eight products with a barrier coating were collected. Five of them have a barrier against mineral oil. To evaluate the recycling behaviour using existing methods, all products were tested at the PTS according to the PTS-Method RH 021-97 "Kennzeichnung der Rezyklierbarkeit von Packmitteln aus Papier, Karton und Pappe sowie von graphischen Druckerzeugnissen" and at the PMV according the EcoPaperLoop-Method 1 “Recyclability Test for Packaging Products (Leaflet, July 2014)”. Furthermore different processes were investigated for modelling the accumulation process of colloidal and solved substances in the process water during the recycling process.

Application/Economic Benefits:

In order to maintain high recycling rates for an increasing use of barrier coated papers and boards, a new assessment method is needed. This is the only way to ensure the ban of new products that could negatively affect the production process of recycled paper products, being of existential importance for manufacturers of solid and corrugated board which process most of the recovered paper in Europe.

Project Period: 01.05.2014 – 30.04.2015

Remarks:

The research project INFOR 178 is being funded by Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V. and performed in close cooperation between PTS and PMV.

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Forschungsgebiet: Produkt-Ziele

Endprodukte aus Papier, Karton und Pappe // Wellprodukte

Schlagworte:

Wellpappe, Bedruckbarkeit, Qualitätsüberwachung

Topic:
Method for Evaluation Wash Boarding Based on Topographic Measurements

Background/Problem Area:

The surface of corrugated board shows a typical pattern, giving a characteristic appearance. These undulations are in most cases undesired. The term wash boarding describes the geometric shape of the ripple, which arises from the bonded joints of flute tips and liner board. The wash board effect can lead to serious problems in printing. Stripyness in print is a typical cause of low print density in flute valley and high ink coverage on flute tip.

Wash boarding is a complex interaction of paper properties, manufacturing conditions and constructions such as double or triple-wall with different flute sizes. Latter shows repetitive patterns caused by frequency differences between different flute types. These factors and possible damages of the structure due to rough treatment influences local compressibility, which in turn affects wash boarding and print quality.

Objectice/Research Result:

The project will provide a technical leaflet concerning topographic measurements on corrugated board and methods for evaluation of wash boarding. The leaflet comprises recommended measuring parameters like field sizes as a function of flute type and resolution required. Measurement systems and possible setups will be discussed.

The technical leaflet presents an evaluation algorithm based on wavelet transformation in order to analyse topographic data according flute size. Signal decomposition enables to assign the wash board effect to flute types which is of particular importance for double or triple-wall types.

Furthermore the leaflet presents a method for measuring wash boarding as a function of surface load. Local compressibility of corrugated board is calculated from topographic measurements at particular pressure steps.

Application/Economic Benefits:

The technical leaflet standardises the evaluation of wash boarding and defines the requirements on topographic measurements. Both topics are crucial for scientific work, quality control and trouble shooting. Additional economic benefits are expected from measuring wash boarding as a function of surface load in order to detect and to minimise possible causes for printing issues.

Project Period: 01.01.2013 − 31.12.2015

Remarks:

The research project is being funded by Vereinigung Pack- und Wellpappenpapiere (VPWP).

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Forschungsgebiet: Produkt-Ziele

Endprodukte aus Papier, Karton und Pappe // Wellprodukte

Schlagworte:

Wellpappe, Festigkeit, BCT, Qualitätsüberwachung

Topic:
Evaluation of the Dependence of BCT Values on Paper Parameters

Background/Problem Area:

During the last years the grammage of papers used to manufacture corrugated boxes has decreased. In consequence some of the common parameters like CMT or SCT measured at the paper do no longer lead to predictable results in BCT. Paper suppliers and box manufacturers have difficulties to define the correct quality values needed for the paper to get the desired strength for the box.

Objectice/Research Result:

The approach is to carry out a screening with different papers, varying in grammage, fibre orientation, and delivering paper machine. The different papers will be used for manufacturing of FEFCO 0201 boxes with B-flute on different corrugating machines. Relevant paper parameters will be measured as well as board parameters and the BCT-value. Aim of this project is to renew the famous “McKee formula”.

So long obtained results show that the McKee-formula still gives a prediction within a range of ± 10 % of the finally achieved BCT-values. SCT-values of the paper in MD have the highest impact on the BCT, but the influence of the fluting machine and the box-forming machine has to be taken into account.

Application/Economic Benefits:

It’s crucial for the customer-supplier relationship to define values for the delivered paper that are stable concerning the ongoing converting processes and will consequently lead to good box properties. The experience of the past has to be adapted to new time developments. Otherwise today’s transaction of business will tend to drive into uncertainty and the confidence of the market in corrugated boxes as a well developed product will be lost.

Project Period: 01.07.2014 − 31.12.2015

Remarks:

The research project is being funded by Vereinigung Pack- und Wellpappenpapiere (VPWP).

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Research area: Product aims

End products made of paper, paperboard and board // Corrugated products

Key words:

corrugated board, glue line quality of corrugated board packaging

TITLE:
Development of a method for the objective evaluation of the adhesive seam quality of corrugated board packaging

Background/Problem area

The Free State of Bavaria is an important industrial location for the German corrugated board industry. Approx. 20 % of all German corrugated board products are manufactured in more than 20 plants in Bavaria with a total staff of 3600 employees. This accounts for approximately one-fifth of all German-wide sales in this sector.

In order to manufacture corresponding transport packaging, an essential process step is not only the production of the corrugated board itself, but also how it is processed. During this process, the material is die-cut, folded and glued to form corrugated boxes. The gluing step plays an important part here, since it contributes to the stability of the packaging. It has also been discovered, however, that the adhesive seam of the packaging often causes breakage or damage to the packaged merchandise in trade or in the consumer goods industry. As a result, the adhesive seam must be examined and evaluated in order to ensure quality standards. Until now, however, there has never been an independent and physically correct evaluation procedure, thus giving rise to an urgent need to develop one.

Objectives/Research results

The project objective is to develop an objective and physically correct test procedure for evaluating and testing the quality of the bond strength of corrugated board packaging.

For manufacturers of corrugated board packaging, it is also important that the procedure for evaluating the bond seam is easy to carry out and is reproducible.

Within the scope of the project, a new measuring procedure is being developed for objectively evaluating the bond strength of corrugated board packaging. This measuring procedure is intended to comply with the following requirements on a new evaluation procedure:

The objective evaluation of bond strength requires a measuring procedure, i.e. the test procedure should provide a robust, physical measurand.

The measurand determination should ensure good resolution so that the results make a gradation and evaluation of quality possible.

The measuring procedure developed must be independent of contributory factors such as the bending stiffness of the corrugated board, and thus objective in order to ensure reproducible results.

The testing procedure should evaluate under practice-oriented stress test conditions to which corrugated board packaging is commonly subjected to, i.e. a "peeling" type of stress.

The evaluation procedure should be simple and easy, and be able to be performed with a low-price test method and without any special qualifications.

Ensuring good resolution renders the results suitable for quality gradation.

The evaluation process should be suitable for monitoring during the production run.

Currently, an initial prototype of the measuring instrument is being developed and evaluated for practical suitability within the scope of the project. As a result, the impact of the type of corrugated board and of the test procedure themselves on the test results will be examined in detail.

Application/Economic benefits

If a new objective and physically correct measuring procedure is successfully developed for evaluating the bond strength of corrugated board packaging, this would mean the further development and expansion of PTS testing and consultancy services.

The direct benefits accruing from these research results will also be advantageous for firms in the mechanical engineering sector who manufacture testing instruments. Companies can expect additional sales in the corrugated board industry from the results of this project. The scheduled project objectives will make a substantial contribution to the innovative capacity of this sector domiciled in the Free State of Bavaria.

In addition, Bavarian manufacturers of corrugated board packaging including the associated added value chain can guarantee a high quality standard of their products as a result of the knowledge transfer from the project. This in turn will lead to a further strengthening of Bavaria as an industrial location.

Period of time: 01.03.2015 – 29.02.2016

Remarks

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Research area: Product aims

End products made of paper, paperboard and board // Corrugated products

Key words:

wet end starches, hydrogel character, polysaccharide, starch retention, drainage

TITLE:
New hydrogel structures for wet end starches

Background/Problem area

Wet end starches are used in the paper industry to compensate for the loss of paper strength caused by the use of recycled fibres with permanently decreasing quality parameters. Furthermore, they act as a retention aid for fines and fillers and they guarantee stable paper machine runnability at high speeds by interacting with other additives. Cationic starch derivatives belong to the most important wet end additives. Due to closure of white water circulation, especially in corrugated board producing mills, large amounts of dissolved salts and anionic trash accumulate in the system. For this reason, the cationic starch derivatives may become ineffective in the pulp suspension. The increase in a charge bound to starch does not further increase its efficiency in highly contaminated systems. It is therefore necessary to develop a new generation of wet end starches.

Objectives/Research results

The aim of this project is to combine the advantages of the effect of the solution structure including charges with the advantages of the particulate structure for the development of new wet end additives on the basis of biopolymers. During the interaction with the fibre fleece, the products will link the effect of surface charge with the effect of anchorage by the filtration of partially swollen structures. The target-oriented modification of polysaccharides is aimed at products with high active component effectiveness which guarantees both high retention in the fibre fleece and a positive quality of drainage on the paper machine. Furthermore, the focus of this project is directed to the technological implementation of the results in industrial practice. The technology for treating the new wet end starches has to be involved as well, since the paper industry has to be provided with a technological solution for the incorporation of the newly developed wet end starch in the thin stock without destroying the hydrogel character.

Previous investigations have shown that the particle size distribution of hydrogels of starch derivatives has a significant impact on the starch retention and strength properties of paper. Therefore the systematic adjustment of the average particle size by varying the modification and shear energy to achieve high retention and high strength properties is the current objective. The newly developed starch derivatives were cool treated with ultra-turrax or rotor/stator machine and were characterized and tested in the lab. Handsheets prepared with salt water (conductivity: 6000 µS/cm) were carried out. The changed structure and the derivatisation of the starch are directly related to the drainage behaviour of the pulp, starch retention and strength properties of the formed handsheets. These results provide the basis for the next target oriented structure change of the starch derivatives. The lab treatment of starch derivatives were scale up in the pilot treatment.

Application/Economic benefits

Starch derivative structures should be produced by a suitable combination of physical and chemical derivatisation of starch polysaccharides in combination with other biopolymers. These derivatives should show restricted swelling even at high salt load of the circulating white water in the paper mill, they should interact with the pulp fibres via mechanical and electrostatic forces and they should enhance the fibre network of the paper sheet during drying by gelatinization of possibly available residual inner starch granular structures.

Period of time: 01.07.2013 – 30.06.2016

Remarks

The RTD project FNR-209 is being funded by German Federal Ministry of Food, Agriculture and Consumer Protection (BMEL). The Fraunhofer Institute for Applied Polymer Research (IAP), Golm as applicant and the Papiertechnische Stiftung (PTS) Heidenau are the research partners in the planned research development proposal.

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Forschungsgebiet: Produkt-Ziele

Endprodukte aus Papier // Sonstige

Schlagworte:

Mikrofluidik, Medizinische Diagnostik, Wasseranalytik

Thema:
Mikrofluidische Papiere – Instrumentenlose Papier basierte Analytik

Ausgangssituation/Problemstellung

Die Wechselwirkung von (komplexen) Fluiden mit Papier spielt in sehr vielen Bereichen aktueller Technologien, wie z. B. der Applikation von Druckfarben, dem kontrollierten Aufbau funktionaler Papiere für maßgeschneiderte Diagnostik, oder in funktionalen Separationstechnologien eine tragende Rolle. Insbesondere der hochporöse Aufbau von Papieren ist hier gleichermaßen ein großer Vorteil, wie auch aus wissenschaftlicher Sichtweise heraus eine große Herausforderung, da z. B. viele Aspekte der Benetzung von Papieren, insbesondere durch komplexe Fluide, wie etwa gelöste Polymere, Emulsionen oder Dispersionen, bis heute nur unzureichend verstanden sind. Ein Anwendungsbereich, in dem die Benetzung eine zentrale Rolle spielt ist der gesamte Bereich der Steuerung sehr kleiner Volumina von Fluiden – der Mikrofluidik.

Während in der konventionellen Mikrofluidik diese Volumina mittels Pumpen transportiert werden, kann man sich aber auch sehr gut vorstellen für diesen Transport Kapillarkräfte in porösen Medien auszunutzen. Gerade deshalb erfährt in jüngster Vergangenheit der Einsatz von Spezialpapieren in mikrofluidischen Anwendungen, z. B. für die instrumentenlose Diagnostik in der Medizin eine zunehmende Attraktivität und Aufmerksamkeit. So wurden Arbeiten zum Design derartiger Papiere in den letzten knapp 10 Jahren von verschiedenen Gruppen publiziert, jedoch ist dieses Anwendungsfeld noch sehr jung und viele Herausforderungen, wie etwa die effizienten Herstellung von Mikrofluidikkanälen auf Papier und eine kontrollierte, pumpenlose Steuerung eines Fluids in diesen Kanälen, sind bis heute noch nicht effizient gelöst. Neben der medizinischen Diagnostik gibt es viele weitere Anwendungsmöglichkeiten von mikrofluidischen Papieren in analytischen Bereichen, z. B. zum Nachweis von (toxischen) Stoffen in Trink- und Brauchwasser. Auch wenn es hier am Markt bereits etablierte Systeme gibt, so sind diese nach wie vor auf umfangreiches Auswerteequipment angewiesen und in ihrer Genauigkeit und Auflösungsgrenzen oft limitiert, was nicht zuletzt auch intrinsischen Struktur-Eigenschaftsrelationen von Papieren geschuldet ist, aber gerade durch eine fundamentale Kenntnis des Letzteren in Zukunft lösbar erscheint.

Forschungsziel/Forschungsergebnis

„Mikrofluididsche Papiere“ sind am MAP bereits seit 2012 Gegenstand intensiver Forschungsarbeiten, welche teilweise in Kooperation mit dem PMV und der PTS durchgeführt werden. Im Rahmen von 3 Doktorarbeiten (2 laufende, 1 abgeschlossen) konnten eine Reihe von Ergebnissen erzielt und bereits veröffentlicht werden. Die Arbeiten konzentrieren sich einerseits auf fundamentale Fragen im Zusammenhang mit der Imbibition von Fluiden in Papier, wie z. B. welchen Einfluss haben Fasertyp, -länge und -orientierung auf den kapillargetriebenen Transport. Andererseits setzen wir am MAP die von uns entwickelten mikrofluidischen Papiere auch schon in ersten anwendungsnahen Untersuchungen ein. Beispiele reichen hier von der Entwicklung von Papier basierten Chlor-Teststreifen, über Teststreifen zum Nachweis von Tuberkulose bis hin zu Teststreifen, auf denen lebende Zellen als „Sensoren“ immobilisiert sind. Die Arbeiten werden teilweise auch in Kooperation mit der chemischen Industrie durchgeführt, mit dem langfristigen Ziel „Plattformen“ für eine einfache, schnelle und dennoch sehr genaue Analytik auf der Basis von funktionalen Papieren zu ermöglichen.

Anwendungen/Wirtschaftliche Bedeutung

Kann man Fluide in kontrollierter Weise in mikrofluidischen Papieren hinsichtlich des Volumenstroms über Kapillarkräfte steuern, so ergeben sich eine Reihe von spannenden Anwendungen im Bereich der instrumentenlosen Analytik und point-of-care Diagnostik, zum Aufbau von Papier basierten Mikroreaktoren und intelligenten Filtern. Auch wenn dieses Gebiet zur Zeit noch sehr wenig beforscht ist, so kann man sich im Erfolgsfall aber auch eine wirtschaftliche Bedeutung im Bereich der Spezialpapiere und damit auch neuen Märkten für Papiere mit sehr hohem Wertschöpfungspotential vorstellen.

Bearbeitungszeitraum: seit 2012

Bemerkungen

Das Projekt wird zur Zeit aus Landesmitteln des Landes Hessen (Grundfinanzierung der TU Darmstadt) finanziert.

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Research area: product aims

End products made of paper, paperboard and board // Other

Key words:

switchable polymers, safety, surface, product protection

Title:
New, printable multi-safety label based on hygro/thermochromically switchable polymers

Background/Problem area

Trademarks are the most frequently infringed industrial property rights today. Losses in turnover caused by counterfeiting are growing dramatically. Counterfeiters copy single product components, complete products or their packages. The market for trademark protection and the necessary safety technologies increases with the amount of losses incurred by counterfeiting. It grows even faster because safety features tend to be forged as quickly as the products themselves.

The use of switchable polymers to obtain new, specific safety features – for example identifiers in the form of “breath signals” – will be studied as a possible novel solution. Switchable polymer brushes that must be stimulated by changes in moisture and/or temperature can produce such “breath signals”. Prerequisite is that they can be functionally linked with the paper surface and provided with the necessary structure.

These issues will be investigated in the project, to finally enable the printing of the new safety feature on paper.

Objectives/Research results

Aim is to link switchable polymers with the paper surface by printing them as structures that are sensitive – i.e. change in response to - moisture/temperature variations. Important results achieved until now are:

- Investigation and selection of suitable raw materials
- Production of base layers in various compositions
- Selection of suitable polymer brushes
- First conformity tests with polymer solutions (reference material)

Special task is to pre-coat the paper with a smooth layer. This primer must be resistant to solvents and must also have functional groups for the grafting-from process of switchable polymers. It could be shown that the covalent attachment of polymer brushes on pure cellulose surfaces is possible. In this case the modification of the surface is not visible. It is necessary to have a smooth and glossy primer. The work on this is still in process.

Application/Economic benefits

The envisaged new product protection based on hygro- and/or thermochromically switchable polymer brushes will respond to exhaled air by changing its structure and, thus, appearance. Economic benefits are expected from the packaging sector, among other, because changing from supplier to branded goods manufacturer is currently the predominant trend in this industry. Its market volume, demand and current amount of counterfeiting clearly justify the development and implementation of a new type of product protection. A high percentage of polymer manufacturing, packaging and printing companies are SME. In the field of plant construction and engineering, at least 200 companies are SME.

Apart from adding a new product to their portfolio (polymer production), the application of a new, improved and forgery-proof product protection technology will also enable these companies to secure and improve their turnover and market position.

Project period: 01.01.2014 – 31.12.2015

Remarks

The RTD project IK-MF 130120 is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Research area: Product aims

End products made of paper, paperboard and board // Other

Key words:

mechanical properties of fibre based materials, optical strain field analysis, Poisson's ratio, shear modulus, material mechanics simulation, design of packaging and lightweight materials

TITLE:
Optical analysis of strain fields to determine mechanical properties of fibre-based materials

Background/Problem area

An essential prerequisite for utilizing the potential of paperfibre-based materials in lightweight construction is the application of design principles that are already established in other areas, e.g. mechanical or construction engineering. For this purpose an improved material characterisation is required, since some of the needed parameters are not easily accessible or not available at all. The use of optical strain field measurements in principle is suitable for an enhanced analysis of material displacements due to mechanical loading and might overcome this problem. However, a further method development is needed for the determination of the associated material parameters.

Objectives/Research results

The project aims at the development of new methods to determine hitherto difficult to access material-mechanical parameters such as shear modulus and Poisson's ratio of thin natural fibre-based materials. For this purpose optical strain measurement systems are used, that offer a great potential for the detailed analysis of displacements and strains in mechanical loading experiments of fibre-based semi-finished or finished products. The information obtained from the evaluation of two-dimensional strain fields is used to derive individual material properties in the context of continuum mechanics formulations of material laws and to provide direct support to the design process of new or improved products.

The following sub goals are to be achieved:

- adaptation of appropriate test sites by extension of the existing equipment via the combination of mechanical loading with optical strain field measurements
- development of methods for direct and indirect determination of material parameters and screening the range of applications
- determination of mechanical material characteristics such as Poisson's ratio and shear modulus, associated elastic and plastic deformation boundaries for the use in continuum mechanics and associated material laws
- practice relevant recommendations for selected manufacturing processes and design steps concerning cardboard and corrugated board products

Application/Economic benefits

The economic importance of the project is to make attractive semi-finished products based on paper fibres to a broad range of other industries where they might substitute established materials based on oil or other fossil fuels. This enables new applications for cellulosic paper fibre materials, for example in customized three-dimensional packaging solutions and in construction or lightweight applications. Harnessing development and design methods from other areas for paperfibre-based materials opens up new markets for semi-finished composite materials at a marketable price level by means of established paper production technologies. A targeted and load-oriented design e.g. in the field of packaging papers will lead to innovative, lightweight and rigid packaging products. Economic benefits are a result of raw material savings and decreased transport costs due to basis weight reductions. These effects also make an active contribution to sustainability (energy efficiency, resource utilization).

Period of time: 01.07.2014 – 30.06.2016

Remarks

The RTD project IK-VF 130044 is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

PROZESS-ZIELE

Forschungsgebiet
Faserstofferzeugung

Zellstoffherstellung
Holzstoffherstellung
Altpapieraufbereitung
Faserstoffbehandlung

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Forschungsgebiet: Prozess-Ziele

Faserstofferzeugung // Altpapieraufbereitung

Schlagworte:

Altpapieraufbereitung, Deinking, Altpapiermischungen, Druckerzeugnisse, digitale Drucke

Topic:
Synergistic and Antagonistic Effects during Deinking of Recovered Paper Mixtures

Background/Problem Area:

New printing technologies will change the composition of recovered paper mixtures in the future. More digital print products and less conventional offset newsprint has to be expected in recovered paper for deinking. Unfortunately the influence of changing recovered paper mixtures on the behaviour in deinking is not understood well. It is well known that a mixture of offset coldset newspapers, offset heatset magazines and rotogravure magazines can be deinked well in industrial scale. However, the deinking result is not a linear function of the share of single components. There can be synergistic and antagonistic effects. How digital prints behave in the recovered paper mixture is not evaluated systematically as well.

Objective/Research Result:

The aim of the research project is basically the investigation, assessment and modelling of the deinking behaviour of single print products in a recovered paper mixture. First the deinking behaviour of single print products in a one and a two-loop deinking process is analysed. Since there is no standardized two-loop lab deinking process, parameters for the lab trials are adjusted to match industrial scale dispersion and first and second stage flotation in terms of brightness gain, dirt specks and yield. Beside traditional print products also flexo newspapers and some digital print products are investigated. Additionally, for all print products the natural and artificial ageing behaviour will be assessed. Subsequently the influence of a single print product in the mixture will be described. For this assessment systematic mixtures of various print products will be assembled and deinked. Based on the deinking results of single products and product mixtures models will be developed to describe the behaviour of recovered paper mixtures.

After describing the effect of single print products on the deinking result difficult to deink print products will be added to the recovered paper mixture to investigate appropriate process steps and process conditions to improve the deinking results.

For the first time this project will deliver systematic findings about the effect of single print products in recovered paper mixtures on deinked pulp quality. With the results it can be estimated how recovered paper mixtures should be composed to be especially useful for production of deinked pulp for improved graphic paper grades.

Application/Economic Benefits:

Recovered paper for deinking (1.11.00) is the most important raw material for the production of deinked pulp for manufacturing graphic recycling paper, newsprint, SC and LWC paper as well as hygiene paper. Recovered paper for deinking is always o mixture of different print products. The deinking behaviour of single print products is well known, but not their behaviour in a recovered paper mixture. But this knowledge is necessary to adjust the recovered paper treatment process to the raw material input in the deinking plant. Paper mills would be able to produce the optimum deinked pulp from the used recovered paper mixture.

The knowledge can also used from the recovered paper sorting plants to produce a certain recovered paper mixture for deinking, adopted to the requirements of the customers. This enables the use of more recovered paper in higher graphic paper grades. Overall this will help to preserve the fibre resources due to the fact that in high quality graphic paper grades large amount of virgin fibres are used.

Project Period: 01.07.2014 − 31.12.2016

Remarks:

The project IGF 18288 N of the research association Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V. is funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Forschungsgebiet: Prozess-Ziele	**Schlagworte:**
Faserstofferzeugung // Altpapieraufbereitung	Mikro-Stickys, Labormethode, Messung

Topic:
Development of a Laboratory Method to Assess the Microsticky Potential of Adhesive Applications in Pulp Suspensions and to Optimize Stock Preparation Plants for Paper for Recycling

Background/Problem Area:

Stickies cause deposition problems in pulping, papermaking and converting operations. Consequently, stickies need to be removed and controlled during the stock preparation of paper for recycling. For the determination of macrostickies two standardized and commonly used laboratory procedures exist: INGEDE Method 4 and TAPPI T 277. For microstickies a broad number of procedures is proposed in literature, but most have significant drawbacks. In the year 2013 the Canadian research center *FPInnovations* presented a promising new agglomeration technique to quantify microstickies in recycled pulp: samples are heated and stirred to agglomerate microstickies so that they become macrostickes. Afterwards a common macrosticky method can be applied.

Objective/Research Result:

One objective of this project is to extensively investigate this agglomeration technique with the aim to develop a laboratory method for standardization.

Provided that this aim is reached, the second objective is to build a database containing the microsticky potential of relevant adhesive applications.

So far, first tests with model suspensions from copy paper with self-adhesive labels confirm that the proposed technique can agglomerate microstickes in a way that they can be detected with the INGEDE Method 4.

In continued tests with the same model suspensions the agglomeration temperature and time, stirring parameters, the consistency as well as the setting conditions after the agglomeration were investigated. It can be summarized that all these parameters influence the agglomeration.

Application/Economic Benefits:

The method to be developed can be used to evaluate the recyclability of adhesive applications. With this knowledge adhesive applications with a bad recyclability could be discarded and adhesvie applications with a better recyclability could be developed. Additionally stock preparation plants could be optimized to remove microstickies. These measures could lower costs in the stock preparation of paper for recycling as well as in papermaking and converting of recycled paper.

Project Period: 01.12.2014 − 31.05.2017

Remarks:

The project IGF 18521 N of the research association Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V. is funded by the Federal Ministry for Economic Affairs and Energy (BMWi).

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Forschungsgebiet: Prozess-Ziele

Faserstofferzeugung // Altpapieraufbereitung

Schlagworte:

Altpapierqualität, Deinkbarkeit, FT-IR Spektroskopie

Topic:
Entrance Quality Control of Recovered Paper Regarding Deinkability of Printed Products by FT-IR Spectroscopy

Background/Problem Area:

During stock preparation of graphic paper products with deinking it may occur that the quality of the produced paper is impaired by insufficient ink removal. Very often this effect originates from additions of papers with defined printing processes or special finished print products in the recovered paper delivery. Sometimes these "conspicuous" print products are even noticed visually, but the potential risk for the deinked pulp quality cannot be assessed realistic. Therefore, for paper mills a simple and fast analytical technique is missing to determine the deinkability of print products and reject them if necessary.

Objective/Research Result:

The near infrared measurement technique (NIR) is used industrially since several years, for example in sorting of recyclable material as plastic or recovered paper. This measurement technology can also be used for recovered paper quality control of the composition or determination of the quality of recovered paper. Successful application of the online NIR technology for continuous control of the composition of recovered paper on the belt conveyor to a pulping unit has been published in 2014. Thereby the possibility exists to detect and to control for example the input of varnished print products in a stock preparation line. With the obtained information the stock preparation process can be adapted to the conditions of the recovered paper input. However, with the proposed measurement NIR technology the assessment and eventually necessary refusal of a recovered paper delivery is not envisaged or possible, respectively. Small amounts of difficult to deink print products on the belt conveyor are only to detect by accident because they have to lie on the surface of the accumulation of different papers on the conveyor belt to be detected by the NIR measuring system.

In this project the proposed measuring equipment works with medium infrared (MIR) usually simply named IR. The wave length range of the irradiated (and from the sample absorbed) light is in a range of 3 to 50 µm. Due to the higher wavelength (= lower energy) the penetration depth of the radiation into the sample is limited to 2 to 3 µm. For the project this has the advantage that the most interesting oscillations of inks or varnishes are not much affected from the components of the paper and board mass. The major oscillations are activated from molecular bindings. The intensity of the signals is significantly larger as for NIR measurements and the absorption band is considerably sharper. Thereby a direct analysis is possible in the sense of mapping the signals to the existence of functional groups.

Results of spectroscopic FT-IR analysis of print products as well as of deinkability tests of the same samples will be collected in a data base. By linking the FT-IR analysis with the deinking results the data base will be built up in a way that unknown print products can be allocated to not, poor or good deinkable print products. In an ideal case also the problems in terms of dirt specs, discolouration or luminosity losses should be predictable from an unknown print product.

Application/Economic Benefits:

Since the accident with 140 tons of not usable recycling copy paper in a graphic paper mill it is well known that a single-digit percentage of weight of a difficult to deink print product in the recovered paper mixture can have heavy impacts on paper quality. A simple possibility of early detection of critical print products in a recovered paper delivery would offer the paper mills the possibility not to accept problematic recovered paper deliveries, to control recovered paper deliveries more in detail or to dilute problematic deliveries with unproblematic recovered paper deliveries.

Project Period: 01.11.2014 – 31.10.2015

Remarks:

The research project INGEDE 14514 is being funded by INGEDE.

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Research area: Process aims

Pulp production // Recovered paper treatment

Key words:

stray starch, process water, metabolism, recovered paper molar mass, pulper

TITLE:

Reducing the metabolism of stray starch in the process water of paper mills to improve the efficiency of biomass utilisation

Background/Problem area

Studies have shown that appreciable amounts of starch are introduced into the pulp together with the recovered paper. Owing to the weaker bonding forces, the starch is removed together with the process water from as many as 70 % of the fibres during pulping in the pulper. Actually, the substance, known as stray starch, contains active components immediately after pulping that can bring about an increase in strength during papermaking.

The stray starch metabolises relatively fast in the process water so that only a small amount of the starch introduced together with the recovered paper is retained in the fibre network and only a slight increase in strength can be achieved in the finished paper.

In addition, the stray and metabolising starch leads to an increased COD loading in the process water as well as in the effluents. This increases the costs of effluent treatment. Moreover, unused stray starch and its degradation products can give rise to corrosion, deposit formation, odour generation and efficiency losses of chemical additives.

In the light of all these points, the question arises how the starch introduced together with the recovered paper can best be prevented from metabolising so that it can continue to develop its strength-enhancing action in the finished paper.

Objectives/Research results

It was therefore the objective of the research project to create the preconditions to ensure that the starch present in the recovered paper can be used effectively to develop strength in the finished paper.

In framework of numerous laboratory tests and three operating tests were shown that a suitable treatment of the process water can reduce the bacterial counts by several decades and therefore the microbial contamination significantly.

Thereby the effect of starch degrading enzymes were decreased so much that with selected chemical substances, biocides, especially sodium hypochlorite and alternatively with flash pasteurisation the starch metabolism could be prevented completely. Depending on the load of the process water the effect could continue up to three hours.

Additional physical treatment procedures, e.g. ultrasonic treatment, electrical pulsed fields and most of the biocides effect also a significant but not complete reduction of the starch metabolism. With individual further development also these procedures can be optimised in that way to get almost complete starch preservation.

By the starch metabolism in the stock preparation the starch is cut down in that way, that the strength in the produced paper is 10 to 20 % lower as if the added starch would be complete effectively. If the process water were treated in the described way, the starch from the recycled paper could be settled down to the paper fibres and result in a strength benefit in the same size.

Application/Economic benefits

The amounts of wet-end and surface starch can be reduced significantly because strength-enhancing amounts of stray starch are being retained. Due to the diminished use of surface starch, drying energy can also be saved and the associated CO2 emissions be cut as well. These measures can potentially save starch costs in a magnitude of 2 to 9 Euros per tonne of paper produced.

On the other hand, the COD loadings, that are largely due to the metabolising starch and are passed on to the effluent treatment plant, can be reduced as well, together with a drop in the specific sludge accumulation, oxygen and energy requirements in the aeration stage.

In addition, the negative effects in the process (e.g. corrosion, deposit formation, odour generation, reduced efficacy of additives) can be diminished as well and thus the operation of the plant improved.

Period of time: 01.02.2013 – 31.01.2015

Remarks

Research project FNR 210 is being funded by German Federal Ministry of Food, Agriculture and Consumer Protection (BMEL) via the Agency for Renewable Resources (FNR) and coordinated by PTS, Munich, in cooperation with project partners (Fraunhofer-Institut für Angewandte Polymerforschung (IAP), vermicon AG, CRENANO GmbH) and industrial partners (Hamburger Rieger GmbH & Co. KG, Papierfabrik Adolf Jass Schwarza GmbH, Klingele Papierwerke GmbH & Co, DS Smith Paper Deutschland GmbH, Papierfabrik Schoellershammer Heinr. Aug. Schoeller Söhne GmbH & Co. KG, Papierfabrik Julius Schulte Söhne GmbH & Co., Smurfit Kappa Hoya Papier und Karton GmbH, W. Hamburger GmbH, Papierfabrik Pitten, aquagroup AG, Buckman Laboratories GmbH, BK Giulini GmbH, Ceresan Erfurt GmbH, Servophil GmbH, Solenis Technologies Germany GmbH, Wöllner GmbH & Co. KG, Enviolet GmbH, Fourmart GmbH, Ingo Jänich Ultraschall + Technologien, Weber Ultrasonics GmbH).

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Research area: Process aims

Pulp production // Recovered paper treatment

Key words:

Deinking, flotation, process water quality

TITLE:
Impact of process water quality on the deinking potential of paper for recycling and measures to increase the quality of deinked pulp

Background/Problem area

Deinking mills are forced to reduce their fresh water consumption with a resulting higher load of various contaminants in the process water and/or getting higher contamination levels in their mills due to lower recovered paper quality. This has an influence on achieving the target brightness levels since more bleaching chemicals are now required to recover the optical properties. Several reasons could explain this trend: (i) process water quality is altered (more coloured dissolved and colloidal molecules), (ii) conventional ink particles are less efficiently removed due to unknown interactions disturbing the flotation behaviour (iii) ink particles are being smaller due to the development of new printing processes including water based inks or getting larger due to more oxidative inks, (iv) peroxide in the pulping phase or during the bleaching treatments is less efficient due to the water loop closure.

It is therefore necessary to understand first the main causes and mechanisms of reduced water consumption on the impact of DIP quality. Based on those findings investigations on solutions are performed to overcome the problems including possibilities of efficient process water cleaning at minimum cost.

Objectives/Research results

The aim of the research project are to increase the DIP quality and to reduce variations in quality of DIP in use of paper for recycling for the production of graphic papers by improving existing processes (process water purification).

The objective of the work is to determine the main reason explaining poorer DIP quality or poorer deinking potential based on the impact of process water quality. Poorer DIP quality results in higher bleaching chemical consumption or has to find preventive process water treatment possibilities to stabilize optical DIP characteristics.

This requires a systematic assessment of differences in process water quality and their impact on the development of optical properties in the deinking process. From the results solutions will be worked out for improving the deinking results depending on the process water quality.

Application/Economic benefits

The project will increase the knowledge of the facts how to clean the water circuits in an economic way by evaluating chemicals, cleaning technology and dosage points of chemicals.

Period of time: 01.04.2015 – 31.03.2017

Remarks

The RTD project IGF18698 N is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi) and carried out in cooperation with the TU Darmstadt (Paper Technology and Mechanical Process Engineering).

PROZESS-ZIELE

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Papier- und Kartonherstellung

Stoffaufbereitung
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Oberflächenbehandlung

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Forschungsgebiet: Prozess-Ziele

Papier- und Kartonherstellung

Schlagworte:

Kartonherstellung, Verpackungspapiere, Trockenverfahren, Wassereinsparung, Ressourceneinsparung

Thema:
Kartonherstellung im Trockenverfahren – Ein innovatives und umweltfreundliches Verfahren zur wasser- und energiesparenden Produktion von Karton.

Ausgangssituation/Problemstellung

Die Herstellung von Papier, Karton und Pappe erfolgt seit jeher ausschließlich in einem Nassprozess. Dabei sind die notwendigen Teilprozesse mitunter so wasser- und energieintensiv, dass die Papierindustrie zu den drei größten Energieverbrauchern des produzierenden Gewerbes zählt. Als Hauptgrund hierfür kann der hohe Wassereinsatz genannt werden, da die mitunter großen Wassermengen zusätzlich zu den Fasern gepumpt und gefördert werden müssen. Vor allem aber muss das Wasser auf mechanischem und später thermischem Weg wieder entfernt werden, wobei insbesondere die thermische Trocknung den energieintensivsten Produktionsschritt überhaupt darstellt.

Aus den genannten Gründen stellt sich nicht erst seit den Zeiten stark steigender Energiekosten die Frage, warum nicht auf Wasser verzichtet werden kann, um Papier bzw. Karton in einem Trockenprozess herzustellen. Ein Vorbild für die geplante Entwicklung bietet die Faserplattenherstellung, deren ursprüngliche Produktion im Nassverfahren nahezu vollständig durch umweltfreundlichere Trockenverfahren ersetzt wurde. Treibende Kräfte dabei waren vor allem die Abwasserproblematik und die hohen Trocknungskosten, also Nachteile und Kostenfaktoren, die bis heute den konventionellen Papierherstellungsprozess energetisch und ökologisch belasten.

Forschungsziel/Forschungsergebnis

Das Projekt beschäftigt sich mit der wissenschaftlich-technologischen Entwicklung eines neuen innovativen Verfahrens zur nahezu wasserlosen und energiesparenden Produktion von Karton. Im Gegensatz zum konventionellen Kartonherstellungsprozess, in dem sämtliche Produktionsschritte nur unter Zuhilfenahme teils großer Wassermengen möglich sind, soll das zu entwickelnde Verfahren weitestgehend auf die Verwendung von Wasser verzichten und somit als extrem ressourcenschonender Trockenprozess entwickelt werden.

Die Zielstellung dieses Projekts lautet, eine trockene Prozesskette zu entwerfen, die es erlaubt, das verwendete Altpapier ohne Wasserzugabe in Einzelfasern zu zerlegen, papierfremde Bestandteile und Verunreinigungen zu entfernen, die Einzelfasern zu einem trockenen Faserflies zu legen und anschließend unter Zuhilfenahme eines geeigneten Bindemittels zu einem Karton zu verpressen.

Entsprechend müssen für die Realisierung des zu entwickelnden Trockenverfahrens folgende Teilziele erreicht werden:

1. Altpapier- und Stoffaufbereitung
   - Störstoffabscheidung, Vorzerkleinerung und Faseraufschluss
2. Blattbildung
   - Benetzung der Faserwolle mit Bindemittel (Beleimung)
   - Streuung der Fasern zu einem gleichmäßigen Vlies
3. Verpressung
   - Verpressen des Faservlieses zu einem Karton

Die Entwicklung eines geeigneten Bindemittels stellt dabei eine der größten Herausforderungen des Projekts dar, da neben den produktspezifischen Eigenschaften auch die Wirtschaftlichkeit eine entscheidende Rolle spielt.

In Vorversuchen konnte die grundsätzliche Machbarkeit bereits nachgewiesen und ein Karton ohne Wasserzugabe hergestellt werden. Durch die manuelle Faserstreuung und die damit einhergehende Inhomogenität des Vlieses weisen insbesondere die Festigkeiten noch Defizite gegenüber einem konventionell hergestellten Karton auf. Auch das verwendete Bindemittel erfüllt noch nicht die Kriterien hinsichtlich Rezyklierbarkeit und Wirtschaftlichkeit.

Anwendungen/Wirtschaftliche Bedeutung

Durch die Entwicklung eines kontinuierlichen Trockenprozesses sollen nicht nur der Energie- und Wasserbedarf gegenüber dem Stand der Technik deutlich reduziert, sondern auch die Umweltverträglichkeit signifikant verbessert werden. Weiterhin wird erwartet, dass die Investitionskosten des skizzierten Trockenprozesses deutlich unterhalb der Kosten des konventionellen Nassprozesses liegen werden. Erste Kalkulationen haben weiterhin ergeben, dass mit Hilfe eines Trockenverfahrens bis zu 90 % des sonst benötigten thermischen Trocknungsenergiebedarfs eingespart werden können. Im Vergleich zum Nassprozess würde die Kartonherstellung im Trockenverfahren demnach deutlich wirtschaftlicher und ressourcenschonender möglich sein und wäre somit eine attraktive Technologie für die Papierindustrie.

Durch den Verzicht auf Wasser ist die Anwendung eines solchen Trockenverfahrens zudem in Gebieten großer Wasserknappheit möglich.

Bearbeitungszeitraum: 01.07.2015 – 30.06.2017

Bemerkungen

Das ZIM-Projekt KF 2418634CM4 wird über die AiF Projekt GmbH vom Bundesministerium für Wirtschaft und Energie (BMWi) aufgrund eines Beschlusses des Deutschen Bundestages gefördert. Das Projekt wird in Kooperation mit der Kartonfabrik Porstendorf GmbH bearbeitet.

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Research area: Process aims

Paper and paperboard production // Stock preparation

Key words:

cavitation, broke treatment, sonotrode, venturi

TITLE:

Enhancement of machine availability and improvement of paper properties by optimized broke treatment with cavitation technology

Background/Problem area

To meet the demands of their customers, many paper producers must offer a broad variety of grades and realize increasingly smaller lot sizes. The paper grades made on a single machine are sometimes used for several different applications, which limits the choice of suitable raw materials and treatment methods, and certification requirements for e.g. food contact can make it difficult to realize several different grades on the same production line within short periods.

The frequent grade changes required in this situation result in constantly growing amounts of broke. Mills can use these broke materials only for lower-quality products which must be sold at markdown prices. The reason for this is the additives, coating binders, optical brighteners and other aids contained in broke. Once added to achieve the desired optical, barrier, sizing or wet strength effects, the chemicals end up as sticky contaminants or dirt specks in the paper or cause frequent web breaks in mills using high amounts of broke.

Starting point of the project is the fact that cavitation effects offer great potential for the treatment of internal stock flows. However, the requirements and input parameters of stock preparation plants vary greatly – the material flows to be treated can have so different compositions that treatment aims and technologies must be specifically selected or adapted for each application.

Moreover, it is necessary to look at the economic side, i.e. the profitability and treatment effects achievable by a technology for the desired throughput and with the investment/operating/maintenance costs required for each application, which can vary greatly as well. Generally, one must distinguish between hydrodynamic cavitation (venturi tubes or perforated plates, even though the latter seem less suitable here) and acoustic cavitation (ultrasound, using rod transducers or flow cells).

Objectives/Research results

Aim of the research project is to use hydrodynamic cavitation effects to eliminate bound and unbound binders or additives in the broke flows of mills to minimize deposit formation and web breaks, increase the availability of plant components and achieve a more consistent production quality. The corresponding effects of acoustic and hydrodynamic cavitation processes will be compared to assess their economic efficiency as basis for future investment decisions.

Application/Economic benefits

The use of a simple technology that requires little investment like cavitation jets for the optimised treatment of internal broke flows will enable paper producers to stabilize their productions and minimize variations in the quality characteristics of their products. Besides increasing the plant availability and technically feasible production output, this will also enable them to use further fixing agents and other aids.

Project period: 01.07.2015 – 30.06.2016

Remarks

The INFOR research project 190 is being funded by Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V.

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Research area: Process aims

Paper and paperboard production // stock preparation

Key words:

microfibrillated cellulose, bio-polymers, compounds, thermoplastic starch, fibre composites

TITLE:
Preparation of masterbatches containing fibres and biopolymers for the development of novel bio-plastics and paper materials

Background/Problem area

Natural fibres are common reinforcement in composite materials. The reinforcement effect depends on the aspect ratio and is superior in microfibrillated cellulose (MFC). MFC can be prepared by mechanical disintegration of plant fibres down to their building blocks. But their fibre matrix interaction in composites is often poor, because of their hydrophilic nature. This inhibits the use of their full reinforcement effect and a wide-spread application.

In contrast to bioplastics, paper fibres are not only reinforcement but the main component of the material. One drawback of fibre networks in paper is that the structure and bonding in the web do not allow plastic moulding as known from plastics because the melting point is above the decomposition temperature. However MFC and compounds based on MFC have also a high potential to improve the strength properties of paper because of their high specific surface area and their interaction with common papermaking additives. The most commonly used dry strength additive in papermaking is native and modified starch. But starch and starch blends are widely used also in bio-plastics. For this reason masterbatches based on MFC and biopolymers like starch and their blends could be used in papermaking in order to improve the paper properties.

Profitably in this context is the fact that MFC can be produced in a conventional co-rotating twin-screw extruder. It can also be assumed that this process involves not only mechanical decomposition, but also a change in the molecular structure of the cellulose. There are still open questions how those processes can be used to modify the fibres more specifically in order to use the full reinforcement potential of the fibres, whilst adjusting the hydrophobic to hydrophilic properties.

This problem will be solved by a cooperation of three research institutes: Papiertechnische Stiftung (Pulp and Paper Institute Heidenau, PTS-IZP), Fraunhofer Institute for Environmental, Safety, and Energy Technology UMSICHT and Albert-Ludwig University of Freiburg, Institute of Earth and Environmental Sciences (Chair of Forest Biomaterials).

Objectives/Research results

The objective of the project is a target-oriented fibrillation of fibres during the treatment in a twin screw extruder in order to find an optimal aspect ratio of the fibres and more precisely also to produce MFC with an optimized interface interaction.

If the bonding properties of the fibres come closer to the interactions found in bio-plastics, there is the chance to develop new paper-based materials with radical new strain-elongation properties, dimensional stability and barrier properties. It should be sufficient if a minimum amount of bio-polymers can be immobilized in the fibre contact area or in the fibre wall itself, or thermoplastic starch or blends are added directly.

In order to demonstrate the general feasibility, bio-polyethylene will be evaluated as representative of polyolefines and thermoplastic starch, which are used in both bio-plastics and paper.

Application/Economic benefits

The project aims to support the SME in the plastics industry in developing innovative packaging materials with a high amount of sustainable raw materials. In the papermaking industry new products can be developed for emerging markets also in the field of packaging. Here properties like plastic mouldability and high rigidity can be used to extend the application spectrum of paper products. Furthermore the project supports the supplying industry of starch and bio-polymers with a new market opportunity.

Period of time: 01.01.2014 – 31.12.2016

Remarks

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Research area: Process aims

Paper and paperboard production // Stock preparation

Key words:

Deinking, ink fragmentation, cavitation, paper strength

TITLE:
Hydrodynamic surface treatment of recycled fibers in a cavitation nozzle for a better DIP-stock preparation

Background/Problem area

The average utilisation rate of recycled fibers for production of printing papers stagnate since 2009 at a level of 48 %. A limiting factor for higher use of recycled fibers are increased amount of difficult deinkable printing inks (toner, uv cured inks, uv varnishes) in recovered papers, especially from magazines and catalogues.

The big and shear resistant ink particles are difficult to remove from the cellulose fibers surface (low ink detachment) and therefore not separable in deinking flotation. At current state there is no suitable technological solution available to solve this problem.

For using deinked fibers in high quality printing papers a high technological input is necessary (1 – 2 disperger stages, pre- and post-flotation, several bleaching steps) in order to reach a sufficent brightness and low amount of optical inhomogenities. A considerable disadvantage of conventional disperger treatment of recycled fibers is the fibers darkening by redeposition of ink partikels. This must be compensated later by bleaching. Generally the dispersing stage in stock preparation is the most energy consuming process step.

There is an urgently need for alternative technological solutions for improved deinking process with regard to efficieny and costs. In literature and in some orientational pretrials by PTS the possible improvement of ink elimination in flotation by using a pretreatment by hydrodynamic cavitation was demonstrated.

Objectives/Research results

Aim of this project is the improvement of the deinking process regarding efficiency and costs. In that way the utilisation rate of recycled fibers for production of printed paper shall be increased.

The recycled fibers shall be treated with hydrodynamic generated pressure pulses in a cavitation nozzle before the ink particles will be removed in a flotation cell. The research objective is the evaluation of required process conditions and the reachable effects by cavitation.

Therefore several partial effects shall be combined in only one technological process step: Improved ink detachment, better ink fragmentation, avoidance of fiber darkening and restoring of fiber bonding ability.

Firstly basic research shall be done by using a cavitation nozzle in lab size (8 mm diameter) for evaluation of basic parameters for cavitation intensity. Subsequently the influence of cavitation treatment to ink detachment and fragmentation will be investigated at selected printing inks and at standard deinking furnish. In the second part of the project the influence of cavitation treatment to the flotation process shall be examined followed by test trials in a bigger nozzle for evaluation of the effects during upscaling.

The results showed a strongly increased ink fragmentation in DIP stock when raising the flow velocity in the used cavitation nozzle from 18 to 38 m/s. Below 18 m/s no significant ink fragmentation was observed. The maximal ink fragmentation (= reduction of ink particles > 50 µm) was 60 – 65 %. This reduction rate is comparable to current dispergers in deinking plants. The needed number of up to 100 passages through the lab scale cavitation nozzle is a limiting technical factor at the actual state of work. The total energy consumption is expected to be lower than in current dispersers in paper mills.

An increase of 20 % in Tensile strength was reached by fibers treatment with cavitation impulses. Simultanously no significant reduction in dynamic Tear strength was determined which is a very positive aspect in comparision to DIP refining. The strength increase was performed with significantly lower passages through the nozzle than the ink fragmentation. So the specific energy consumption is expected to be lower for cavitation treatment in relation to pulp refining.

Application/Economic benefits

The potential application of cavitation treatment will be at all paper producers which are using complete or partially recycled fibers containing printing inks: newsprint, SC and LWC-paper, tissue, white covered liner paper mills.

The cavitation treatment can contribute to reduction of energy consumption in stock preparation (when replacement of disperger is possible) and to process design simplification (if the post flotation can be cutted down). An improved ink detachment allows the reduction of fiber loss in the flotation cells. Also an increase in tensile paper strength can be realized by hydrodynamic cavitation.

Period of time: 01.01.2014 – 31.12.2015

Remarks

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Research area: Process aims

Paper and paperboard production // Stock preparation

Key words:

reactive extrusion, fibre modification, thermoplastic properties, fibre composites

TITLE:
Reactive extrusion of cellulose fibres for application in paper production

Background/Problem area

Cellulose fibres, in comparison to various polymer fibres, are not thermoplastic. At the microscopic level cellulose fibres are a heterogeneous system consisted of individual fibrils held by the adhesion forces such as enthalpy-driven ionic and H-bonds and dispersion forces. The same is true for paper that consists of individual cellulose fibres at the macroscopic level. On the contrary thermoplastics are a homogeneous system of interlaced polymer chains held together mostly by weak cohesive dispersion forces. To achieve the material softening upon heating, intermolecular bonds have to be destroyed like it is common for thermoplastics. It enables processing of polymers like injection moulding, film blowing or fibre spinning. However the adhesion forces in and between cellulose fibres are so strong that fibres decompose rather than start softening. The basic idea staying behind the present work is to substitute undesirable H-bonds on the surface of the fibres for the weaker dispersion forces through the reactive extrusion process.

The ‘reactive extrusion’ process is a mechanical equivalent to a ‘one-pot’ approach familiar in chemical industry. In the reactive extrusion, a compounding extruder is applied as a continuous reactor for carrying out chemical reactions rapidly at high consistency. Simultaneous impact of kneading, shearing, pressuring and heating results in highly homogenous products with the reduced amount of chemicals required. Along with the low reaction duration and the high stock consistency, it is the major manufacturing cost-saving factor. Reactive extrusion of cellulose fibres requires using a conventional co-rotating twin-screw extruder. Because of a wide utilisation of this type of extruders in the plastics industry the process up-scaling is facilitated.

It has recently been shown that cellulose fibres can be chemically modified in extruder. However no efforts have yet been invested in achieving thermoplastic or barrier properties of paper products by applying the reactive extrusion.

Objectives/Research results

The objective of the project is developing a platform technology for selective chemical functionalisation of cellulose fibres under solventless conditions in a twin screw extruder. It has been demonstrated that upon tuning the reactive extrusion conditions both the thermoplastic cellulose fibres and thermoplastic polymer matrixes can be produced in a pilot-plant scale twin screw extruder. The thermoplastic cellulose fibres may be thereafter converted into paper sheets. Because of the thermoplastic character of the fibres, paper heating results in partial melting of the fibre network. Therefore the paper porosity as well as the air and water permeability decrease and the transparency and the hydrophobicity increase. By turn it opens new opportunities for novel products of packaging or lightweight construction sectors.

Application/Economic benefits

The project aims to support the SME in the pulp&paper industry in developing innovative packaging materials with a high amount of sustainable raw materials. In the papermaking industry new products can be developed for emerging markets also in the field of packaging. Here properties like plastic mouldability and high rigidity can be used to extend the application spectrum of paper products.

Period of time: 01.02.2015 – 31.12.2016

Remarks

The RTD project IK-VF 140022 is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Forschungsgebiet: Prozess-Ziele

Papier- und Kartonherstellung // Papierherstellung

Schlagworte:

Prozesswasser, chemische Additive, Retentionsmittel, Nassfestmittel

Topic:
Investigations on the Influence of Process Water Quality on the Effect of Selected Chemical Additives for Production of Paper and Board

Background/Problem Area:

Chemical additives have an important influence on the quality properties of paper. They are needed for an optimal and efficient production process as well as for the adjustment of essential paper properties. Although the share of chemical additives (incl. starch) of all used material is only 3 % today it is difficult to imagine to produce paper and board without these useful chemicals. An optimal dosage of chemical additives is commonly very difficult and depends on a lot of parameters such as used fibres and fillers, manufactured paper grade, plant technology and installations, process management and so on. Chemical additives, both process chemicals and functional chemicals, have to be used sparingly due to the costs in purchasing and due to environmental protection. In this context the quality and purity of process water as carrier medium is of outstanding importance. Charged particles, filterable substances, colloidal and dissolved compounds in process water influence the effect of chemical additives. Because of closure of water circuits, increasing use of recovered paper and fillers as well as new technologies and requirements on the manufacturing of pulp and paper general conditions for the application and the impact of chemical additives are constantly changing.

Objective/Research Result:

As an example for different retention agents (quantitatively the most important representatives of process chemicals) and several wet strength agents (as functional chemicals) the impact of process water parameters (for example COD, pH, water hardness, filterable substances, conductivity, cationic demand, zeta potential, surface tension) on the effect of the additives should be investigated. For this purpose fibre suspensions and process water samples from the paper production process will be used to simulate real conditions. The sampling of fibre suspensions and process water for investigation of retention agents will be carried out in paper mills for the production of corrugated paper. Results of the retention and drainage tests in the first paper mill have shown that the dry matter content of process water has a significant influence on the effectiveness of retention agents, whereas other parameters like COD, pH (in the buffered range), cationic demand do not affect the retention and drainage behaviour significantly. Wet strength agents will be tested in process water from tissue mills. Exactly defined amounts of chemical additives will be added. The effect of the additives will be tested after formation of lab sheets. The emphasis of the investigation is to understand the chemical interactions between the process water quality and the effect of different chemical additives, to find correlations and to optimise the usage of the chemical additives. Furthermore knowledge about the required purification of white water should be gained.

Application/Economic Benefits:

Chemical additives are used in all paper and board mills in Germany. An efficient use of additives with optimal effect is of great importance in terms of economical and ecological aspects. This is only possible if the influence of process water quality is known and the dosage of additives can be adapted to the different chemical and physical parameters of process water. Recently mills increasingly reported production problems with deposition of particulate matter and web breaks at irregular intervals. These production failures often attributed to uncontrolled interactions between the chemicals among themselves and with constituents of process water. These problems are associated with huge economical damage for the paper mill concerned.

Project Period: 01.01.2014 – 31.12.2015

Remarks:

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Forschungsgebiet: Produkt-Ziele

Papier- und Kartonherstellung // Papierherstellung

Schlagworte:

Primärfaserstoffe, Überkritische CO_2-Extraktion, Trocknung, Bleiche

Topic:
Supercritical CO_2 ($scCO_2$) Treatment of Virgin Pulp – Effect on Bleaching and Drying Processes

Background/Problem Area:

Supercritical CO_2 extraction is a widely used technique for many applications: decaffeination of coffee, extraction of hops, herbs, spices; removal of mineral oils from contaminated soils, textile dyeing, impregnation and other processes. Within the last 10 years other interesting research work has been published: Drying of textiles (made of cotton or silk), dewatering of sapwood and others. An ongoing project at PMV deals with the supercritical CO_2 extraction of paper for recycling to remove contaminants as mineral oils and others. In November 2011 CEPI launched the Forest Fibre Industry 2050 Roadmap. As one of the eight breakthrough technology concepts to reduce the fossil-based CO_2 emissions, drying with supercritical CO_2 was pointed out. By using supercritical fluids for drying of pulp and paper a lot of heat and steam could be saved. To take CO_2 in a supercritical state only little energy is required due to the moderate critical point of CO_2 (temperature > 32 °C, pressure > 74 bar [7,4 MPa]). $ScCO_2$ shows interesting chemical and physical properties. The viscosity is in the range of the gaseous state, the diffusion coefficient and the density are similar to a liquid matter. Due to these properties $scCO_2$ has a high dissolving power, very interesting penetration and transport properties. In the supercritical state CO_2 has no boundary surface and no interfacial tension. Therefore $scCO_2$ shows outstanding wettability of surfaces and complete diffusion into the pores.

Objective/Research Result:

By means of this research project some fundamental questions should be answered:

- Is it possible to treat pulp and paper with high moisture/water content successfully?
- Is it possible to dry paper by means of $scCO_2$?
- How does the $scCO_2$ treatment affect the optical properties of pulp and paper? Are there any impacts on the bleaching process?
- How does $scCO_2$ treatment influence paper properties and process water quality?

At PMV a high pressure plant in lab scale is running for the experiments with $scCO_2$. $ScCO_2$ is a nonpolar solvent. Due to that fact it has to be investigated how much $scCO_2$ is needed to remove the polar components like water. Therefore the drying potential will be evaluated. Next to the influence of the extraction on optical, fibre, surface and mechanical properties, also a reduction of chemical additives will be investigated by analysing two retention agent systems for their effectivity in the process water.

First results show, that it is possible to dry refined TMP with a dry content of 50 % up to 96 %. The solubility of water in CO_2 (at 400 bar and 90 °C) is at the beginning of the drying process around 6 g water in 1 kg CO_2 and decreases with increasing dry content of the sample. Using a high amount of CO_2, which flows through the TMP in the extractor, the optical and mechanical properties of the TMP were investigated. It can be shown, that no significant influence on the optical properties is detected and that the mechanical strength decreases only a little bit due to the extraction. But these results must be verified in the next project time. Furthermore, the extraction has no influence on the retention behavior of TMP and chemical pulp using different retention agents. And typical process water parameters like pH-value or the electrical conductivity are not affected, too. Interesting is, that the chemical oxygen demand (COD) of the TMP can be reduced due to the extraction by nearly 50 %. But also these results (influence on retention and process water quality) must be verified, too.

Application/Economic Benefits:

The technology offers savings exactly where the largest fossil CO_2 emissions take place today, in the drying section of pulp and paper. CO_2 can be obtained from industrial gas producers. It is not emitted in the $scCO_2$ treatment plant but used in a close system and constantly recycled. According to CEPI, replacing the drying section could reduce energy costs by 10-20 %, as well as allowing for lower infrastructure costs and boiler capacity. Heat and steam for drying would no longer be needed. This project will establish a basis for the technology of CO_2 extraction, to identify an energy efficient alternative to current methods of fibre preparation and paper drying processes.

Project Period: 01.07.2014 − 30.06.2015

Remarks:

The research project INFOR 179 is being funded by Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V.

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Forschungsgebiet: Prozess-Ziele

Papier- und Kartonherstellung // Papierherstellung

Schlagworte:

Papiermaschine, Initiale Nassfestigkeit, Fasermorphologie, freier Zug

Thema:
Initiale Nassfestigkeit von Papier

Ausgangssituation/Problemstellung

Es gibt eine Vielzahl von Veröffentlichungen, die empirisch zeigen, dass die initiale Nassfestigkeit von Papierbahnen durch Additive, mechanische oder chemische Fasermodifizierungen beeinflusst werden kann. Dem gegenüber gibt es jedoch kaum Hinweise in der Literatur, welchen chemischen oder physikalischen Mechanismen die initiale Nassfestigkeit folgt und wie diese gezielt beeinflusst werden kann.

Die initiale Nassfestigkeit stellt im Papiererzeugungsprozess die wichtigste Größe zum Einstellen des ersten freien Zuges in der Papiermaschine dar und ist damit der wichtigste Parameter zur Verringerung von Abrissen innerhalb der Papiermaschine. Insbesondere für Papiere, die ein niedriges Flächengewicht haben und/oder die auf Maschinen mit offener Bahnführung nach der Sieb- oder Pressenpartie gefertigt werden, ist dieser Parameter sehr wichtig.

Immer höhere Maschinengeschwindigkeiten in der Folge von Produktivitätssteigerungen führen zu größeren Zugbeanspruchungen der Papierbahn, die häufig zu Abrissen führen. Der Wirkungsgrad einer Papiermaschine ist dabei immer nur so gut, wie der schwächste Abschnitt der Anlage. Der erste freie Zug mit noch initial nasser Papierbahn kann daher den Gesamtwirkungsgrad empfindlich reduzieren.

Forschungsziel/Forschungsergebnis

Das Ziel dieses Projekts ist es, die Mechanismen der initialen Nassfestigkeit zu identifizieren und dieses Wissen zu nutzen, um die initiale Nassfestigkeit in der Produktion von Papieren gezielt zu steigern und damit eine wirtschaftlichere Papierherstellung zu ermöglichen.

Am Rasterelektronenmikroskop konnten sehr gute Aufnahmen zur Festigkeitsentwicklung im nassen Papier gemacht werden. Die Bilder zeigen am realen Blatt mit entsprechend hohen Wassergehalten das Verhalten der Fasern und Fibrillen, das bislang nur in Modellvorstellungen beschrieben werden konnte. Die Untersuchungen zu den Phänomenen der Festigkeitsbildung wurden mit unterschiedlichen Faserstoffen und physikalischen Randbedingungen erfolgreich durchgeführt. Aus den Ergebnissen konnte eine optimierte Nutzung von Additiven abgeleitet werden, die derzeit in Zusammenarbeit mit den Industriepartnern nach Laborversuchen in die Praxis umgesetzt werden sollen. Die Ergebnisse der verschiedenen Partner werden in den Arbeitstreffen ausführlich diskutiert.

Anwendungen/Wirtschaftliche Bedeutung

Die Herstellung der Muster für die Mikro- und Makroanalytik wird über die Blattbildner im Labor der Hochschule München erfolgen, oder über die Versuchspapiermaschine vom Institut für Verfahrenstechnik Papier e. V. Diese hat eine Siebbreite von 22 cm und eine Zwei-Nip-Presse. Über die Einstellungen in der Sieb- und Pressenpartie kann der Trockengehalt der Muster sehr variabel eingestellt werden. Sie eignet sich daher optimal zur schnellen Generierung unterschiedlicher Muster.

Die Papierindustrie und die entsprechenden chemischen Zulieferfirmen bestätigen immer wieder die gute Reproduzierbarkeit der Ergebnisse auf einer solchen Maschine.

Die bayerische Papierindustrie produziert mit großen, schnelllaufenden Maschinen an verschiedenen Standorten Druck- und Verpackungspapier sowie auf langsamer laufenden Maschinen Spezialpapiere. Beide Gruppen haben ein großes Interesse an den Ergebnissen dieses Projekts. An den Maschinen mit großer Tonnage und Geschwindigkeiten sind es besonders die Adhäsions-und Fliehkräfte, die eine hohe initiale Nassfestigkeit in der Presse erfordern. Bei den Spezialpapierherstellern sind es vor allem freie Züge und damit verbundene Zugspannungen zwischen den einzelnen Prozessschritten, die dem noch nassen Papier hohes Kraftaufnahmevermögen abverlangen.

Bearbeitungszeitraum: 01.05.2012 − 31.12.2015

Bemerkungen

Das Forschungsprojekt wird gefördert durch die Bayerische Forschungsstiftung, München. An diesem Kooperationsprojekt beteiligen sich sieben Unternehmen aus der Wirtschaft.

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Research area: Process aims

Paper and paperboard production // Papermaking

Key words:

wet-laid, nonwoven, spunlace, speciality paper

TITLE:
Development of new paper and wet-laid nonwoven materials by inclined wire technology and integrated spunlace treatment for innovative uses in fibre composite materials

Background/Problem area

Fibre-plastic composites for high performance applications are among the most advanced materials with a dynamically growing market potential. Due to their low weight, fibre-plastic composites are also increasingly used for lightweight solutions in other industries such as rail vehicle, machine and apparatus manufacturing or plant engineering and construction. The necessary breakthrough for mass application is currently hampered by the low level of automation in their production and resulting high costs. Currently, fibre-reinforced plastics are produced by different process technologies which are characterized by long processing and cycle times and therefore of only limited suitability for mass production. For the production of high-performance and especially high-strength components, thermosetting systems continue to be most widely used materials.

Objectives/Research results

The project aim is to determine if or to what extent it is possible to produce reasonably priced nonwovens meeting the specific requirements of fibre materials for fibre-reinforced composites by combining wet-laid nonwoven production with a two layer inclined wire paper machine and spunlace treatment. For this purpose, the following three aspects are to be investigated:

- Relationships between fibre properties (surface roughness, fibre flexibility, fibre length, bonding properties, fibrillation) and the web properties achievable by single and two-layer web forming on an inclined wire machine
- Identification of relationships between the geometrical and material parameters of dewatering wires and achievable web properties
- Determination of technological fundamentals for the control of web properties (stress-strain behaviour, impregnation, porosity) by fibre re-orientation in z-direction through spunlace treatment.

It will be investigated to what extent the structural characteristics of wet-laid nonwovens produced with an existing inclined wire machine can be modified by subsequent spunlace treatment. The influences of different pulps, functional additives and paper-technological parameters as well as of the spunlace treatment on the structural properties and impregnation behaviour of wet-laid nonwoven materials will be evaluated.

The two-dimensional fibre-based materials will be processed to multilayer composite components (demonstrators) and subjected to customary physical tests. Based on these results, concepts for using the composites in products will be developed.

For the first tests, various natural and synthetic fibres were procured and characterized. Fibres were selected based on their suitability for inclined wire technology and the manufacture of semi-finished products for fiber-reinforced composites. Another criterion was that the fibres were expected to give significant strength gains when used in combination with the subsequent spunlace treatment.

Application/Economic benefits

Due to the high cycle times of their production processes, applications based on thermosetting matrix systems have been limited to small series so far. Developments in the field of lightweight construction were therefore almost exclusively focused on thermoplastic material systems. Research is needed to develop possibilities for reducing the cost of fibre-based reinforcement elements. In view of the required higher level of automation, work in this area should focus on endless components which can be used in continuous processes. Papermaking pulps are significantly cheaper than the carbon, synthetic or regenerated fibres currently used for reinforcement.

Period of time: 01.04.2015 – 31.03.2017

Remarks

The RTD project IK-MF 140216 being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Research area: Process aims

Paper and paperboard production // Surface treatment

Key words:

surface treatment, coating, polymer brushes, polymer grafting, antimicrobial equipment

TITLE:
Development of a procedural approach to functionalize paper surfaces using the example of antimicrobial finishing

Background/Problem area

This new procedural approach enables the covalent attachment of stable polymer layers on paper surfaces. The surface is modified to prevent microbial infestation on paper (wallpaper, tissue, packaging paper). The antimicrobial activity can be enhanced by stimuli-responsive induced changes (switch) in functional surface properties caused by a so-called polymer brush layer. Biocidal molecules are chemically introduced into the polymer brush structure and attached onto paper surfaces.

Antimicrobial substances in/on paper, like silver nanoparticles, stannic organyles, triclosan or antibiotics, are already known. Because of their toxicity and danger of developing bacterial resistances, these substances have disadvantages. In addition, they are not tightly bound and can be released or consumed. Accordingly, there are concerns about possible health-damaging effects, which provided the starting point of this project.

Objectives/Research results

The aim of this project is to develop a generally applicable process to covalently bind switchable polymers to paper surfaces via grafting-to polymerization. The functionalization is intended to be permanent, without release of active ingredients to the environment. This new paper surface treatment by the grafting-to process of polymer brushes would avoid common problems of conventional antimicrobial functionalization such as toxicity of active substances or development of bacterial resistances. In addition, the antimicrobial effect will only be induced in case of need.

Important results achieved until now are:

- Development of a model substrate, for which Si-wafers have been spin-coated with cellulose derivatives to perform grafting-to polymerizations and evaluate the polymer brush structures,
- Synthesis of an antifouling polymer,
- Procurement of different industrial paper samples which will later be surface-treated to prove the concept.

Application/Economic benefits

As a result of this research project specifications will be formulated for novel or improved paper surfaces enabling for example switchable antimicrobial properties. Such new functionalization should lead to new possibilities in paper and tissue finishing as well as to more versatile and innovative applications beyond antimicrobial finishing.

Until now it has not been possible to provide paper with switchable antimicrobial activity by means of a grafting-to process. This leads to the assumption that the project will arouse great market interest.

The project results can be expected to benefit mainly small and medium sized enterprises in the tissue, technical paper and wallpaper industry.

Period of time: 01.04.2015 – 30.09.2017

Remarks

The RTD project IGF-Koop 18696 BR is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi) carried out in cooperation with the IPF Nanostructured Materials.

PROZESS-ZIELE

Forschungsgebiet
Weiterverarbeitung

Trennen
Verbinden/Fügen
Umformen
Beschichten

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Forschungsgebiet: Prozess-Ziele

Weiterverarbeitung // Umformen

Schlagworte:

Tiefziehen, wirkmedienbasiertes Umformen, mehrdimensionaler Spannungszustand, Materialcharakterisierung

Topic:
Application of Hydroforming Processes for 3D Forming of Paper and Board

Background/Problem Area:

3D forming of paper and board is established in classic deep drawing processes. It is used for example for the production of paper plates, cheese boxes and French fries dishes. These products are manufactured for decades in almost unchanged manner. They usually have low degrees of deformation and simple geometries. Recent studies show, however, that the deep drawing of paper has a much larger potential.

A more widespread use of deep drawing processes in paper converting is currently restrained by a lack of understanding of the factors that influence the forming results. This implies that simulation possibilities for design and layout of new geometric shapes do not exist. Suitable material laws that could be used for description of the material behaviour under multiaxial load are not available. In addition, the production of complex three-dimensional structures is constrained by the typically poor ductility of paperboard.

Hydroforming, a commonly used variety of sheet metal forming, allows the production of complex shapes at high degrees of deformation. It appears reasonable to examine whether a transfer of knowledge from the metal sector to paperboard forming is possible.

Objective/Research Result:

The aim of the research project was a further development of deep drawing of paper to model-based development methods, more complex components and adapted materials. The two main issues of the project were:

- What qualities must paper have to show optimal formability?
- How do forming processes have to look like in order to form paper optimally?

A bulge test method suitable for paperboard testing was used to measure the influences of different raw material compositions as well as laboratory treatments on the mechanical properties of paper. In the observed hydroforming process both, the achievable deformation degree and the workpiece quality, strongly benefit from a high breaking strain. Therefore in particular those factors that influence paper's elongation were investigated in detail. This includes the intentional creation of curled fibres as well as an analysis of the effects of drying conditions, temperature, moisture and filler content.

Further steps of the project included FEA investigations, fibre treatments with enzymes and closer investigations of the Poisson's ratio of paper. A highly sensitive, specially adjusted friction tester has been developed and deeper looks into the influences of moisture, temperature and coatings on the mechanical properties of paper were taken. Finally, the developed simulation model could be used to design a demonstrator that was subsequently produced.

Application/Economic Benefits:

With the development of formability optimised paper and corresponding forming processes new market opportunities and applications for the products could arise. For example, optimised deep drawn paper would benefit from the fact that sustainability and ecology thoughts increasingly influence the selection of packaging and are used specifically for marketing.

Also in the automotive industry, the furniture industry and in the architecture new applications for paper, with its excellent recycling facilities and good lightweight properties, could arise. Appropriate modelling tools would thus considerably broaden the range of economically producible paperboard geometries. The gained knowledge concerning favourable stock compositions and production methods can be of interest for board mills as well as manufactures of different other paper grades.

Project Period: 01.05.2013 - 30.04.2015

Remarks:

The project IGF 17788 N of the research association Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V. is funded by German Federal Ministry for Economic Affairs and Energy (BMWi) and performed in close cooperation between PtU and PMV.

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Forschungsgebiet: Produkt-Ziele

Weiterverarbeitung // Beschichten

Schlagworte:

Mineralölmigration, Barrierecoating, Nachwachsende Rohstoffe, Celluloseester

Thema:
Neue Barriereschichten auf Basis von Cellulose-Nanokolloiden

Ausgangssituation/Problemstellung

Barriereschichten stellen in vielen Bereichen der funktionalen Ausrüstung von Papieren eine wichtige Grundlage für die Performance einer ganzen Reihe von Papiersorten dar. Oft werden heute z. T. schwierig zu rezyklierende Beschichtungsmaterialien (Kunststoffe, Metalllaminate, etc.) eingesetzt oder solche, die aufgrund von Inhaltsstoffen nicht in allen Anwendungsbereichen eingesetzt werden können (z. B. Oberflächen in Kontakt mit Lebensmitteln), um z. B. Barrieren für Wasserdampf, Fett, Sauerstoff, Mineralöle, etc. zu schaffen. Barrieren aus „nachwachsenden Rohstoffen“ haben häufig den Nachteil, dass sie entweder sehr teuer sind, oder im Vergleich zu den vorgenannten Materialien nicht über eine ausreichende Performance verfügen. In ersten Arbeiten am Lehrstuhl MAP wurden in der Gruppe von Dr. Kai Zhang neuartige Cellulose basierte, hydrophobe Nanokolloide hergestellt, die sich hervorragend dafür eignen, Papiere zu beschichten und Oberflächeneigenschaften gezielt einzustellen.

Ausgehend von mikrofibrillierter Cellulose wurden in Vorarbeiten verschiedene Celluloseester mit gesättigten Fettsäuren dargestellt. Durch ein spezielles Verfahren (Nanoprecipitation in wässriger Lösung) können kolloidale Celluloseesterpartikel mit mittleren Durchmessern von 80 − 300 nm erhalten werden. Als nächster Schritt ist es von großem Interesse die Barriereeigenschaften dieser Filme besser zu verstehen sowie bereits im Hinblick auf einen möglichen technologischen Einsatz unterschiedliche Auftragsverfahren zu evaluieren und die daraus erhaltenen Filmstruktur-Filmeigenschaftsbeziehungen abzuleiten. Um dies durchzuführen wird Expertise in der Darstellung der Materialien (TU Darmstadt, MAP) und andererseits Expertise in Standardcharakterisierungen der Barriereeigenschaften (PTS München) eingesetzt.

Forschungsziel/Forschungsergebnis

Ziel des Forschungsvorhabens ist es, die Barriereeigenschaften der Papierbeschichtungen, welche aus hydrophoben Cellulose-Nanokolloiden aufgebaut sind, zu untersuchen und daraus abzuleiten, ob diese Beschichtungen eine „nachhaltige“ Alternative für konventionell eingesetzte Barriereschichten darstellt. Im Fokus der Untersuchungen sollen Eigenschaften wie die Wasserdampfdurchlässigkeit und die Fähigkeit den Übergang von Mineralölen zu unterbinden, stehen. Während an der TU Darmstadt (MAP) die Cellulose-Nanokolloide erzeugt und als Barriereschicht auf Modellpapiere aufgebracht werden, sollen die Barriereeigenschaften dieser neuartigen Beschichtungen im Detail an der PTS untersucht und verstanden werden. Ein weiteres Ziel ist es verschiedene Auftragsverfahren im Hinblick auf die sich ergebenden Barriereeigenschaften zu evaluieren. Letzteres soll insbesondere auch temperaturabhängig untersucht werden, da sich die Morphologie der Filme bei 70° C ändert und damit sich auch Barriereeigenschaften ändern – im Erfolgsfall sogar gezielt „thermisch schalten“ lassen. Schließlich soll die Rezyklierbarkeit der Barriereschichten untersucht werden. Das über INFOR finanzierte Anschubprojekt ist so ausgelegt, dass man sich sehr gut vorstellen kann, im Anschluss eine Verstetigung der Arbeiten durch ein öffentlich gefördertes Projekt anzustreben.

In ersten Schritten wurden Partikel aus Celluloseacetat/-butyrat hergestellt und hinsichtlich chemischer und thermischer Eigenschaften charakterisiert. Der Auftrag auf Modellpapiere erfolgte durch ein Sprühverfahren. Die wenige µm dicken Filme zeigen spannende Eigenschaften u. a. in Kontakt mit wässrigen Lösungen: die Oberflächen zeigen superhydrophobe Eigenschaften, was auf die partikuläre Natur der Filme, und die damit verbundenen Rauigkeit auf nano- und µm-Skala zurückgeführt werden kann. Barriereeigenschaften, wie Wasserdampfdurchlässigkeit, Fettdichtigkeit und Mineralölmigration werden zur Zeit in Abhängigkeit der intrinsischen Parameter der applizierten Filme (Beladungsdichte, chemische Zusammensetzung und Mikrostruktur) untersucht.

Anwendungen/Wirtschaftliche Bedeutung

Barriereschichten auf der Basis von nachwachsenden Rohstoffen können für eine Vielzahl von Anwendungen im Bereich der Verpackungs- und Spezialpapiere eine Alternative zu bestehenden Systemen darstellen. Die Rohstoffe für die Herstellung der Nanokolloide (Cellulose und Fettsäuren) sind zu 100 % nachwachsend und der vorgeschlagene Ansatz zielt somit auf die Entwicklung „nachhaltiger“ Lösungen für neuartige Barriereschichten ab.

Bearbeitungszeitraum: 01.1.2015 − 31.12.2015

Bemerkungen

Das Projekt INFOR-Nr. 185 wird aus Mitteln des Kuratoriums für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V. finanziert.

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Forschungsgebiet: Prozess-Ziele

Weiterverarbeitung // Umformen

Schlagworte:

Werkstoffverbunde

Thema:
Effiziente Herstellung von ebenen metallischen- und metall-keramischen Verbundfolien durch papiertechnologische Beschichtungs- und Verarbeitungsverfahren und deren Weiterverarbeitung zu zwei- und dreidimensionalen Demonstratoren (PaperTape)

Ausgangssituation/Problemstellung

Ebene multifunktionale und schadenstolerante metallische und metall-keramische Werkstoffverbunde mit definierten Funktions- und Strukturmerkmalen gewinnen in verschiedenen Einsatzgebieten immer mehr an Bedeutung. So wird z. B. intensiv an ihrem Einsatz in der Umwelttechnik (Membranen) gearbeitet, da sie die notwendigen funktionellen Eigenschaften mit einer hohen Schadenstoleranz unter Betriebsbedingungen verknüpfen können. Inhalt des Forschungsvorhabens ist es, Metall-Keramik-Endlosfolien zu entwickeln und deren Herstellung über einen massentauglichen papiertechnologischen Fertigungsprozess zu demonstrieren, sowie die effiziente papiertechnologische Verarbeitbarkeit für die ausgewählten Werkstoffkombinationen zu großflächigen (grünen) Halbzeugen zu entwickeln.

Forschungsziel/Forschungsergebnis

In den bisherigen Arbeiten wurden bereits dünne Keramikschichten in Kombination mit metallischen Schichten erfolgreich appliziert. Dabei konnten funktionelle Schichten im Bereich weniger Mikrometer hergestellt werden.

Die hergestellten Grünfolien wurden in einem weiteren Verarbeitungsschritt zu gewellter Metall-Keramik-Grünfolie umgeformt und anschließend eine Co-Sinterung durchgeführt.

Die Vorteile gegenüber der etablierten Technologie zur Herstellung von großflächigen keramischen Bauteilen sind eine Verringerung der Blechdicke von 0,3 mm–0,5 mm auf 0,05 mm–0,2 mm und damit 50 %–75 % weniger Materialeinsatz, die Steigerung des Abscheidegrades sowie eine effizientere Fertigung durch die Nutzung vorhandener Produktionstechnik.

Anwendungen/Wirtschaftliche Bedeutung

Die Herstellung mehrlagiger Metall-Keramik-Werkstoffverbunde ist von hohem wirtschaftlichem Interesse. Der Bedarf liegt vor allem im Bereich der Energie- und Umwelttechnik sowie in der Produktionsverbesserung von gesinterten keramischen und metallischen Bauteilen.

Für Firmen aus der Papierindustrie ergibt sich ein völlig neues Anwendungsgebiet, sowohl für Hersteller von Streichanlagen als auch für die Produzenten gestrichener und strukturierter Papiere.

Bearbeitungszeitraum: 01.12.2014–30.11.2016

Bemerkungen

Bundesministerium für Wirtschaft und Energie

Das IGF-Vorhaben 18520 BR der Forschungsvereinigung Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V., Adenauerallee 55, 53113 Bonn wird über die AiF im Rahmen des Programms zur Förderung der Industriellen Gemeinschaftsforschung (IGF) vom Bundesministerium für Wirtschaft und Energie aufgrund eines Beschlusses des Deutschen Bundestages gefördert.

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Forschungsgebiet: Prozess-Ziele

Weiterverarbeitung // Umformen

Schlagworte:

Formteile, Zellulose, Nachwachsende Rohstoffe, Umformverfahren

Thema:
Entwicklung von dreidimensionalen Formteilen mit speziellen Eigenschaften aus zellulosebasierten, nachwachsenden Faserstoffen

Ausgangssituation/Problemstellung

In der Verpackungstechnik haben sich die Packstoffe Papier und Karton weltweit besonders in Form von flexiblen Packmitteln, Faltschachteln und Dosen etabliert und werden insbesondere auch wegen ihrer Umweltfreundlichkeit zukünftig noch an Bedeutung gewinnen. Das Potential von Papier und Karton und noch mehr das der Faserstoffe, aus denen sie hergestellt werden, ist aber durchaus noch längst nicht erschöpft. Ihr in dieser Hinsicht wesentlicher Nachteil ist die begrenzte Verformbarkeit, die die Gestaltungsspielräume bei Packmitten ebenso einengen wie in neuen, technisch und wirtschaftlich hochattraktiven Anwendungsbereichen, z. B. im Bereich des Leichtbaus.

Zwar werden biogene Fasern schon seit einiger Zeit für die Herstellung von Kunststoffverbunden eingesetzt, aber die Matrixwerkstoffe sind fast immer synthetische Polymere. Der Einsatz natürlicher Polymere würde die Umweltkompatibilität solcher Verbundwerkstoffe und eventuell auch ihre Rezyklierbarkeit deutlich verbessern. Solche Entwicklungen stehen aber erst am Anfang. Überraschend ist dabei, dass die Möglichkeit, Formteile ausschließlich auf der Basis von Llignocellulose oder Cellulose herzustellen, bisher weitgehend unberücksichtigt blieb. Mit dem Projekt soll die Realisierbarkeit dieses Ansatzes zur Herstellung vermarktungsfähigen Produkte zellulosebasierter Formteile für konkrete Anwendungsbereiche bewertet werden.

Forschungsziel/Forschungsergebnis

Das geplante Projekt zielt auf die wissenschaftliche und technologische Entwicklung innovativer Formteile mit anwendungsspezifischen Eigenschaften ab, die die wirtschaftliche Substitution von nichtbiogenen Produkten erlauben. Die Innovation des Verfahrens liegt in dem Einsatz von zellulosebasierten, nachwachsenden Rohstoffen, deren Eigenschaften durch das Herstellungs- bzw. Umformungsverfahren und durch den Einsatz von eigens entwickelten Additiven systematisch entwickelt und gesteuert werden können

Der Vorteil des zu entwickelnden Verfahrens- und Produktkonzepts resultiert aus dem Umstand, dass insbesondere Umformgrad, Festigkeitseigenschaften und Formstabilität durch Rezeptur und Fertigungsparameter gezielt und anforderungsgerecht entwickelt werden können. Projektziel ist die Entwicklung eines Verfahrens zur Herstellung 3-dimensionaler Formteile, die ausschließlich aus zellulosebasierten Faserstoffen bestehen.

Dazu gehört sowohl die geeignete Material- als auch die Prozessentwicklung. Es soll zunächst ein Grund- bzw. Vormaterial entwickelt werden, welches – bestehend aus 100 % Zellulose – zur Umformung im „Thermopress-Verfahren“, zur Freihandformung bzw. Modellierung geeignet ist. Darüber hinaus muss das Umformverfahren entsprechend angepasst und parametriert werden, um die Verarbeitung des speziellen Materials zu ermöglichen. Der große Vorteil an der Entwicklung von Material und Umformverfahren ist die Tatsache, dass damit direkt im Herstellungsprozess die Eigenschaftsentwicklung gesteuert werden kann. D. h. die Formteileigenschaften können anforderungsspezifisch durch den Aufbau, die Rezeptur und die Produktionsparameter in einem breiten Bereich festgelegt und eingehalten werden. Somit können neue und erweiterte Anwendungsgebiete für zellulosebasierte Formteile erschlossen werden.

Anwendungen/Wirtschaftliche Bedeutung

Vor dem Hintergrund der aktuellen umweltpolitischen Zielsetzungen können im Falle der erwarteten positiven Projektergebnisse erhebliche Impulse für die Verbesserung der Marktposition und der Einsatzmöglichkeiten zellulosebasierter Formteile generiert werden. Fortschritte auf diesem Gebiet sind das erklärte Ziel der Papierindustrie und Gegenstand in jüngerer Zeit intensiv forcierter Forschungsaktivitäten. Durch die Möglichkeit eines hochflexiblen Formgebungsverfahren und einer angepassten Werkstoffbeschaffenheit werden für zellulosebasierte, nachwachsende Faserstoffe neuartige Einsatzbereiche erschlossen und damit ein Beitrag zur Ressourcenschonung und zur Kreislaufwirtschaft, d. h. der stofflichen Verwertung von Biomasse geleistet.

Bearbeitungszeitraum: 01.05.2014 – 30.09.2016

Bemerkungen

Das ZIM-Projekt KF 2418621TA3 wird über die AiF Projekt GmbH vom Bundesministerium für Wirtschaft und Energie (BMWi) aufgrund eines Beschlusses des Deutschen Bundestages gefördert. Das Projekt wird in Kooperation mit der OF Stanz- und Dichtungstechnik UG bearbeitet.

PROZESS-ZIELE

Forschungsgebiet
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Research area: Process aims

Process measuring and control technology

Key words:

analytics, analytical methods, mineral oil, monitoring

TITLE:
A feasibility study for a rapid method for quantifying traces of hydrocarbons in mineral oils in papermaking

Background/Problem area

In preparation for the scheduled legal regulation of the migration of mineral oil from paper packaging to foodstuffs, many raw materials and papers are currently being examined for their mineral oil contents in different process and production stages. Current gas chromatographic determination procedures are slow and costly from the human resources point of view. There is a basic lack of a method that would allow for rapid detection and estimation of the quantities contained in the individual process stages of a production plant. The development of such a procedure poses a challenge to the currently available analysis and sensor technology owing to the small quantities to be detected, the complex composition of mineral oils and any existing interference of the matrix. Yet it should be borne in mind that since solutions have already been found in other fields with comparably difficult with comparably difficult issues (e.g. the detection of noxious, odorous and explosive substances), this ought to be possible as well in the case of aromatic hydrocarbon traces.

Objectives/Research results

The objective of the research project is to verify the technical feasibility of a rapid procedure for determining mineral oil traces. The verification should provide evidence within the framework of a feasibility study comprising the following work packages:

WP1: Drawing up a requirements profile as the basis for assessing any eligible methods

WP2: Literature searches for potentially suitable methods

WP3: Collection and evaluation of the search results

WP4: Determination of benchmark figures for the technical implementation of correspondingly suitable measuring instruments

In coordination with the Supervising Committee, it was decided that the feasibility study was to focus in particular on a faster laboratory procedure designed to improve the shortcomings of current gas chromatographic methods. The current method is unsatisfactory because it is slow, requires a major personnel effort and produces multiple results in some cases.

The basic components required for a rapid method include a device for detecting and concentrating mineral oil traces (sampler), a device for separating interfering substances and fast-response detectors. The more sensitive and selective the detectors are, the less effective the other two basic components have to be.

According to past literature searches, thermodesorption appears to be a promising method for detecting and concentrating mineral oil traces. Accordingly, further project work should give more detailed consideration to automated procedures such as adsorption/thermodesorption, SPME (Solid Phase Micro-Extraction) and Purge&Trap. These are also capable of separating interfering compounds. Besides water, the latter include in particular low-molecular-weight hydrocarbons (< 16 C atoms), fatty acids, resin acids and their esters.

The following detectors and detection procedures were also taken into consideration: semiconductor gas sensors, especially metal oxide sensors, oscillating quartz sensors such as SAW (Surface Acoustic Wave) sensors, ion mobility spectroscopy (IMS), infrared spectroscopy (FTIR), flame ionisation detectors (FID) and photoionization detectors (PIDs).

In the course of the literature searches, many mobile devices were found that are easy and simple to handle and already contain the three basic components listed above. Test measurements are to be conducted using a few selected devices.

Application/Economic benefits

The planned method should allow for a quick classification of raw materials and the papers produced in respect of the contents of aromatic and aliphatic mineral oil hydrocarbons. The method should contribute to a more flexible utilisation of existing raw materials and should also be able to be used as an instrument in quality assurance. The rapid method should not only replace existing gas chromatographic methods recommended by the BfR (German Federal Institute for Risk Assessment) but also independently make fast pre-evaluation of sample materials possible.

Period of time: 01.04.2015 – 31.03.2016

Remarks

RTD project INFOR 189 is being funded by Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V.

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Research area: Process aims

Process measuring and control technology

Key words:

THz spectroscopy, suspensions, emulsions

TITLE:
Characterisation of emulsions and suspensions by means of ATR-THz spectroscopy

Background/Problem area

Many raw materials and media in the paper production, but also in other industrial sectors, are dispersions of liquids and solids, thereby emulsions or suspensions. These mixtures, which usually appear macroscopically homogeneous, consist of often completely immiscible fractions, whereby critical and user-relevant properties arise of the interaction of a number of parameters, ranging from the charge distribution and ion mobility up to the particle size distribution. In addition to the dry content or material density usually sum parameters are collected and used for production monitoring.

The measurement of density or dry matter of various dispersions seems to be an easy task in the industrial practice, but has not yet been solved for fibre suspensions of the paper industry. Common are microwave methods as well as techniques that mechanically determine the required values Therefore a substance-specific adaptation of the measurement technique is required in both cases.

The attenuated total reflection (ATR) spectroscopy is a niche terahertz measurement technique with a clearly defined field of application: it is suitable for highly absorbent and liquid samples.

Objectives/Research results

The aim of the project is to determine the composition of suspensions and emulsions using ATR-THz spectroscopy and to detect deviations from a desired value. The test setup should already be designed for a possible application as an inline measurement method. The goal for the field of paper making is, to shed light on the core parameters beginning with density and ash, and to evaluate the possibilities for detecting secondary components (stickies, starch, additives), which have significant effects on processes and production even in small quantities.

Technical results

- Setup of a terahertz spectrometer ATR
- Results on the suitability of fibre-coupled components in the THz-ATR spectroscopy
- Development of an algorithm for data analysis of the THz-ATR measurements
- Quantification of the attainable accuracy of the data analysis
- Statements about the robustness of the THz ATR measurements related to environmental conditions

Scientific results

- Creation of a simplified physical model of suspensions
- Derivation of the interaction between the suspension and the THz radiation within these models
- Database of terahertz spectra for suspensions of different composition and
- Combination of measurement results with the composition of the suspensions

Application/Economic benefits

The research results are especially useful in the fields of process technology, production, measuring, monitoring and automation, as well as in the industries of paper production and processing and food production, as well as in other areas where emulsions and dispersions represent raw materials in the production.

Economic benefits will be

- Ensuring a uniform and good production
- Improving the knowledge of the production process
- Prevention, reduction and faster recognition of rejects by early measurements in the suspension
- Selective detection of production disruptions and fluctuations

Period of time: 01.04.2013 – 31.03.2015

Remarks

The RTD project IGF 475 ZBG has being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Research area: Product aims

Process measuring and control technology

Key words:

Terahertz transmission measurements (THz), fibre orientation, internal stresses, paper reshaping

TITLE:
Determination of internal stress states in non-transparent, fiber-based nonwoven materials

Background/Problem area

Many isotropic materials have the property of being birefringent under mechanical stress and thus to rotate the plane of polarization of incident light. These stresses that arise in manufacturing and treatment processes are usually frozen in the moldings and affect their properties. Weaknesses in the product usually occur in the areas of higher stress states. Knowledge of these vulnerabilities is a prerequisite to understand material failures, optimize production processes and increase product quality.

The state of the art revealed that both the level of development of Terahertz measurement in terms of robustness and practicality as well as the possibilities of spatial resolution and speed are sufficiently advanced to parallel access the basis weight, thickness and fiber orientation in comparatively thick materials. Linking THz measurement data and strength characteristics of substitute tests should give statements on more complex states of reshaped materials.

Objectives/Research results

The aim of the project is to develop a measuring method (incl. testing regime) for the evaluation of stress states in fiber-based materials, which are caused by reshaping processing methods. Therefore sufficiently resolved measurement data from a THz system with respect to the material thickness, basis weight, and fiber orientation will be linked to conventionally detected force measurements during or directly after the reshaping of the materials. From the combination of strength parameters and THz based measurement data mathematical models are to be created to represent the basis of simulation approaches and to improve forming processes.

Until now a setup has been developed to perform THz measurements on single spots, lines and areas. The samples used have to be of a flat surface with no 3 dimensional shapes. These measurements run automatically, using up to 5 motorized axes. The resolution has been set to 1 mm in x-y direction. From the data the fibre orientation can be calculated as main angle of the fibres as well as their relative intensity. Additionally the thickness and grammage can be calculated as well.

First approaches on a fast software-based evaluation of the results out of raw data as well as a visualisation have been made.

Application/Economic benefits

The research results will be especially useful in the fields of processing fiber-based materials to innovative lightweight construction and packaging products with high material and energy efficiency and for suppliers of optimized process materials for special applications.

The development in the field of forming technology is crucial to the use and dissemination of this technology in packaging segments with high demands on the quality of packaging and to the automation and machine availability. In this way material and machine technology will be made available with which a new generation of molded parts and thus new opportunities for packaging technical correspondingly innovative products can be achieved. From the results an economically significant competitive advantage can be generated and an efficient and reliable implementation of new packaging strategies by forming is expected.

Project period: 01.11.2014 – 31.10.2016

Remarks

The RTD project IGF 18452 BR is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Research area: Process aims

Process measuring and control technology

Key words:

Raman spectroscopy, chemical imaging, paper analysis

TITLE:
Application of Raman Microscopy to Paper Analysis

Background/Problem area

With a few exceptions, paper is a product with a highly complex structure. Apart from fibrous materials, it contains a multitude of different components such as fillers, pigments, sizing and wet strength agents in addition to other chemical additives. The resulting paper properties depend strongly on the penetration and its consequent cross-sectional distribution (z-direction) of the additives in the paper sheet. Therefore, it is important to know the z-distribution of these substances in paper and paper board. However, analytical methods investigating the structure and composition of paper in z-direction have been lagging behind surface-analytical methods (x-y direction) to this day. Measurements in z-direction continue to present a major challenge regarding both local resolution and material specificity.

Raman spectroscopy offers new opportunities to analyse the z-distribution of substances in paper, making it possible to selectively detect organic and inorganic chemical compounds. The use of an excitation laser and an optical microscope provides for a very high spatial resolution of up to 1 µm. Paper samples can be measured directly, i.e. there is no need for lengthy or complicated preparation procedures. To study the distribution of substances, spectra are acquired point by point across the entire cross-section of the paper. The data collected in the scanned area can then be used to generate spectral images and distribution curves.

In addition, Raman spectroscopy is particularly suitable for the spectroscopic analysis of paper because the numerous OH groups present in cellulose give no signals in the Raman spectra. Therefore, unlike infrared and near infrared spectra, the Raman spectrum shows many characteristic vibration bands of the other paper components which can then be evaluated.

Objectives/Research results

The objective of the research project was the development of Raman Chemical Imaging measuring methods for paper analysis. The developed measuring and analysis methods allow the detection and identification of chemical substances in the paper cross-section and the evaluation of their distribution with a spatial resolution of up to 1 µm. The Raman Imaging analysis tools are part of the multispectral image analysis system DOMASmultispec by PTS.

The following results have been achieved:

- Development of measuring and analysis methods for Raman imaging measurements on paper
- Development of a spectral imaging software for the analysis of Raman imaging and other data, e.g. NIR imaging data
- Development of two standard analysis methods for
  - Detection and identification of individual substance layers in a multilayer system
  - Distribution analysis of paper component along the paper cross-section
- The developed measuring and analysis methods have been tested and demonstrated on different paper systems

The results of the project have been presented, for example, at the 26th PTS Streicherei Symposium in Munich from 16 to 17 September 2013 and at the XXIV. International Conference on Raman Spectroscopy in Jena from 10 to 15 August 2014.

Application/Economic benefits

The use of the Raman imaging technique for the micro analysis of the paper cross-section offers new promising possibilities to investigate the distribution of chemical particles and components in paper and to evaluate coatings. Until now, Raman spectroscopy has mostly been used for product control in the pharmaceutical and polymer industry. Applications in the paper industry still have to be explored and developed.

Raman imaging represents a major enhancement to the capabilities of other methods that were used to analyse paper cross-sections until now, especially Scanning Electron Microscopy (SEM). Raman spectroscopy adds to SEM the chemical information. The use of this information will be the key to the understanding of the bulk chemical and physical properties of paper products and consequently how these parameters influence their intended functionality.

Period of time: 01.02.2013 – 31.01.2015

Remarks

The RTD project IK-MF 120171 was funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Research area: Process aims

Process measuring and control technology

Key words:

THz TD measurements, dynamic effects, penetration

TITLE:
Development of a method for the online monitoring of the dynamic behaviour of liquid interfaces in manufacturing and coating processes

Background/Problem area

The refining of raw materials by impregnation and coating as well as the manufacture of composite materials from liquid and solid origin are defining trends of modern materials technology. This applies to industries such as textile, paper, leather, wood and plastic industry. In addition to the development of products and production processes the provision of appropriate measurement methods for the design and manufacturing is vital, to ensure the quality of the products. Understanding the dynamics of penetration of liquids into substrates plays a central role and is the subject of extensive laboratory work.

Finishing agents do influence and determine the product properties. Liquid materials are often overdosed to achieve a specified concentration at the surface. Elsewhere, an overdose is associated not only with excessive use of materials, but leads directly to a reject production. Currently, existing measurement methods do not give adequate insight into the immediate process of finishing, whose relevant processes are completed soon after the application of material and their effects can usually be ascertained only on the finished product. Furthermore, there are often no or only very limited opportunities to examine the finished product partly or as a whole in terms of the quality of the impregnation using non-destructive methods.

The Terahertz TDS technique offers a non-destructive and contactless method to monitor the processes described online with high resolution in the z-direction.

Objectives/Research results

The aim of the project is the development of an online-enabled measurement method for tracking the dynamic processes during the penetration of liquids into solid, sheet-like materials such as paper, textile or nonwoven, as well as related materials, such as wood and wood materials. From the detection of the nature and progress of the liquid interface in the second or sub second range after applying conclusions shall be drawn on optimal production parameters for a more uniform production.

Technical results

- Setup of a suitable terahertz system
- Design and testing of static and dynamic impregnation unit
- Development of a method for the determination of the mean depth of penetration of liquids into solid materials as well as methods to characterize the kind and shape of liquid layer front.
- Adjustment of the measuring system and mathematical methods to practical relevant disturbances
- Statements about the robustness of the THz measurements related to environmental conditions

Scientific results

- Comparison and possible adjustment of different online and offline methods in terms of measuring penetration effects
- Development of a mathematical based model of the behaviour of liquids in solid materials and compounds
- Enhancing the understanding of the THz Time Domain measurement
- Creation of a concept for selection of appropriate solid and liquid materials for specific applications

Application/Economic benefits

The research results are especially useful in the fields of process technology, production, measuring, monitoring and automation, as well as in the industries of the production and processing of sheet like materials using coating or impregnation techniques.

With a direct visualization of the process, a stable impregnation, finishing and coating can be maintained. This leads to a better utilization of high-quality coating systems. The optimization of process parameters on the basis of on-line measurements allows a consistent product quality with minimal use of finishing agents. This leads to a reduction of material use and savings of energy for the preparation of impregnation, finishing and coating materials and specially for the drying.

By providing an on-line measurement method, the need for relatively complex analysis of material cross sections is reduced. The method can shorten the time necessary for development cycles.

Period of time: 01.01.2014 – 31.12.2015

Remarks

The RTD project IK-MF130095 is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Research area: Process aims

Process measuring and control technology

Key words:

THz, quality monitoring, defect detection, web inspection

TITLE:
"Web Defect Inspection (WeDefIn)" – 100 %-Inspection of material web using TeraHertz-radiation

Background/Problem area

Production of functional materials, of compound materials and multilayers is increasing. For these products with its special functional properties and its complex structure the monitoring of the properties becomes more and more important. Measuring methods based on a statistic inspection by random samples or by measuring on only some spots are not enough. 100% inspection is forced.

Another aspect is the production of high level materials based on recycled raw materials. The recycling process includes the danger of unwanted particles and components in the stock. Those particles can decrease product quality further more disturb or destroy expensive production equipment.

Objectives/Research results

Aim of the research project is the development of an innovative, ready for industrial use measuring system for 100 % inspection of web-formed materials like paper or paperboard. Defects like inclusions, voids, bubles, pipings or delaminations can be found in a web material.

A new kind of TeraHertz-antenna (THz) will be designed. It is the base for a multi-channel measurement initiated from one radiation source. A fs-Laser pulse generator with high performance will enable THz-signals at a high repetition rate across the web. An appropriate data acquisition unit accumulates the signal information. Special algorithms extract the material information from the signal data. Deviation from the normal signal is a sign for web defects.

The procedure is able to inspect complete material web in cross direction (100 % inspection). Materials impervious for visible light are in the focus.

The use of electro-magnetic radiation in the THz-range offers an alternative solution to x-ray-scanners and measuring devices working with visible light.

Application/Economic benefits

The project result can be used as safty equipment in production lines. The preventive monitoring of stock or raw materials can reduce destruction or disturbtion of expensive equipment. And so it can reduce downtime and increase machine availability.

The new inspection device helps to ensure product quality of paper and paperboard production, of special papers production, of multilayer material or compoud materials.

Period of time: 01.08.2014 – 31.07.2016

Remarks

The RTD project ZIM KFZ 2037918AB4 is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Research area: Process aims

Process measuring and control technology

Key words:

data-based modelling, process optimization, online soft sensor, generic software platform

TITLE:
Generic platform to accelerate and formalize a continuous lifecycle support for online soft sensors

Background/Problem area

The informative value of production data-based mathematical models should be used directly, i.e. online, in current complex procedural manufacturing processes. The immediate availability of production parameters that were extracted through online-capable model-based applications supports a detailed understanding of the process, helps to solve problems and opens up potentials for optimization of the production process. Product quality, throughput, material and energy efficiency can be shown to become improved.

Up to now, a large number of existing model applications have been offline simulations, i.e. simulations where the required relevant process data has been extracted, preprocessed and stored before model application. Thus, the simulation result is based on a snapshot of the past. Offline simulations are usually used in the process design-phase or for the planning of process modifications, but are of limited use in current manufacturing process.

From a technical point of view the development of online model applications is significantly more demanding compared to that of offline sensors:

- A continuous flow of data from control systems and related sensors must be ensured
- Processing of data must be performed automatically in real-time
- Model software must be implemented real-time capable
- A runtime system for the repetitive application of the simulations must be set up
- A high degree of flexibility to adapt to equipment or process changes must be provided

Until now these applications has been created in individual developments with considerable specific effort. Furthermore, experience shows that a sustainable industrial use of such applications requires a continuous methodological and technical support which goes far beyond the mere design process.

Objectives/Research results

The goal of the proposed project is therefore the development of a methodology and based on this development of a generic software platform to accelerate and formalize the lifecycle process for online-capable soft sensors. The platform includes all the essential phases of the life cycle of new models as well as the option to adapt existing models for variable process control and / or measurement systems. The systematic composition and variant maintenance of model libraries for the paper industry are supported. Specifically for this purpose, the following procedure shall be implemented:

- Formalization of the process data acquisition and processing
- Support for data acquisition libraries
- Development and support of generic interfaces to the models used
- Management of model libraries
- Formalization of soft sensor integration into control systems
- Continuous integration of the different functions in one tool / framework without a system changeover
- Design of an associated design flow for efficient creation and industrial use of soft sensors
- Provision of logic modules to facilitate the integration and changes of standard model applications to plant-specific features
- Startup and model validation support through integrated trend logging, trend analysis and trend data export to external databases or common export formats
- Support for remote monitoring of model-based applications in order to improve the use of expert knowledge to optimize or troubleshoot running applications

Application/Economic benefits

The development expense is difficult to calculate in advance and usually causes initial monetary effort, which can overburden small and medium businesses economically. Applicants believe that the use of a generic platform for soft sensors yields a potential savings of 15 to 20 % of engineering overhead for soft sensors. The planned project effectively supports the real-time application of mathematical models in the process industry which can thus be a valuable tool to ensure product quality, to avoid process failures and to reduce raw material and energy use. The resulting efficiency increase of production processes implies a higher added value. These advantages make the use of soft sensors potentially attractive specifically for small and medium sized businesses.

Period of time: 01.11.2013 – 31.10.2015

Remarks

The research project ZIM-KF 2037916KM3 is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi) and is carried out in collaboration with LeiKon GmbH, Herzogenrath.

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Research area: Process aims

Process measuring and control technology

Key words:

topography, OBA, NIR, paper structure

TITLE:
Mobile device for space-resolved optical measurement of paper structures

Background/Problem area

Paper is produced on machines having widths of up to 10 m and velocities of up to 2000 m/min today. Even though some basic paper characteristics are already monitored online, most of the properties escape online measurement because of the high velocities involved. However, there is a demand for analysing the outer and inner structures of paper on site during production – quickly, accurately, with space resolution and minimum effort, as these structures influence the paper quality and converting results such as the print quality of graphic papers. Measurement devices fulfilling these complex demands have not been available in the market so far.

Objectives/Research results

Aim of the research project is the development of a mobile device to optically analyse the internal and outer structures of paper and distribution of main ingredients in coated and uncoated papers. Measurements should be possible close to production, and results should be space-resolved and precise, focusing on the following characteristics:

- surface structure (smoothness, topography)
- internal structure (micro formation)
- coat thickness variations (indirect measurement) → measuring the structural distribution of optical brightening agents (OBA) in coated papers as indicator of coat thickness variations
- structural distribution of ingredients (e.g. binders) using NIR-technology.

To identify interactions, the structures or structural distribution of ingredients (OBA, binders etc.) will be determined on identical measuring surfaces or parts of the measuring surface. A data base of structural paper characteristics will be compiled for the device and compared to competitive products to show the advantages of the measurement device.

Pre-trials focussing finding options for an optimised light source in terms of UV have been successfully started.

Application/Economic benefits

The fast and reproducible measurement of main paper characteristics is an essential prerequisite for prompt quality control and thus the basis for systematic product and production optimizations leading to relevant cost savings in paper production. The measurement device to be developed can be combined with highly accurate laboratory systems to significantly improve the assessment of paper structures during or close to production

Project period: 01.04.2015 – 31.03.2017

Remarks

The RTD project ZIM KF2037923AB4 is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

QUERSCHNITTS-ZIELE

Forschungsgebiet
Energie

Energiegewinnung
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Research area: General aims

Energy // Energy use

Key words:

condensate, paper, drying section, membrane

TITLE:
Increasing the efficiency of water and energy use in papermaking by new concepts of heat integration and condensate recycling from moist exhaust air from the drying section

Background/Problem area

High energy input is needed in the drying sections of paper production. To some extent, this energy gets lost with the warm and moist exhaust air leaving the drying section. State of the art is a single-stage heat recovery system in which heat is transferred from the exhaust air to cold supply air. Anyway, today the excess heat and the condensates from paper mill drying sections are not used completely in most cases. Only some of the paper mills are using a multi-stage heat recovery process in the drying section. In such mills, even more thermal energy is obtained and a stream of condensate forms since the moist exhaust air continues to be cooled. In many cases the condensates arising in the heat recovery system have a high water quality – depending on the produced paper grade – and could be used for special recycling purposes. The process of multi-stage heat recovery in the drying section is very profitable already due to the energy recovered. Coupled with recycling of condensate water, the benefits will be even greater. The basic idea of this research project was to reuse condensates as boiler feed water, as these processes require very high water qualities.

Objectives/Research results

The objective of the project is to develop integrated concepts for the combined use of excess heat from the drying section and the condensate thereof. A new process of water treatment has to be developed with the aim of increasing the quality of condensates to meet the needs of boiler feed water. Methods like filtration, reverse osmosis and ion exchange, among others, have been considered.

Precondition for the use of condensates is the presence of a multi-stage waste heat recovery system in the paper mill. The quality of drying hood condensates strongly depends on the stage of the heat recovery system where the condensate arises, on the produced paper grades and on the degree of closure of the water circuit. In the studied paper mills the chosen drying hood condensates basically are of good quality concerning conductivity (60-80 µS/cm), salt content and amount of solids (largely free of solids). Hardness (0.03-0.2 mmol/l), pH (4-6), organic load (COD: 100-550 mg/l; TOC: 34-160 mg/l) and organic acids (acetic acid equivalents: 20-200 mg/l) have to be improved. The required water quality depends on the type and operation mode of the boilers. In the studied paper mills the amount of drying hood condensate of a suitable quality averages about 6 and 20 m³/d. The required amount of make-up water for the boiler is in the same range or below.

In water treatment trials the quality of the drying hood condensates could be improved. The best results have been achieved by reverse osmosis (RO): hardness down to 0.014 mmol/l; pH 5-7; COD 7-100 mg/l; acetic acid equivalents <1 mg/l; conductivity 12-60 µS/cm. Varying the pH significantly influenced the efficiency of the RO treatment. PH 7-10 showed to be most effective in terms of reduction of organic load (COD elimination up to 93 % at pH 7 and 10) and conductivity (elimination up to 97 % at pH 7). Flocculation and treatment with different types of activated carbon showed minor effects.

Multi-stage systems offer the opportunity to enhance the degree of thermal recovery, thus lowering the heat requirements in production. Depending on the heat sinks available, the additional amount of energy recovered from the exhaust air can be used to preheat the workshop air or to heat water (e.g. fresh water, process water).

Since the availability of heating steam is essential for paper production, using treated drying hood condensates as boiler feed water intervenes in one of the most sensitive parts of the production. This is why a workshop was held to identify the possible risks, to evaluate and to derive solutions to minimize these risks. Representatives of paper mills, suppliers of heat recovery systems and water treatment plants and experts in the field of requirements and treatment of boiler feed water discussed their knowledge and experiences as well as expected impacts of a change in boiler feed water quality – caused by the use of drying hood condensate as makeup water – on the operation of the boiler, steam production and the entire steam system.

Application/Economic benefits

Small paper mills, in particular, have the greatest potential of benefiting from the results compared to big and medium-sized enterprises, because they very rarely have multi-stage heat recovery units. The contribution made to increasing their competitiveness is a significant reduction in production costs. In order to implement the project results, investments must be made for condensate treatment processes and heat exchangers. This would benefit plant manufacturing companies in turn.

An assessment of economic efficiency conducted during the application phase showed very high savings potential when condensate is used as boiler feed water. This possibility exists for all possible user groups in the paper industry. For instance, new plants could of course be designed in an energy-saving manner, although such possible savings can be achieved in a similar manner in existing plants. For example, existing ion exchange plants could be unburdened with reverse osmosis that would pay even within a short time

Period of time: 01.08.2013 – 31.07.2015

Remarks

The RTD project IGF17772N was being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

QUERSCHNITTS-ZIELE

Forschungsgebiet

Umwelttechniken

Wasser
Emissionen
Reststoffe

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Forschungsgebiet: Querschnitts-Ziele

Umwelttechniken // Reststoffe

Schlagworte:

stoffliche Verwertung, WPC, Komposite

Thema:
Verarbeitung von faserhaltigen Reststoffen des Papierproduktionsprozesses in naturfaserverstärkten Kunststoffen

Ausgangssituation/Problemstellung

Bei der Altpapieraufbereitung fallen gemäß der Rückstandsumfrage 2013 des Verbandes Deutschen Papierfabriken e. V. (vdp) und der Papiertechnischen Stiftung (PTS) pro Jahr feuchte, faserhaltige Rückstände von ca. 3 Mio. Tonnen an. Sie werden bisher zumeist energetisch verwertet oder in der Zement- und Ziegelherstellung eingesetzt. Die Verbrennung verursacht vor allen in kleinen und mittelgroßen Papierfabriken, die über keine eigenen Feuerungsanlagen für die energetische Reststoffverwertung verfügen, erhebliche Entsorgungskosten.

Gleichzeitig wächst der Markt für Produkte aus naturfaserverstärkten Kunststoffen (NFK) kontinuierlich. Wood Polymer Composites (Abkürzung: WPC, deutsch: Holz-Kunststoff-Verbundwerkstoffe) sind dabei eine relativ große Untergruppe. Für WPC wird vorranging Holzmehl als Ressource für die benötigten Naturfasern eingesetzt. Aufgrund der steigenden Nachfrage nach biogenen Energieträgern und damit auch nach Pellets aus Holzmehl verteuert sich der Rohstoff zusehends.

Forschungsziel/Forschungsergebnis

Entwicklungen bewegen die Professur für Papiertechnik der TU Dresden dazu, dem Forschungsansatz nachzugehen, inwieweit faserhaltige Reststoffe aus der Altpapieraufbereitung als Ersatz für Holzmehl bei der Herstellung von NFK/WPC eingesetzt werden können. Ebenfalls sollen die Forschungsarbeiten einen Beitrag zum effizienten Umgang mit Ressourcen liefern und umweltpolitische Zielstellungen wie die verstärkte Kaskadennutzung biogener Rohstoffe sowie den Vorrang des Recycling vor der energetischen Verwertung unterstützen.

Sowohl Fangstoffe aus der Feinsortierung bei der Kartonherstellung als auch Deinkingschlämme, die bei der Druckfarbenentfernung für die Herstellung grafischer Papiere anfallen, werden für den Einsatz in Kompositen mit thermoplastischer Matrix getestet. Die Eigenschaften der in den Reststoffen enthaltenen Fasern sind mit denen von Holzmehl vergleichbar, wobei die Fasern der Reststoffe wegen ihres günstigeren Schlankheitsgrads (Längen-/Dickenverhältnis) hinsichtlich der Verstärkungswirkung Vorteile aufweisen. Die bereits hergestellten Komposite aus behandelten Reststoffen der Papierherstellung und Kunststoffen werden als Paper Polymer Composites (PPC) bezeichnet.

Ziel des Projektes ist es, das im Labormaßstab erprobte Verfahren zur Herstellung von PPC auf eine industrielle Produktionskette zu adaptieren. Hierfür soll vor allem die Schnittstelle zwischen Papierherstellung und Kunststoffverarbeitung im Vordergrund stehen, an der eine dosierbare, aus Reststoffen der Papierindustrie gewonnene Faserstoffkomponente an die Kunststoffverarbeitung übergeben wird. Aufbauend auf den Erfahrungen bereits durchgeführter Untersuchungen soll die für die Weiterverarbeitung entscheidende Dosierbarkeit mittels einer geeigneten Pelletierung der Faserkomponente sichergestellt werden.

Anwendungen/Wirtschaftliche Bedeutung

Potenzielle Nutzer der angestrebten Forschungsergebnisse sind vor allen kleinere und mittelgroße Papierfabriken sowie Kunststoffhersteller (siehe Grafik). Für beide ergeben sich insbesondere wirtschaftliche Vorteile.

Eine umfassendere Nutzung der Reststoffe hätte ein durchaus nennenswertes Potenzial für eine nachhaltigere Nutzung nachwachsender Rohstoffe in der Papierindustrie. Für kleine und mittelgroße Betriebe mit Deinkinganlagen findet sich nachfolgend eine Abschätzung von Einspar- und Umsatzpotenzialen auf Basis des Jahresberichts des vdp „Papier 2014 – Ein Leistungsbericht“.

Anfall Deinking-schlämme, gesamte Branche	Anfall Deinkingschlämme aus Papierfabriken < 250.000 t/a Kapazität	Einsparpotenzial Entsorgungskosten für Deinking-schlämme, feucht (Annahme: 25 Euro/t)	Umsatzpotenzial für Pellets aus Deinkingschlämmen (Annahme: 0,20 Euro/kg)
960.000 t/a	182.400 t/a	4,6 Mio. Euro/a	23,1 Mio. Euro/a (berechnet im lufttrockenen Zustand bei 5 % Restfeuchte)

Bearbeitungszeitraum: 20.08.2014 – 29.02.2016

Bemerkungen

Das Projekt AZ 32045 wird aus Mitteln der Deutschen Bundesstiftung Umwelt – DBU gefördert. Das Projekt wird in Kooperation mit der Kartonfabrik Porstendorf GmbH, Papierfabrik Hainsberg GmbH und Biofibre GmbH bearbeitet.

QUERSCHNITTS-ZIELE

Forschungsgebiet
Produktionswirtschaft

Managementsysteme
Beschaffung
Logistik
Fabrikationsplanung
Leitsysteme

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Research area: General aims

Production economy // Production planning

Key words:

model based product and process design, innovative fibre based products

TITLE:
Integrative method for product and process development

Background/Problem area

The paper industry is in a global process of change. The current situation is characterized by saturated markets with significant overcapacity in parts of the world, geographical shift of capacities and extremely high cost pressure due to rising energy and raw material prices. Moreover, the markets change by user behavior (e.g. print media vs. electronic media), increasing demand for packaging (global flows of goods), and increased requirements for product safety (food contact).

Increased commitment to the development of innovative products and manufacturing technologies in material, energy and environmental aspects is essential for the sustainability of the sector. A push of innovation is mainly expected in the development of entirely new fiber-based products. However, the development of new products requires the development of new or adapted production processes.

Today, many innovative industries (e.g. automotive, aerospace, plastics) use model-based design as a key technology for the design of new products. Concurrent use of simulation tools support the development processes. Modern design flows integrate all necessary data, information, methods and techniques to solve the development task. Conventional techniques and simulations are complementary.

Objectives/Research results

In paper industry, the model-based design is not yet established. The particular challenge in the development of materials is to control the dependencies of macroscopic properties on physical properties of individual fibers and fiber network structures and physical and chemical mechanisms of the micro- and nanoscale. Therefore, it is required to virtually complement the technical possibilities of real systems and equipment by integrating simulations into the tool chain of product development.

Advances in measurement and simulation technology now offer the chance to establish the model-based design in the paper industry. New testing methods provide opportunities for material analysis in micro-and nano-scale structure.

The aim is to develop a method for model based design of fiber-based products and their manufacturing processes by continuous integration of measurement and analysis technology, pilot plant and simulation throughout the entire product development cycle.

Progress of the development:

- an universal design flow was developed based on an innovative database concept matching the special requirements in the development cycle of complex fiber-based materials
- a modern platform for the integration of pilot plants, laboratories, measuring and analysis technology and simulation in product development cycle was implemented based on State-Of-The-Art web technologies
- a demonstrator "Virtual Product Design" to illustrate the model-based design method by using the product design platform was implemented
- an internet portal www.ptspaper.de/prometheus was implemented to share dedicated parts of the platform with customers and other research institutes

Application/Economic benefits

The intended method for model based design offers new and significant opportunities for optimization and development of new fiber-based materials for the PTS and their customers. The PTS serves the entire value chain of paper production. Within the scope of model-based consulting services the new method and the functional tool are offered for an increasingly large customer base of forestry, wood and paper sector. In the medium term, the project results shall be effective in the growing market segment of paper, cardboard and packaging.

Added value for PTS is created by shortened product development cycles (shorter time-to-market), the development of untapped industries and markets with new products and process design, the extension of the PTS consulting and service portfolio, increased quality of advice, the marketing of partial access to the product design platform and new educational products based on product and process engineering simulations.

Paper manufacturers, processors and suppliers benefit from project results due to new products and shorter product development cycles, saving of resources (fibers, additives, energy) and energy, enhanced effectiveness due to significantly higher number of variant tests and reduced trial costs and time, cost and time savings for the manufacturing industry through papers with optimal processing and machining properties.

Period of time: 01.01.2013 – 30.06.2015

Remarks

The RTD project IK-MF 120081 is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Research area: General aims

Production economy // Monitoring and control systems

Key words:

PBS, Balemat, measuring system, recovered paper, quality, control, moisture, content, brightness

TITLE:

Transformation of the Paper-Bale-Sensor II Prototype Balemate System (Recovered Paper Monitoring Station) into PBS III - Balemate Automatic

Background/Problem area

Recovered paper is the most important raw material in the german paper industry. The total usage is rising and is actually at 16.5 Mio tons per anno in Germany. This tendency will proceed in the future because there are economic and ecological reasons but also a negotiated agreement of the European paper industry to reuse the recovered paper.

With the rising requisition for recovered paper and the extensive collection there are new requirements to the recovered paper quality. One danger is that with the extensive collection mostly from households the recovered paper quality will decrease. Furthermore the quality requirements for the end products are rising and recovered paper is also more and more used for higher quality papers. This also increases the quality requirements for the recovered papers.

PTS has developed a control system for the incoming goods inspection of recovered papers that are mostly delivered as bales. The system is based on the NIR (near infra-red) technology and has been transferred into practice. For the inspection a hole gets drilled into the bale and then is inspected by the measuring lance. The measurement calculates values for the paper moisture, the ash and plastics content and the mechanical and chemical pulp relation.

Objectives/Research results

The aim of the project is the development of an innovative fully automated handling, drilling and measuring system to determine important quality parameters during incoming goods inspection of recovered paper bales. The main part of the system is the hand-held unit brought successfully into the market by PTS and Sentronic. At the company MM-Karton GmbH in Gernsbach it was demonstrated how the measuring could by assisted by a half automated drilling and handling unit.

The new measuring system must be robust for industrial environment, must have a long time stable measuring accuracy, low maintenance and service friendly. To reach this the project partners will redevelop some components and integrate them into a new measuring unit. Furthermore the system will not only measure the today implemented parameters but also some optical parameters like color and brightness. During the project PTS will explore the possibilities to additionally determine the content of additive components like sizing agents, wet strength agents or binder.

Application/Economic benefits

The system will be used to control the recovered paper quality (R&D, production control) in paper mills during incoming goods inspection.

The economic relevance lays in the shortening of evaluation time, the reduction of manual handling and in the enhancement of information variety about the recovered paper bale quality that can be used to optimize the production process control. And last but not least the product PBS-III will result in sales revenue for Sentronic, Haarla and PTS.

Period of time: 01.01.2015 – 31.12.2015

Remarks

The RTD project ZIM-KF 2037921DB4 is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

QUERSCHNITTS-ZIELE

Forschungsgebiet
Ressourceneinsparung

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Forschungsgebiet: Querschnitts-Ziele

Ressourceneinsparung

Schlagworte:

refining energy, enzymes, enzymatic treatment, cellulose modification

Thema:
Energieeinsparung durch enzymunterstützen Refinerbetrieb
Energy Saving by Means of Enzymatic Assisted Refining

Ausgangssituation/Problemstellung

Energy consumption in the pulp and paper industry is high, contributing to about 18 – 25% of the production cost. For the development of desired properties of paper, the pulp must be subjected to the refining process, which represents 15 – 18% of the total electrical energy required to produce paper. Due to the depletion in available energy and the high energy cost, energy conservation has become a necessity for the paper industry. Consequently, any pulp treatment that promotes a decreasing in energy consumption, particularly with regard to the refining process, will have a positive effect on the consumption of energy in the paper industry.

Different solutions were developed, such as adapting plate pattern to modify fibre treatment or varying consistency. Other methods consisted in increasing flow through refiner or redesigning refining strategy (Lumiainen 2000). Nevertheless, these methods require important investments. Thus, a simpler method has to be found. It should request limited changes in process neither interact with wet end chemistry. Enzymes seem to be a good alternative.

Forschungsziel/Forschungsergebnis

Paper production is a complex process aiming at producing paper from fibers of various origins with maximum strength at the lowest cost. After pulping, these fibers do not present enough bonding strength. Consequently, a mechanical treatment, i.e. refining, is required to increase fiber bonding and develop paper strengths. However, such a treatment is highly energy consuming. Today, because of cost reductions and environmental regulations, paper producers need to reduce energy consumption in refining. In conventional refining process the cellulosic fibers are mechanically treated in water, resulting in morphological and structural changes. The main effects of refining in fibers are internal and external fibrillation, fines formation, fiber shortening or cutting and fiber curling. These effects do contribute in increasing mechanical strength properties of paper, but on the other hand has irreversible damage on the fiber.

The objective of this research project is to investigate the possibility of using enzymes to treat cellulose fibers for reduction in refining energy while maintaining the fiber morphology.

Anwendungen/Wirtschaftliche Bedeutung

The application for the proposed research is the reduction in refining energy in the paper, board and tissue production with use of enzymatic treatment. Reduction in refining energy with added advantage of maintaining important cellulose fiber characteristics is the significance of this research. Overall the research targets cost structure of the manufacturing process as well as it will improve ecological impact by reducing energy.

Bearbeitungszeitraum: 01.01.2015 −31.12.2015

Bemerkungen

Das Projekt INFOR Nr. 186 wird aus Mitteln des Kuratoriums für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V. finanziert.

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Research area: General aims

Resource saving

Key words:

resource-efficiency, value chain, paper for recycling, Life Cycle Assessment, paper design models, process models, analytical tools, by-products

TITLE:
Tools for Monitoring and Assessing Resource-efficiency in the Value Chain of process Industries (REFFIBRE)

Background/Problem area

Paper and board are unique products being both the end products as well as the main raw materials for the next cycle; thereby creating a circular economy. In order to ensure long term profitability, the industry needs to focus on resource efficiency and creating innovative products and value out of the streams discarded from the main production line due to resource efficiency reasons.

Currently, the impact of product or process development in the paper mill can to some extent be determined for energy or material efficiency within the mill itself. However, the current tools are not able to incorporate impacts of novel innovations that make the total value chain (or circle) more resource efficient. The impact on e.g. the energy use outside of the paper mill or reduced quality in recycling needs to be considered and optimized.

Objectives/Research results

The main aims of this project are to develop tools and knowledge needed for the ecodesign of the resource efficient paper- and packaging material production chains. Industrial applications investigated in this project are based on paper for recycling and waste fractions from the processing. In addition to paper as the main outcome of paper industry processes also so called "by-products" are in focus. The main scientific and technical objectives of the project are:

- Objective 1: Develop methodologies and models for environmental and economic assessments (Life Cycle Assessment & techno-economic analysis of the value chains).
- Objective 2: Develop methodologies and tools for eco-designed paper production (paper production design models).
- Objective 3: Develop process modelling tools and innovative analytical tools to control production in multi-product mill concept (physical process models, analytical tools and novel by-products).
- Objective 4: Integrate and validate tools to the practical guide for decision makers and control systems for multi-production units (multi-product mill concept cases). The validation will be based on several demonstrators carried out by five industrial partners taking part in the project.

Application/Economic benefits

These results will also contribute to the European objective for reducing greenhouse gas emissions by 80 % until 2050 compared to the level of 1990. The results of this project will help to create the conditions that will enable complete value chains of paper and board industry, converting industry and end users, to

1) decrease their overall waste production and improve resource efficiency,
2) increase competitiveness and
3) approve with a standardised way that the final impact on the environment is reduced.

Period of time: 01.11.2013 – 31.10.2016

Remarks

The research project REFFIBRE is being funded by European Commission (Seventh Framework Programme) and coordinated by VTT Technical Research Centre of Finland in cooperation with 4 European research institutes for paper technology (Technische Universität Darmstadt Germany; Papiertechnische Stiftung, Germany; Instituto Tecnologico del Embalaje,Transporte y Logistica, Spain; Bumaga BV, The Netherlands), the Confederation of European Paper Industries (CEPI) and 4 industrial partners (S.C. Vrancart S.A. Adjud, Romania; Alucha SL, Spain; Papierfabrik Utzenstorf AG, Switzerland; Holmen AB, Sweden).

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Research area: Product aims

Resource saving

Key words:

starch, recycling, process water, membrane filtration, metabolism, conservation, surface starch, glue, corrugated board

TITLE:
Recycling of starch from process waters to reduce the fresh starch consumption in paper and corrugated board production

Background/Problem area

The use of starch for surface strength enhancement or adhesive/coating colour preparation is state of the art in the paper industry. Many corrugated board adhesives are starch-based products today.

Their increasingly difficult economic environment and market situation forces paper and corrugated board manufacturers to look for ever more cost-effective raw materials. The results of a completed research project on "stray starch" have shown that starch introduced in the process water by paper for recycling can be preserved for the duration of paper production (approx. 2 to 5 hours) by suitable methods to become usable as recycled starch and substitute for fresh starch in surface starch and corrugated board adhesive production.

In this context, it has yet to be investigated how process water ingredients - especially starch – must be treated and separated to become usable as recycled materials (starch) for surface treatment or corrugated board adhesives. To improve the methods and approaches already available for this, the following questions must be answered:

- Are the chemicals and methods investigated so far capable of preventing starch metabolism in process waters for significantly longer periods than the present 2 to 5 hours? To be usable as surface starches or in corrugated board adhesives, starches must be stabilized for one day. This time is necessary to recover them from process waters and preserve them for further processing and use.
- Is it possible to use the positive – i.e. inhibitory and preserving – effects of tannin also in the paper industry? The production of food and wood materials involves many similar processes and media – it is therefore likely that some of them could be modified and transferred to paper production.
- Which process is capable of removing the process water for starch accumulation in an economically efficient and technically feasible way? Are fines and impurities detrimental to starch recycling? Is it necessary to separate the ingredients into single fractions?
- How much recycled starch can be substituted for fresh starch in surface starches and corrugated board adhesives without quality losses?
- How must recycled starches be treated and preserved to meet all relevant requirements?

Objectives/Research results

Aim of the project is to use process water ingredients as so-called recycled starches in surface starch or adhesive products for paper and corrugated board production.

To begin with, it is hypothesized that:

- starches introduced by paper for recycling are capable of replacing fresh starch in surface starches or corrugated board adhesives without thermal or chemical modification,
- it is possible to treat starches introduced by paper for recycling to prevent them from being destroyed by microorganisms until they will be removed from process waters,
- other process water ingredients can be separated by fractionating filtration prior to recycled starch use, because water reduction is a key prerequisite for the usability of recycled starch
- tannin, being a natural raw material that is capable of preserving and cross-linking substances like starch, holds the key to practically feasible formulations for surface starch products and corrugated board adhesives based on recycled starch.

Application/Economic benefits

The suitable treatment of process waters and recovery of ingredients like starch will lead to marketable recycled materials. The material recycling of process water ingredients could thus generate cost savings due to:

- reduced expenses for cost-intensive raw materials
- reduced wastewater treatment costs

Project period: 01.04.2015 – 31.03.2017

Remarks

The RTD project IGF 18699 N is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

THEMENVERZEICHNIS

SCHLAGWORTVERZEICHNIS

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