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Forschungsprojekte im Überblick
2017

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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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 2017 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-Wertschöpfungskette 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 Holztechnik und Faserwerkstofftechnik (HFT)
    - Arbeitsgruppe Papiertechnik
- Hochschule München
  - Fakultät 05, Papier- und Verpackungstechnik

Wir danken den Forschungsinstituten für die Erstellung der zahlreichen Projektbeschreibungen.

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.

In der Forschungsübersicht 2017 wurden Kurzbeschreibungen von rund 70 Forschungsvorhaben erfasst und nach Forschungsgebieten geordnet. Am Ende der Broschüre finden Sie ein Schlagwortverzeichnis und ein Themenverzeichnis, die das Auffinden bestimmter thematischer Schwerpunkte ermöglichen.

Die Forschungsübersicht 2017 ist über das Extranet der VDP-Website für bereits registrierte Benutzer abrufbar. Sollten Sie noch nicht dazu zählen, können Sie sich anmelden unter https://www.vdp-online.de/extranet/anmelden.html.

Falls Sie gedruckte Exemplare der Forschungsübersicht wünschen, wenden Sie sich bitte per E-Mail an das Referat Forschungsförderung e.kloss@vdp-online.de. Wir stellen Ihnen gerne eine Papierversion zur Verfügung.

PRODUKT-ZIELE

Forschungsgebiet
Rohstoffe

Holz
Landwirtschaftliche Nutzpflanzen
Altpapier
Füllstoffe, Pigmente
Chemische Additive

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Forschungsgebiet: Produkt-Ziele

Rohstoffe // Holz

Schlagworte:

Nachhaltigkeit, Biopolymere, Umweltschutz

Thema:
ValChem: *High-Value*-Materialien und -Lignin aus Holz

Ausgangssituation/Problemstellung

Die Nutzung erneuerbarer Ressourcen für die Herstellung von Chemikalien ist insbesondere aus Gründen der Nachhaltigkeit ein bedeutendes Ziel allgemeinen und wissenschaftlichen Interesses. Damit würden zahlreiche gesellschaftliche Vorteile wie z. B. die Stärkung ländlicher Gebiete, einhergehen. Dieser große Nutzen wird zunehmend erkannt, wodurch der Markt für „Grüne Produkte“ stetig wächst. Gleichzeitig werden *Biorefinery*- und biologische Verarbeitungsprozesse werden immer kostengünstiger. Folglich steigt die Nachfrage nach Chemikalien, die aus Biomasse-Rohstoffen, einschließlich Holz-basierter Biomasse, hergestellt werden. Deshalb haben sich UPM, SEKAB, METabolic EXplorer und die Technische Universität Darmstadt zusammengeschlossen, um ihre Kompetenzen der Wald-, Chemie- und Biotechnologie zu vereinen.

Forschungsziel/Forschungsergebnis

Bereits vor diesem Projekt haben UPM, SEKAB und METEX jeweils einzelne Prozessschritte bis hin zum Pilot- oder Demonstrationsmaßstab entwickelt. Beispielsweise transformiert das CelluAPP®-Verfahren von SEKAB Holz zu Zucker und rohem Lignin. Die CelluAPP®-Technologie konnte für die Herstellung von Zucker-, Lignin-, Biogas- und Ethanol im Demonstrationsmaßstab für den kontinuierlichen *rund-um-die-Uhr*-Betrieb implementiert werden. Das ValChem-Projekt kombiniert das CelluAPP®-Verfahren mit den Rohzucker- und Roh-Lignin-Aufbereitungstechnologien von UPM und dem Zucker von METEX zu Bio-MPG (MonoPropylenGlycol). Diese Technologien werden weiter optimiert und bestehende Demonstrationsanlagen der einzelnen Projektpartner genutzt, um die vertikale und horizontale Prozessintegration und Langzeitproduktionsversuche zu demonstrieren. Das dadurch gewonnene *Performance*-Lignin soll langfristig fossile Komponenten in hochaktiven Reaktivharzen und Verbundwerkstoffen ersetzen. Methoden zur Nutzbarmachung werden gemeinsam von der Technischen Universität Darmstadt und UPM entwickelt.

Anwendungen/Wirtschaftliche Bedeutung

Ziel von ValChem ist es, die technische und wirtschaftliche Machbarkeit einer innovativen und nachhaltigen Wertschöpfungskette zu demonstrieren, die Holz als Rohstoff zur Herstellung der Bio-Alternative der Plattformchemikalie MPG sowie von Lignin nutzt. Der ValChem-Ansatz umfasst die Demonstration eines integrierten und kostengünstigen Biochemikalienprozesses sowie Premarketing- und Produktanwendungstests bei potentiellen Kunden, um die Eignung und Wettbewerbsfähigkeit von Bio-MPG- und Lignin-basierten *Performance*-Chemikalien für nachgelagerte Prozesse in Bezug auf Qualität, Leistung und Produktionskosten zu eruieren.

Bearbeitungszeitraum: 01.07.2015 – 30.06.2019

Bemerkungen

ValChem ist ein im Rahmen von Horizon 2020 EU-gefördertes Demonstrationsprojekt und bezieht sich auf das gemeinsame Unternehmensprogramm der Bio Based Industries (BBI JU). BBI Thema: BBI.VC1.D2 2014: „Chemische Bausteine und Wertschöpfungsmaterialien durch integrierte Holzverarbeitung“. Die formellen EU-Projektinformationen finden Sie im CORDIS-Portal. Die Forschungsergebnisse die im Rahmen des Projekts an der TU Darmstadt entstehen, werden für eine Doktorarbeit genutzt.

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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 developed and evaluated 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 was 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 developed 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 included:

- 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.

In the course of the project a number of prototypes had been prepared and exhibited that demonstrate the technical viability of the CaReWood process. The research has also focussed on developing scanning techniques for detecting contamination on the surfaces of recovered wood and modelling the potential recovery of clean wood lamellae machined from recovered wood streams. The models indicate that around 39 % of the volume of recovered wood can be converted to clean, high-value, solid wood products.

Application/Economic benefits

The idea behind CaReWood was 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.

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.

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 WOODWISDOM-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 // Paper for Recyling (PfR)

Key words:

paper for recycling, separate collection

TITLE:
IMPACTPapeRec - Boosting the implementation of participatory strategies on separate paper collection for efficient recycling

Background/Problem area

IMPACTPapeRec is a European project aiming to boost the Circular Economy by further increasing the separate collection of Paper for Recycling (PfR) and promote appropriate schemes to avoid landfilling and incineration.

Currently, the production of paper and board in the EU stands at 91 million tonnes per year. Consumption of paper and board stands at 82 million tonnes. 58 million tonnes of PfR are collected from households, commerce, industry and offices. The paper recycling rate is therefore 71.7 %. The contribution of PfR to the raw material mix of the European paper industry has increased over the last few years from 25 million tonnes in 1991 to 47 million tonnes in 2014.

However, the increase in the availability of PfR has not taken place in all EU member states, and this is especially true in Central and Eastern European countries. Moreover, the quality of the collected material does not always meet the requirements of paper recycling. Without additional measures, these two facts will make it difficult to keep up with the increases in PfR collection observed over the last few years.

IMPACTPapeRec is a consortium of 19 partners from eight countries, i.e. Austria, Belgium, Bulgaria, France, Germany, Poland, Romania and Spain. The innovative approach of the defined participatory strategies on separate paper collection for efficient recycling is based on the commitment of the whole paper value chain: Research entities (ITENE and PTS), large paper companies (Saica, Hamburger, Stora Enso), large waste management company (Tega), a European retailer (Carrefour), representative SME groups (PROPAKMA, Fenix Dupnica) municipalities (ACR+, Sfantu Gheorge, Mihai Viteazu, Dupnitsa, Mezdra, Trivalis), the German Institute for Standardisation (DIN), an EPR scheme (Ecofolio), the European paper sector organisation (CEPI), and an eNGO (EEB). They represent a clear balance along the value chain.

Objectives/Research results

IMPACTPapeRec aims to further increase the separate collection of Paper for Recycling (PfR) and promote appropriate schemes to avoid landfilling and incineration.

The main objective is to put Europe at the forefront of PfR collection by providing an innovative and common knowledge platform, which will enable present and future cooperation. Analysis on best practices in PfR collection and assessment procedures are delivered, considering specific local conditions. They will encourage reliable decisions and make solutions available to decision makers, e.g. local authorities ensuring the procurement and supply of PfR in Europe through the improvement of municipal paper collection.

The project focuses on countries with below average paper recycling rates such as Bulgaria, Poland and Romania as well as countries where paper from households, small shops and offices is often collected in a commingled stream with other recyclables as is the case in France and the UK. A best practice handbook will be developed to support the different EU regions in the implementation of best collection procedures.

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Application/Economic benefits

IMPACTPapeRec wants to act as the common European information point for PfR collection for the European industry, by pooling and disseminating information and bringing together stakeholders from the value chain to exchange results, findings and experiences. In order to improve the development and promotion of best practices in paper collection there is a need for common evaluation and benchmarking methodologies.

All stakeholders within the paper value chain will benefit:

- Paper industry: reducing production costs through improved PfR quality; increase of PfR availability
- Waste management industry: optimisation of waste treatment and transport costs
- Municipalities: reducing cost for waste disposal by selling recyclable materials
- Citizens:prevention of landfilling and incineration increases in quality of life

Period of time: 01.02.2017 – 31.01.2018

Remarks

The research project IMPACTPapeRec has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 690182.

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Forschungsgebiet: Produkt-Ziele

Rohstoffe // Altpapier

Schlagworte:

Altpapier, Inhaltsstoffe, Pentachlorphenol

Topic:
Pentachlorophenol in Paper for Recycling

Background/Problem Area

Within the project "Benchmarking of paper for recycling quality for the production of corrugated base paper" of the Association of Packaging Paper and Corrugated Board (Vereinigung Pack- und Wellpappenpapiere) in 2014 and 2015 between other parameters the undesired substance pentachlorophenol (PCP) has been investigated in the used paper for recycling in different paper mills. Due to its toxicological effects, especially its carcinogenic potential, use of PCP is prohibited in Germany since 1989. Since then the production, placing on the market and the use of PCP, Na-PCP and PCP containing products with a PCP concentration of more than 5 mg/kg has been banned. PCP is a persistent substance that is hardly biologically degradable and accumulates in the food chain. On the basis of the significant restricted industrial use in the EU member states the amount of PCP in paper for recycling and recycling paper should be reduced slowly but steadily. However, in the above mentioned investigation in some paper mills significantly higher PCP concentrations in the paper for recycling grades 1.02 and 1.04 and the paper products derived from there have been determined. The PCP amounts have been compared with the results of a multi client project from 2005 in the same paper mills. These results are confirmed by current analytical data from the product monitoring of different paper grades. In finished paper and board products made from paper for recycling in routine analyses repeatedly increased PCP concentration in relation to previous years are de-termined. The measured PCP concentrations are clearly below the limit values of the different regulations for food packag-ings but an investigation of the current PCP inputs in the paper recycling loop is urgently needed.

Objective/Research Result

In the current project the PCP concentrations in paper for recycling and paper and board products should be analysed. To get a representative overview of the PCP amount of different paper for recycling grades and different paper and board products a large number of samples from different areas of origins are necessary.

A literature search related to the legal situation and realistic circumstances of PCP has been carried out. The areas of focus were industrial uses as wood preservative agents, printing inks, impregnation of textiles, leather products and the use as biocide in Europe (outside EU) as well as in other countries of the American and Asian economic area. The possible PCP input in the paper recycling loop has to be assessed.

In this project an extensive PCP monitoring (quantitative PCP analyses) concerning all paper for recycling grades relevant to the German paper industry has been carried out. In relation to the former studies the paper for recycling grades 1.02 and 1.04 were of special interest, but other paper for recycling flows had to be considered, too. Additionally recycling paper and board products and virgin fibre paper products manufactured in Germany have been analysed concerning their PCP concentration. Another area of emphasis was the investigation of packagings and other paper products that are imported from non-EU countries with different consumer goods to Germany (textiles, shoes, electronic devices and others).

The chemical analyses have been carried out in the solvent extract (methanol) of the paper and board samples to deter-mine the total PCP concentration. The 45 investigated corrugated packagings taken from different commercial enterprises and households in Germany showed concentrations of < 5 to 68 µg PCP/kg (mean value 42 µg/kg). Only one of the 45 corrugated boxes did not contain PCP in measurable amounts. PCP is still in use in some countries inside and outside the European Union as wood preservative agent. On the other hand PCP shows a poor water solubility and is hard to remove from the paper recycling loop. But the measured PCP concentrations even in a methanol extract are on a low level far below the former limit value of 150 µg/kg in cold water extract. Chemical analyses are still ongoing and will continue in the beginning of 2018.

Application/Economic Benefits

Paper and board products that are intended to use as food packagings or food contact materials or other sensitive applications have to be safe in use and do not contain substances of toxicological concern in avoidable amounts. Therefore the current situation of PCP load and input in the paper recycling loop has to evaluated in a realistic way.

Project Period: 01.01.2017 – 01.02.2018

Remarks

The research project INFOR 194 is being funded by „Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V.“, VPWP (Vereinigung Pack- und Wellpappenpapiere) and RESY GmbH

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Research area: Product aims

Raw material // Fillers, pigments

Key words:

Extruder technology, microfibrillated cellulose (MFC), precipitated calcium carbonate (PCC), in-situ precipitation, fiber reinforced filler

Title:
Functionalization of nanostructures of the cellulosic fiber wall from saturated calcium solutions for the production of novel composites

Background/Problem area

Mineral fillers are indispensable in many industrial branches and are used in a variety of different materials. In plastic technology they act as a classic extender to lower the costs of the production process but also as "active fillers" to improve the property profile, including mechanical and optical properties. In the paper industry, fillers are also used to reduce raw material costs and to adjust the optical as well as surface properties.

However, fillers entail the problem that their application quantity is sharply limited. Inorganic fillers show no binding properties. They reduce the product strengths during higher use and lead to complications in the further processing of the products (e. g. increased dust propensity during the packaging and printing processes).

In order to expand the use of fillers and their positive effects on varying products and to prevent the negative effects of the material in parallel, mineralized cellulosic structures should be created for versatile applications in different branches of industry.

Objectives/Research results

To overcome this problem, the objective is to develop a process for the mineralization of microfibrillar cellulose by the precipitation and irreversible binding of $CaCO_3$ on the nanostructure of the cellulosic fibre wall. To ensure a high efficiency, the high consistency conditions in a twin-screw extruder are supposed to be used. The chemical pre-treatment of the cellulose and the application of a double exchange reaction are said to favour the ionic bond to the functional groups of the cellulose.

The idea of the production of fiber reinforced fillers is to precipitate calcium carbonate with a double exchange reaction from saturated solutions of calcium halogenides ($CaCl_2$ solution) and alkali metal carbonates (e. g. Na_2CO_3, K_2CO_3, NH_4CO_3, $NaHCO_3$). In this case the PCC modification can be controlled by careful adjustment of the precipitation conditions.

The concept for the mineralization of cellulosic structures involves the mechanically (fibrilling) and chemically modification and pre-treating (e. g. carboxymethylation) of the cellulose in the extruder under varying conditions prior to the carbonate precipitation so that surface modified, fibrillated cellulose (i.e. CMC) is available for subsequent process steps. This is charged in a second extruder pass with saturated $CaCl_2$ solution and the abovementioned precipitation reagents. Thus, the fibrillated cellulose is converted to MFC and simultaneously the $CaCO_3$ is precipitated on the nanostructure of the cellulosic fibre wall and irreversibly bound.

An additional advantage of the process is that both steps take place in completely aqueous medium.

Application/Economic benefits

$CaCO_3$ particles as well as cellulose fibres are used in manifold fields, for example in environmental, biological and process engineering as well as other techniques. The potential offered by the novel process for the mineralization of cellulose and the fiber reinforced filler (PCC-MFC-Nanocellulose) thus developed is correspondingly versatile.

In the field of papermaking, it is the goal and could be demonstrated in the first experiments that various paper properties such as strength and optical properties can be improved with the aid of mineralized cellulose. The filler content in the paper can also be increased so that a reduction of the raw material use as well as the production costs is possible.

The application of PCC-MFC-Cellulose is also conceivable in the field of plastics. In NFC (Natural Fibre Composites) and WPC (Wood Plastic Composites) as well as in PVC products, they can be used for strength and stiffness enhancement. Furthermore, fibres and $CaCO_3$ reduce the shrinkage of the plastic products and improve their optical properties. Accordingly, it is a cost-effective possibility to adapt and improve different plastic products both optically and mechanically.

A further idea is to use PCC-MFC-Nanocellulose in plaster for lightweight plaster walls. With the help of the composites, it should be possible to increase the porosity and the volume of the material and thus to achieve a weight reduction with constant component dimensions. In addition, the fibre network can increase the strength of the plaster walls.

Foamforming offers the possibility to develop new fibre based products as well as to reduce production costs and environmental impacts. It promises an ideal application for mineralized cellulose, as its surface properties support the voluminous formation of paper or fleece, reduces the material weight and increases air permeability. In addition, the composite increases the strength and optical properties of the products.

Period of time: 01.04.2017 – 30.06.2019

Remarks

The research project IK-VF 160034 is being funded by German Federal Ministry for Economic Affairs and Energy BMWi.

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Research area: Product aims

Raw materials // Chemical additives

Key words:

mass and surface treatment, coating, switchable polymers, improvement in drying efficiency

Title:
Improvement of the energy efficiency during the drying process of paper and paper coatings via intelligent, switchable polymers

Background/Problem area

By reason of the increasing shortage of resources, rising raw material as well as product costs and due to the politically required sustainability of processes and products, industries like paper industry, which are using lots of raw materials and energy, have to reinvent their manufacturing process. One of the biggest parts of energy input in paper manufacturing can be located in the drying processes. Accordingly in the course of the energy revolution lots of procedural alternatives for energy saving, for example more efficient drying plants have been further optimized. However, the drying process is an enormous technical effort and proportional to the realized effect with a very high energetic input. For this reason new products, which can reduce the use of energy significantly are a promising possibility to optimize the drying process.

Economization of drying energy based on procedural arrangements is mostly exploiting in various sectors of the paper industry and offers hardly potential capacity therefore. Additional the unfavorable cost-value ratio do not enable positive mutually exclusive investment decisions for other technologies. But drying energy can be cut down on using new additives. One possibility are so called switchable polymers, which can be used as functional additives. In principle this materials have the ability to reduce the amount of combined water. During the drying process the function of the additives is activated by the temperature and that leads in an exchange of properties from hydrophilic to hydrophobic.

Objectives/Research results

The aim of this project is to develop a generally applicable process to covalently bind switchable polymers to paper surfaces and/or paper mass. There are rashes of polymers that show so called "miscibility gaps" at higher temperatures in solvents. That means the polymers collapse by rising temperatures and displace the molecules of the solvents. This water is existent as "free water" and is much easier to release with less drying energy than combined water. In the literature this polymers are known as LCST-polymers (LCST = Lower Critical Solution Temperature) and they can be designed differentially. Therefore, the macromolecules can be assembled to collapse from 30 degrees over 80 degrees. According to this the research project is a proof-of-concept study to use unmodified and modified LCST-polymers. Because of their intrinsic characteristics this polymers exhibit the potential to relieve desorption and release of water to save drying energy.

Important results to achieve:

- Selection of suitable polymers and attachment to exclusive paper products as well as coating colors ingredients
- Identification of the effectivity of the polymers added to paper surfaces
- Identification of the effectivity of the polymers added to coating colors ingredients
- Definition of the influence of the polymers on the end product properties and optimization
- Increase of the energy efficiency of drying processes in the paper industry

Application/Economic benefits

As a result of this research project specifications will be formulated for novel or improved paper surfaces and/or coating color ingredients enabling a more efficient drying process. Such new functionalization should lead to new possibilities in paper finishing as well as to more versatile and innovative applications. Including to this new approach for conservation of energy with direct economic benefits for paper industry is generated. The results can be used interbranch for different kinds of paper grades (e.g. graphical paper, packaging paper and board, tissue and specialty paper).

Period of time: 01.07.2017 – 31.12.2017

Remarks

The research project INFOR 193 is being funded by „Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V“

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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 von Gebrauchs- und Verarbeitungsprozessen, in denen Papiersorten eine hohe Festigkeit im feuchten oder nassen Zustand bewahren müssen. Aktuell kommen dafür u. a. Polyamidoamin-Epichlorhydrin-Harze, Melamin- und Harnstoff-Formaldehydharze und untergeordnet Glyoxalharze zum Einsatz. Die genannten Nassfestmittel haben alle gemeinsam, dass die chemische Bindung zwischen Harz und Faser nur thermisch erreicht wird. Vorteilhaft wäre es aber, wenn diese Komponenten photochemisch vernetzt würden, da man die Anbindung dadurch unabhängig von den auf einer Papiermaschine gewählten Prozessparametern insbesondere auch in Gegenwart von Restfeuchte durchführen könnte. Ein Ansatz zur Realisierung ist es entsprechende funktionale Polymere in das Papiervlies (oder in Komponenten des Papierstrichs) einzubringen, die photochemische Reaktionen zulassen. Ein seit längerem bekannter Photoinitiator für Polymerisationsreaktionen, u. a. auch in Druckfarben, ist Benzophenon. Neben der Möglichkeit Polymerisationen zu initiieren werden Benzophenone aber auch als Photovernetzer (z. B. in der Biomedizin und Biologie) eingesetzt. Hierbei abstrahiert das Molekül nach Licht-induzierter Radikalbildung u.a. aliphatische Protonen (z. B. aus Proteinen) und rekombiniert anschließend mit den resultierenden Kohlenstoffradikalen im Aliphat. Implementiert man solche Gruppern in Polymere, können die resultierenden photoreaktiven Moleküle als Vernetzer in Faservliesen eingesetzt werden, um eine chemische Vernetzung der Papierfasern durch Belichtung zu erreichen.

Forschungsziel/Forschungsergebnis

Ziel des Forschungsvorhabens war es, photoreaktive Polymere herzustellen, die als alternative funktionelle Papieradditive (neuartige Nassfestmittel und Streichfarbenvernetzer) eingesetzt werden können. Das Projekt, das durch das BMWi gefördert wurde, war ein Gemeinschaftsprojekt der TU Darmstadt und der Hochschule München (HM). Die Arbeiten an der TU Darmstadt umfassten insbesondere die Synthese und Charakterisierung verschiedener Polymeradditive, die dort in Laborversuchen als Papieradditive untersucht werden. Die Hochschule München übertrug die entwickelten Methoden auf den halbtechnischen Maßstab auf der VPM. Es wurden verschiedene Faserstoffe (unterschiedlicher Mahlung, Füllstoffe und Additive) auf ihren Einfluss auf die Wirksamkeit als Nassfestiger untersucht. Dabei zeigte sich beispielsweise, dass bei gebleichten Zellstoffen ein größerer Effekt beobachtet werden kann (rel. Nassfestigkeit = ca. 14 %) als bei ungebleichten Zellstoffen (rel. Nassfestigkeit = ca. 11 %). Sowohl die Nass- als auch die Trockenfestigkeit eines Faservlieses wird durch Füllstoffe grundsätzlich reduziert. Das entwickelte neue Funktionsadditiv wurde unter allen untersuchten Füllstoffen nur von Titandioxid negativ beeinträchtigt. Grund dafür ist sehr wahrscheinlich, dass TiO_2 dazu in der Lage ist, UV-Licht zu absorbieren und damit die Effizienz der Photoreaktion zu senken.

Anwendungen/Wirtschaftliche Bedeutung

Von den Forschungsergebnissen können Papierhersteller und -verarbeiter, Unternehmen der chemischen Industrie sowie Anlagenbauer profitieren. Durch den Einsatz der neuartigen Polymeradditive soll es möglich sein, eine Nassfestigung unabhängig von den Prozessbedingungen einzustellen. Durch diese Entkopplung 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 (Zulieferern) eröffnet sich dabei die Möglichkeit, ihr Portfolio im Bereich effizienterer Nassfestmittel zu erweitern. Hier können auch kleinere Chargen an tailor-made-Produkten zum Einsatz kommen, die von KMU aus dem chemischen Zulieferbereich synthetisiert werden. Für Unternehmen, die z. B. UV-Lampen oder -Offsetdruckanlagen produzieren ergibt sich ein großes Potenzial im Absatz ihrer Produkte in einem für sie neuen Industriezweig. Mit dem Einbau der Lichtquellen in die vorhandenen Maschinen (Papiermaschinen, Umroller, Rollen- oder Querschneider, etc.) können auch kleinere Anlagenbauer direkt angesprochen werden.

Bearbeitungszeitraum: 01.11.2013 – 30.04.2017 (abgeschlossen)

Bemerkungen

Ein Projektbericht ist auf der Website des Instituts an der TU Darmstadt (s. o.) online verfügbar. Aus dem Forschungsprojekt wurden Ergebnisse in 2 wissenschaftlichen Arbeiten in peer-review-Zeitschriften veröffentlicht und es entstand eine Doktorarbeit.
Außerdem gewann dieses Projekt den 1. Preis des Ideenwettbewerbs der TU Darmstadt und Herr Jocher (Doktorand im Projekt) hat für seine Arbeiten 2017 den Zellcheming-Nachwuchspreis gewonnen. Aktuell laufen Gespräche/Sondierungen zur Fortführung des Projekts.

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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Forschungsgebiet: Produkt-Ziele

Rohstoffe // Chemische Additive

Schlagworte:

Barrieren, Nachhaltigkeit, Biopolymere

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 im Vergleich zu den vorgenannten Materialien nicht über eine ausreichende Performance verfügen, oder sehr kostenintensiv sind. In ersten Arbeiten wurden neuartige Cellulose-basierte, hydrophobe Nanokolloide hergestellt, die sich als vielversprechende Materialien zur Beschichtung von Papier zeigen, um Oberflächeneigenschaften gezielt einzustellen.

Forschungsziel/Forschungsergebnis

Ziel des Forschungsvorhabens ist es, die Barriereeigenschaften von Papierbeschichtungen, die aus hydrophoben Cellulose-basierten Nanokolloiden bestehen, zu untersuchen und daraus abzuleiten, ob sich diese Systeme als nachhaltige Alternative zu konventionell eingesetzten Barriereschichten darstellt. Im Fokus der Untersuchungen standen Eigenschaften wie die Wasserdampfdurchlässigkeit und die Fähigkeit den Übergang von Mineralölen zu unterbinden. Das Projekt wurde als Gemeinschaftsprojekt mit der PTS bearbeitet. Zunächst 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. im Kontakt mit wässrigen Lösungen: Die Oberflächen zeigen superhydrophobe Eigenschaften, was auf die Morphologie der Filme und die damit verbundene Rauigkeit auf nano- und µm-Skala zurückgeführt werden kann. In laufenden Arbeit konnten in ersten *Proof-of-Concept*-Studien neue Barriereschichten entwickelt werden, die z B. durch Licht von hydrophil nach hydrophob schaltbar sind sowie quervernetzte Barrieren, die eine sehr gute chemische Stabilität zeigen.

Anwendungen/Wirtschaftliche Bedeutung

Anwendungen können sowohl im Bereich von Verpackungspapieren als auch im Bereich technischer Spezialpapiere entstehen. Besonders hervorzuheben ist hier, dass die verwendeten Materialien nahezu quantitativ aus lignocellulosischen Bausteinen bestehen und damit ein hohes Maß an Nachhaltigkeit für Papierbeschichtungen erzielt wird.

Bearbeitungszeitraum: 2015 – offen

Bemerkungen

Das Projekt INFOR Nr. 186 wurde 2015 über das Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V. und seit 2017 aus Landesmitteln (Grundfinanzierung der TU Darmstadt) finanziert. Es ist geplant aus den Ergebnissen dieser Vorarbeiten gemeinsam mit der PTS ein IGF-Projekt zu beantragen.

PRODUKT-ZIELE

Forschungsgebiet
Faserstoffe

Altpapierstoff
Holzstoff
Zellstoff

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Forschungsgebiet: Produkt-Ziele

Faserstoffe // Altpapierstoff

Schlagworte:

Altpapier, Recycling, Qualität, Messtechnik

Topic:
New Methods for Determining the Quality of Paper for Recycling with Regard to the Criteria of the New Version of DIN EN 643 for the Characterization of Paper for Recycling Grades

Background/Problem Area

Paper for recycling is the most important raw material source of the German paper industry. Like any other product, paper products are subject to constant changes and innovations. The effects of these innovations are noticeable in the recycling cycle after some enrichment period, so that a change in the quality of the paper for recycling can be observed. Paper manufacturers therefore have to adapt their processing equipment and recovered paper sorting companies have to adjust their sorting technologies.

The European Union has responded to this situation: In 2013, a revision of the existing list of paper grades for recycling was made, which was adopted as a German standard in 2014. In March 2015, the German Institute for Standardization (DIN e.V.) installed a working committee which has two objectives:

- Development of basic sampling strategies and test methods for use in laboratory and practice.
- Identification and elimination of errors in the present version of DIN EN 643 as well as identification of future potential requirements for the standard.

Both objectives need support from scientific research.

Objective/Research Result

The following research results are aimed at:

- Status of the quality of paper for recycling in the substance groups after revision of DIN EN 643.
- Development of laboratory methods and practical methods for describing the quality of paper for recycling.
- Assessment of sorting plants with regard to sorting quality.
- Objective presentation of the development of the quality of the paper for recycling by comparing the new results with older studies.
- Analysis of the impact of paper production innovations on the development of the quality of paper for recycling.
- Consideration of possible future scenarios for the quality of paper for recycling using the acquired knowledge.
- Development of a measuring device that determines the composition of paper samples automatically with the aid of sensor data and artificial intelligence.

Application/Economic Benefits

The results of the project can reveal ways to deal with paper for recycling more efficiently. This can be an existential issue for SMEs. It will also be possible to check the paper grades of DIN EN 643 based on objective measurements. Correspondingly, the quality of the paper grades can be improved in the sorting systems, which leads to higher revenues. For manufacturers of measuring instruments, the targeted information on relevant paper parameters offers the possibility to develop and offer suitable equipment. The economical processing of paper for recycling as raw material preserves the competitiveness of the German paper industry and thus contributes to the achievement of economic, ecological and social goals. Since the DIN work committee NA 074-01-13 AA benefits form these research results, a broad benefit for the German national econ-omy is guaranteed on an international level.

Project Period: 01.07.2017 – 31.12.2018

Remarks

The project AiF 19118 N of the industrial research association "Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V." is funded by AiF within a program for promotion of industrial collective research (IGF) of the Federal Ministry for Economic Affairs and Energy (BMWi) on the basis of a decision by the German Bundestag.

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 papers

Key words:

paper evaluation, measuring techniques, measuring methods, sheet-fed offset paper, sheet-fed offset printing, print result

TITLE:
State-of-the-art dimensional stability in sheet-fed offset printing; influence of printing parameters on elongation behaviour

Background/Problem area

The quality requirements to sheet-fed offset prints have risen dramatically in recent years: customers expect high colour fidelity and the correct reproduction of highly complex motifs or technical elements. However, printers must also reduce their costs in order to remain competitive. For this purpose, they are pursuing various paths: apart from using higher printing speeds, reducing the set-up times of presses and avoiding misprints, they are trying to print larger sheet sizes at moderate cost. Machine manufacturers have developed larger presses in recent decades which can print sheet sizes of up to 1,5 m x 2,0 m. This lowers the printing costs, but aggravates elongation problems (register deviations) during printing.

Yet another challenge is the increasingly shorter use cycles of consumables like paper, ink, additives etc. They are replaced by new or modified materials much faster today, and press operators must frequently cope with new conditions to achieve the desired quality because the latter depends greatly on the combination of materials used. Register variations can have various causes, but paper is one of the main influences. The moisture introduced by the ink-fountain solution emulsion causes paper fibres to swell, which leads to changes in the dimensions of print substrates.

Objectives/Research results

The project therefore aimed to:

- Characterise printing papers especially in terms of coat thickness variations and elongation behaviour
- Improve the measuring technology for coat layer characterisations
- Improve the modelling of penetration and elongation properties of papers during printing
- Identify paper properties leading to smaller register deviations in printing, and classifying the papers accordingly
- Conducting suitable printing tests to derive recommendations for compensating measures during printing to reduce register deviations

22 industrial illustration printing papers (matt, semi-matt, glossy – mA 90 ...170 g/m2) were procured, covering a broad range of different parameters. They were printed with different motifs (blank, half-tone, full-tone), varying all print process parameters and the grain direction (long/short grain). The dimensional changes were measured, determining the elongation of papers in both machine and cross direction over all four printing units.

Moreover, sample papers were produced on the VESTRA pilot coater, using two base papers, coating colour formulations, applicators and technological conditions that were known in detail. The sample papers were printed and comprehensively analysed as well.

Because of their mutual interactions and partly opposite effects, it was not possible to definitely quantify the relationships between individual parameters. The grammage, print motif, amount of fountain solution and grain direction were found to have significant effects on the dimensional stability of papers. Regarding grain direction, the dimensional changes were smaller in the case of short grain papers. The release forces in the printing machine and effect of fountain solutions were identified as key influences on dimensional stability. No relationships were found with the base paper, coating colour formulation and applicator used. Calendering, however, was found to have an effect because it causes a higher surface quality that leads to higher release forces in the printing machine and, thus, greater dimensional changes.

At the same time, work was started to model the penetration behaviour of liquids into coated paper. Two different approaches were used: FEM modelling and calculations by means of the Bosanquet equation.

Application/Economic benefits

Economic benefits will mainly be derived from the project results by printers (many of them being SME): they get recommendations how to select suitable papers and optimal printing parameters for difficult print jobs. This is expected to improve the runnability of papers especially in high-quality offset jobs (illustration printing, leaflets, posters), and to enable the printing of highly demanding originals on large formats. This will help reduce set-up times and printing costs.

Project period: 01.10.2015 – 30.09.2017

Remarks

The RTD project IGF 18875 BR was funded by the German Federal Ministry of Economic Affairs and Energy (BMWi) and carried out jointly with the Saxon research institute for the graphic arts industry (Sächsisches Institut der Druckindustrie GmbH, SID) in Leipzig.

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Research area: Product aims

Paper, paperboard and board // Graphic papers

Key words:

fixation of pigments, high speed inkjet, optimization of paper

Title:
Optimization of systems for fixation of pigments controlling the migration of pigments in high speed inkjet printing

Background/Problem area

The surface treatment of paper with multivalent salts to control the fixation of pigments is an established procedure to improve the quality in inkjet printing. In particular the inkjet print on uncoated paper with surface treatment can be improved significa-ntly. However, there is much for optimization in the field of multicolor printing. Various colors are processed by mixing of black, cyan, magenta, and yellow. According to the multiple application of drops on one spot of the paper, the pigments are observed in different vertical positions due to consumption of multivalent cations. The last color (often yellow) printed on the paper migrates very deep into the surface resulting also in a lateral shift of pigment. This results in an incorrect mixing of colors. The obstacle is often suppressed by a large amount of salt, which leads to uneven coagulation of the color printed at first (often black). The printed image has a lack of quality due to mottling.

Objectives/Research results

The aim of the project is the investigation and optimization of systems for fixation of pigments. The penetration of all processed colors will be controlled to enable fixation on the surface including improvement of images and further processing of inkjet products. This work is focused on optimization of surface-treated paper for high speed inkjet printing applying pigment-based inks. The influence of the type and amount of fixation agent on the migration of single pigments, i.e. the inkjet print quality, is of particular interest and will be investigated in detail. The most important parameter for evaluation of the surface treatment of inkjet paper is the solubility of fixation agent in the ink formulation including kinetics. Based on the findings, systems for fixation of pigments will be developed and optimized. Therefore, a reliable procedure for analyzing of microscopic cross sections is required. The qualitative and quantitative evaluation of pigment migration is aimed. This includes the development of methods to prepare cross sections without artefacts. Moreover, the processiblity of the fixation agent is a very important issue. The choice of the coating device and the formulation of the system is of crucial importance for the printability.

Application/Economic benefits

The intention of the project is to extent the market of high speed inkjet papers, which is increasing but still small at the moment. An inexpensive surface treatment of paper may enable products with intermediate price level between natural paper and photo inkjet products.

Period of time: 01.05.2017 – 30.04.2019

Remarks

The RTD project IK MF160173 is being funded by the German Federal Ministry of Economics and Energy (BMWi).

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Research area: Product aims

Paper, paperboard and board //
Packaging papers and paperboard

Key words:

hot-melt-adhesives, starch-based, bio compatibility

TITLE:
Development of bio-based hot-melt adhesives and their use in paper and cardboard packaging, „Glykopack“

Background/Problem area

The German packaging market is constantly growing and paper products play an essential part in it. In many cases they seem to be an ecological alternative to plastic packing materials. This position could be further strengthened in future if the adhesives used, which often need to be applied in great amounts during production, can be made from renewable resources.

Since the time when thermoplastic starches entered the market, efforts have been made to use starch and carbohydrate-based polymers for hot-melt adhesives. Numerous papers and patents describe products that could be manufactured from these base materials, but none of them has made it to the market yet.

Objectives/Research results

The goal of this research project is to develop a starch-based hot-melt adhesive and to get it ready for the market. The main applications are folding boxes and corrugated board packaging. The materials used are to be evaluated in terms of availability, costs, processing properties, adhesion, aging and recyclability of the processed products, and to be implemented in industrial applications.

The recipe development in the laboratory has been largely completed. For further analysis (adhesion, thermostability) the best variants of bio based hotmelt will be produced in larger batches in kneader and/or extruder. A new measurement method to assess the adhesive force of hotmelts will be developed.

Application/Economic benefits

The market for biodegradable materials in packaging and every aspect of daily life has grown at a fast pace in the last decade. The general awareness for environmentally friendly products has risen and companies have recognized the potential offered by the marketing of the eco-friendly products.

With new adhesives that could reduce the amount of waste to be burnt or deposited on waste disposal sites, this project contributes to making established manufacturing processes more ecological. In Germany alone the market value of adhesives for paper and cardboard packaging amounts to roughly 9 billion Euros, a large figure that ensures the interest of industrial companies in technological advances in this field.

Period of time: 01.09.2015 – 31.08.2018

Remarks

The RTD project FNR-22005515, „Glykopack“, is being funded by the German Federal Ministry of Food, Agriculture and Consumer Protection (BMEL) and carried out in cooperation with the Leibniz Institute of Polymer Research Dresden (IPF).

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Research area: Product aims

Paper, paperboard and board //
Packaging papers and paperboard

Key words:

coating, barrier properties, mineral oil, hydrocarbons, phthalates, benzophenone, inorganic pigments, migration, tortuosity

TITLE:
Improving the performance of barrier coatings against low molecular organic trace components by the effective use of inorganic pigments and suitable binders

Background/Problem area

Secondary fibre paper and paperboard for food packaging contain traces of low molecular organic substances that are introduced primarily via the printing inks, varnishes, adhesives and chemical additives. Some of these substances can migrate directly or indirectly into the foodstuffs via gas phase transfer. The public notice of impurity traces originating from recovered pulps is mainly driven by NGO reports and - as follow up- by customer demands towards paper manufacturers and converters. Irrespective of legal regulations, the German paper industry has a great interest in reducing health risks to consumers. Papers for recycling, however, are an essential raw material for the production of food packaging paper and board. In Germany 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. 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 low molecular organic substances via the gas phase by means of efficient, pigment-containing coatings, and in this way contributes to the protection of the paper recycling loop. The substances that migrate via the gas phase and may eventually include a potential risk include mineral oil hydrocarbons as well as phthalate plasticisers and benzophenone. These substances are within the focus of this project. Up to now, pigment-containing coatings have been studied as to their capability to reduce mineral oil migration in isolated cases only. Relevant possibilities for reducing phthalate and benzophenone migration, however, have not been published so far. An additional objective of the project is to improve migration test methods for barrier coated paper sample in such a way that prediction of long term migration will be possible.

At the beginning of the project the base components for the barrier coatings are selected. The selected pigments contain mainly different types of kaolin, talcum, bentonites, preciptated calcium carbonates and some unusual types like illite, mica and montmorillonite. The polymeric part contains acrylates, acrylate-copolymers, PVOH, PVOH-copolymers vinylacetate-copolymers, hydroxyethyl-cellulose and methylhydroxypropyl-cellulose. Formulations are made and applied on laboratory scale in constant amounts on a base paper (machine finished craft paper).

The results of the trails show very low migration through layers of PVOH, PVOH-copolymers vinylacetate-copolymers, hydroxyethyl-cellulose and methylhydroxypropyl-cellulose. These products are suitable for building up barrier layers against mineral oil hydrocarbons, phthalate plasticisers and benzophenone. By addition of laminar pigments migration decreases further. Best results are obtained with combinations of PVOH, PVOH-copolymers, hydroxyethyl-cellulose, methylhydroxypropyl-cellulose with kaolin and bentonites. In this cases scanning electron microscopy (SEM) reveal a high orientation of laminar pigment particles. The tortuosity effect often predicted in literature is mainly verified within these investigations.

Time and temperature dependent migration experiments show that for extrapolation to long storage times the use of time dependent data will be better than the use of temperature dependent migration data. Higher temperature (60°C and more) may cause more and sometimes unexpected deviations.

Results are mainly verified with the system kaolin / hydroxyethyl-cellulose on a fast running pilot coater using the reverse side of a whitelined chipboard as substrate.

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 – 31.05.2017

Remarks

The RTD project IGF 18656 is being funded by the 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:

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 size presses have increasingly been replaced by film presses. The latter allow 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 for viscosity reduction to enable surface sizing.

The cooperation partners are representatives of the starch industry, food industry, chemical industry, paper and corrugated board industry and mechanical and plant engineering sectors.

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 on viscosity and 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 included chemically modified xylan products (mainly cationically modified). It is expected that the use of cationically modified arabinoxylan products by recycling the surface sized papers will cause less starch to be replaced and hence lower chemical oxygen demand (COD) values of the waste water.

The xylans used show different effects on the viscosity of starch-xylan blends. The varying viscosity characteristics are caused by enzymes as contaminant in xylan. In the presence of xylan the enzymes are temperature stable to 120°C and pH-stable in a range of 5 – 9. The starch-xylan blends penetrate more deeply into the paper than conventionally degraded starch solutions. The conventionally degraded starch solutions show a higher tendency to retrogradation than the starch-xylan blends. Selected xylan samples are purified with proteases to determine further areas of application.

Application/Economic benefits

The benefits are:

- utilisation of material residues recovered from the starch process, which so far have only been used 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 sized 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 – 30.09.2017

Remarks

The project IGF 18714 BG is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi). The project is being carried out by the research institutes TITK, UH and PTS.

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Research area: Product aims

Paper, paperboard and board //
Packaging papers and paperboard

Key words:

corrugated cardboard, mechanical properties, creep characteristics, speed rate controlled short-time test, generalized viscoelastic Maxwell model, analysis by Prony, influence of moisture, FEM model, design of packaging

TITLE:
Development of a continuum mechanics justified method for calculating the climate-dependent creep characteristics of corrugated containers

Background/Problem area

The increasing interest in packaging and other elements made of corrugated cardboard (e.g. purchase displays or decorations) goes hand in hand with the question of a precise interpretation of the material. The challenge for manufacturers and users of corrugated cardboard is particularly the structural behaviour over a long period and under changing climatic conditions. Qualitative statements about the long-term structural behaviour of corrugated containers are currently given only by time consuming and costly long-term studies. Due to these conditions, these tests are only used in rare cases. The design of the packaging is therefore usually based on simple calculations, such as the McKee-formula. These include only quasi-statically determined material parameters, general geometric relationships and are coupled with the assumption of many conditions (e.g. the ratio of height must agree to scope). In order to ensure a certain degree of security for the package, the results are subjected to general safety factors. Detailed considerations of climate- and long-term loads do not take place. Corrugated cardboard is a hygroscopic material and loses almost half of its strength with an increase in humidity from 50% to 90%. The following, inaccurate interpretation of corrugated packaging in the current sense will lead either to oversizing (waste material) or a failure (damage) by climatic or long time stress. An optimized use of the material does not take place in most corrugated containers.

Objectives/Research results

The aim of the project is to develop a continuum mechanics justified method for calculating the climate-dependent creep behaviour of corrugated containers by means of short-term tests, performed with different loading rates. The method sets the focus of research on the material-specific behaviour of corrugated cardboard with respect to long-term and climate stress. Therefore it is possible to perform an application-oriented design of the packaging and dispense as far as possible on time and cost-intensive long-term tests on the packaging. In this way, a link between tests on the material and the behaviour of the packaging is prepared.

Therefore, the following subordinate targets are to be achieved:

- Creation of a viscoelastic material model and derivation of a creep model for the material,
- Conducting speed differentiated short-term tests on specimens of corrugated board for determining viscous material characteristics and integration into the creep model,
- Comparing the calculation results with long-term studies on specimens,
- Determining the viscoelastic component of deformation and the influence of defined climatic conditions,
- FEM calculation and comparison with practical BCT measurements on packaging.

Application/Economic benefits

An optimal size of corrugated cardboard packaging would save material as well as minimize damages within shipping. The method will lead to a proper design of the wall thicknesses of corrugated containers through the accurate knowledge of the long-term behaviour under different climatic conditions.

In many applications it will be possible to dispense on an undefined increase of the wall thickness for security purposes. Other cases will show that the current interpretation would result in a damage that can be prevented with the correct dimensioning.

Period of time: 01.10.2015 – 30.09.2017

Remarks

The research project IGF 18876 BG is being funded by the German Federal Ministry of Economic Affairs and Energy (BMWi) and is carried out in collaboration with Prof. Sadlowsky, BFSV Hamburg.

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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

Currently, the material of choice for trays for fresh food packaging like meat is mainly thermo-formable plastic (PET, PP or PS) or plastic-paper composite materials. As means to reducing the environmental impact of end-of-life packaging, fibre-based materials have long since been proposed as an obvious packaging solution. In order to promote this solution, novel compostable materials have to be developed exhibiting similar barrier properties for the protection of the packaged good as thermo-formable plastic materials. Unfortunately paper itself cannot be converted via thermo-forming, since the strength of paper is dominated by the hydrogen bonding and mechanical entanglement between individual paper fibres. These bonds are stable up to 200° C. The stretch at break of paper is limited at 5 – 6 %. However special packaging papers achieve values up to 10 %. But even this is merely useable for packages with a depth of maximum 15mm. A real thermo-forming process is not possible as cellulose decomposes before melting. To endow paper with thermo-formable properties the interactions between individual fibres in the network have to be modified.

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. 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.

Within phase I and II different chemical fibre modifications were investigated to create thermo-formable paper like graft-polymerisation or cellulose ring cleavage. Paperboards made out of this material provide high temperature extensibility up to 50 % and are used for thermoforming experiments in a new trial device at PTS Heidenau. A packaging demonstrator was generated and the base material was compared with typical thermoforming films by means of technical and economical properties. Polymers for the ductile barrier coating were characterised according to their ability to thermoforming and their impermeability of oxygen, water vapour, fat and oil. Among the investigated coating materials acrylic dispersion coatings showed best fit to the requirement profile. Suitable foils based on biopolymers (PLA, PBAT and mixtures thereof) were produced for use as lid film using small scale pilot plants for compounding, extrusion and calendering. Antimicrobial agents have been incorporated into polymer matrices.

Two different approaches were started within the development of antimicrobial packaging functions:

Superhydrophobic coatings as prevention to form bacteria films: The materials investigated based on sol-gel chemistry showed high efficacy but modifications must be tested in order to get food contact approval.

Coatings with antimicrobial ingredients: Antimicrobial ingredients with food contact approval were defined and their target efficacy confirmed by experiments.

Application/Economic benefits

Novel concepts for packaging materials will open new markets for producers of packaging materials and also fresh food.
It is expected that the generated solutions 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 packaging producers which can 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. Secondly, 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. 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.

Period of time: 01.05.2015 – 30.10.2017

Remarks

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

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Research area: Product aims	Key words:
Paper, paperboard and board // Technical speciality papers	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 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 were used to form additional fibre-fibre-bonds, optimally using the existing fibre framework. Cellulose-based, synthetic and mineral fibres were used in combination with special binding components to construct the "hierarchic fibre network". Basic prerequisite in the development work was the transferability to conventional installations of the paper industry without additional investments.

In the first step of the project, a raw material screening was carried out to assess the potential to improve paper properties by use of strength-increasing components and to verify the hierarchical structure concept. In the trials, the hierarchical structure concept could be verified. Based on the results, further trials were carried out with promising combinations of strength-increasing components in different amounts to assess the transferability of the results and to optimize the paper composition. Systematic laboratory trials were carried out to produce Rapid Köthen laboratory sheets with different amounts of cellulose, various functional fillers (e. g. aluminium hydroxide, calcium carbonate and kaolin for the application area "fireproof lightweight construction", active carbon and diatomaceous earth for the application area "adsorptive filtration") and strength-increasing compounds (polyvinyl alcohol fibres, polyamide fibres, basalt fibres, fibrillated hemp and flax fibres). The papers were characterized regarding their relevant paper properties (e. g. grammage, residue on ignition, strength properties) and their formability using a laboratory corrugator. The paper strength properties and the formability could be significantly improved by the use of the different strenghtening compounds. In the next step, the results could be transferred from the standard round Rapid Köthen sheets to a larger, square format of 30 cm x 30 cm using a modified Rapid Köthen sheet former. In the last step, the results gathered in laboratory scale will be transferred to the continuous papermaking process using the PTS pilot paper machine.

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 – 30.11.2017

Remarks

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

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Research area: Process aims

Paper, paperboard and board // technical speciality papers

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 anti-microbial 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, document 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 per-form 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 research project IGF-Koop 18696 BR is being funded by the Federal Ministry of Economic Affairs and Energy (BMWi).

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Research area: Product aims

Paper, paperboard and board // technical specialty papers

Key words:

organic conductors, sleekness

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 the 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.

Characterization of the first nonwovens from the pilot paper machine showed, that drapability of the recipes with PA6-fibers is far better than the behavior of the recipes with cellulose fibers - which was expected as the PA6 fibers are much longer and more flexible. Also it was seen, that spunlacing of the cellulose containing recipes didn’t show any positive effect on drapability of the media. Hence, further investigations were focused on the recipes for the thermoplastic composite route. Spunlacing pressure was varied within a limit of 0 bar to 40 bar, pressures higher than that lead to destruction of the fiber web. Characterization of the wet-laid media is already finished, characterization of the consolidated composites in still ongo-ing.

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 re-gard 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 inex-pensive (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 – 30.06.2017

Remarks

The research project IGF 18697 was funded by the German Federal Ministry of Economic Affairs and Technology (BMWi) and is 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 specialty papers

Key words:

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

Title:
Fiber-length-optimized recycling process 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.

The project was successfully finished in March 2017. The developed process combination enables the layer-wise design of staple fiber reinforcements for organo-sheets. Long fibers and directed structures can be placed in layers with high expected loads, while short fibers can be added for surface design and bending flexibility. It was shown that the tensile strength of the hybrid reinforced organo sheets outperformed the strength of the chosen benchmark product (CAMISMA) with 26 GPa Tensile-E-Modulus. A car seat with carbon fiber nonwovens reinforced backing, was chosen as demonstrator. The seat was produced with a state-of-the-art film-stacking process and achieved a c-fiber volume ratio of 25%.

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 possible to manufacture an organic-sheet-material in a one-step-process and to avoid an additional impregnation step. Also flow paths were minimized by blending the matrix fibers into the carbon fiber nonwovens, hence process pressure can be reduced and matrix outflow during consolidation was minimized. The feasibility study at the end of the project showed that the FullCycle approach reduced production costs in comparison to the state-of-the-art benchmark process by 28%. This reductions is mainly based on the higher material yield, reduced costs for PA6 fibers instead of PA6 foils (film stacking) as well as the reduced cycle time in the heat pressing step. Altogether, the feasibility of staple fiber nonwovens-based organo-sheets can strongly be improved.

Period of time: 01.07.2014 – 31.06.2017

Remarks

The research project IGF 18717 was funded by the German Federal Ministry of Economic Affairs and Technology (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 specialty papers

Key words:

moulded pulp structures, functional enhancement, functional fillers, retention, dewatering

TITLE:
Functional enhancement of moulded pulp structures by adapting process conditions for the high-grade incorporation of functional fillers

Background/Problem area

The pulp moulding process offers diverse possibilities for producing complex three-dimensional fibre-based moulded parts. This technology makes it possible, for instance, to realise asymmetrical shapes with a high height/diameter ratio of the moulded parts as well as multicavity shapes. The current applications of moulded pulp structures are found predominantly in the packaging field. The innate functionality of moulded pulp structures is their shock absorption properties by virtue of the pulp and constructive engineering. Functional enhancement with respect to the specific property fields such as an adsorption (e.g. pollutant adsorption) or flame-retardant function requires the high-grade incorporation of functional fillers. The forming process is of critical importance regarding the homogeneity of the material structure of the moulded pulp structure and a corresponding incorporation of the fillers. The dewatering of the pulp suspension – which is significantly influenced by the use of the fillers – plays a crucial role for the uniform layer structure.

Objectives/Research results

The objective of the research project is to adapt the process conditions in the pulp moulding process so that functional fillers are incorporated into the moulded pulp structures. A process concept is to be developed for the high-grade incorporation of functional particulate substances into moulded pulp structures that will make a homogeneous material structure of the moulded structure with the corresponding functional properties possible. In so doing, the functionalities focus on the adsorption and reduction in the fire load and the thermal stability of the moulded structure.

The dichotomy that exists between the incorporation of the functional fillers and the forming process is determined by the dewatering of the pulp suspension and its dewatering behaviour. The solution of this problem is on the one hand the specific adaptation of the pulp system in conjunction with process-related additives and, on the other hand, measures designed to improve dewatering during the forming process (e.g. temperature, ultrasound).

The studies within the framework of the work thus deal initially with the chemical-physical conditions during forming that are influenced by the fibre components, the filler components and the use of specific process-related additives. Relevant laboratory-scale trials have been conducted in terms of a material screening designed to characterise retention and dewatering behaviour. An evaluation system was developed to assess the many parameter settings investigated. Target and limit values were defined for the two criteria retention and dewatering in order to differentiate between test results. The evaluation system was used for assessing the DoE, making it possible to differentiate between the various formulations and identify promising stock systems with high functional filler content on the basis of the aforementioned criteria. Further, a test stand for the pilot-scale production of fibre-based moulded parts (custom product) was designed, built and put into operation. After several modifications and adjustments, the envisaged moulding tests could be successfully realised on the test stand.

Application/Economic benefits

The expansion of the functional properties of moulded pulp structures offers a wide variety of new or additional application possibilities for the use of fibre-based 3D moulded structures. SMEs from the manufacturing sector and from diverse application sectors can set up new product lines and open up a new customer base. Basically all sectors are worth considering in which compact 3D structures (with shapes that have many degrees of freedom of the structure) are used and relevant functional properties are required. As far as adsorption is concerned, there are a myriad of possible uses for the adsorption of odorous or harmful substances in the field of automotive engineering (passenger compartment), in the construction / furniture sector, in the field of presentation media or generally in the filtration field. In particular the focus is on fields of application in which filling is not possible, and structures with a compact shape provide corresponding advantages. Application possibilities for moulded pulp structures with a low fire load/high temperature resistance are found in the field of light-weight construction, thermal insulation (e.g. automotive engineering), in the field of friction materials or in the case of special packaging.

Project period: 01.08.2015 – 31.01.2018

Remarks

The RTD project IGF 18787 N is being funded by the German Federal Ministry of Economic Affairs and Energy (BMWi).

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Research area: Product aims

Paper, paperboard and board // technical speciality papers

Key words:

air filtration, spunlace

TITLE:
Controlling specific properties of paper wet laids for air filtration by means of hydroentanglement

Background/Problem area

Filter materials for air filtration are increasingly made from non-wovens comprised of synthetic or glass fibers rather than from paper, which has been made possible mainly by the better dust holding capacity and new manufacturing processes ranging from spunbond technology to the electrospinning of nanofiber layers. The new materials have strongly improved the filtration efficiency, but the synthetic or glass fibres used have some disadvantages as well: One is their petroleum-based raw materials and resulting fixed prices, whereas all other components can already be produced sustainably. At this point it must be stressed that paper-based wet laid nonwoven filter media should be made from renewable raw materials. However, it is not the aim of this project to perform a life-cycle analysis. The use of paper-based instead of glass fibre filters leads to dramatically higher pressure losses and thus also operating costs (80% of the operating costs are caused by energy costs due to pressure losses). Paper will only succeed as an air filter material if the pressure losses can be limited to the level of synthetic- or glass-fibre based filter materials and if they reach comparable performance characteristics.

In this project, technologies will be developed for producing multi-layer paper-based-wet laid nonwovens by means of hydro-entanglement. The wet-laid nonwovens will be converted to novel and functionalized paper filter media that can be used to make deep filtration air filters from renewable raw materials and with performance characteristics and performance data comparable to synthetic- / glass-fibre-based filter media. The novel air filter media should offer high filtration efficiency and dust holding capacity as well as comparatively low pressure losses at high layer thickness.

Objectives/Research results

The project aim is to control the porosity of paper by reorienting its fibres through hydro-entanglement in the paper machine in order to develop novel multi-layer paper based filters with low pressure loss for air filtration applications. The following issues will be dealt with in the project:

- Analysing the influence of fibre properties (type, length, stiffness, fibrillation) on the effect of hydro-entanglement on paper properties for the control of pressure losses in air filtration applications
- Analysing the effects of various additives (polyelectrolyte and metal-containing fibrids) and of fibres with different properties (bonding capacity, stiffness, fibre length, specific area, type of modification) on the filtration efficiency / specific performance of the filters produced
- Identifying the converting steps needed to achieve maximum filter efficiency / specific filter performance with the papers produced

First laboratory investigations have shown that pressure losses may be reduced by hydro-entanglement and the selection of suitable fibres. The targeted use of specialty fibres has made it possible to control the porosity of papers. The use of metal-containing fibrids led to the envisaged metal contents required for microbial growth prevention.

The results were then used for the pilot-scale production of wet-laid nonwovens, using promising natural and synthetic fibres separately and in mixtures. Further investigations dealt with the effects of metal-containing fibries and various intensities of hydro-entanglement as well as with drying method variations (contact/through-air drying).

Further work will be dedicated to the paper-technological characterisation of nonwovens, and to evaluating their filtration properties. Promising samples will be used to obtain demonstrators for air filter testing.

Application/Economic benefits

The air filtration market grows steadily and continuously, driven by the effects of fine dust pollution on human health. This problem will become even more important in future because air pollution levels and also the requirements to indoor air quality can be expected to increase especially in Asia and urban areas.

According to present studies, the global filter production is expected to grow annually by 6.2% until 2018. Completely bio-based filters made from renewable raw materials could reach a market volume of 300 million EUR in Western Europe in the next years. This will certainly take some time, but there are chances particularly for small and medium-sized companies to fill this market. Possible applications include:

- air filters for air conditioning systems
- air filters for industrial plant systems

This could generate a new product range in the industry and in Germany.

Period of time: 01.01.2017 – 30.06.2018

Remarks

The RTD project IGF-Koop 18981BR is being funded by the Federal Ministry of Economic Affairs and Energy (BMWi) and carried out in cooperation with the Institute of Air Handling and Refrigeration (ILK) in Dresden and the Thuringian Institute of Textile and Plastics Research (TITK) in Rudolstadt.

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Research area: Product aims

Paper, paperboard and board // technical specialty papers

Key words:

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

Title:
rCF-Hybid – Novel hybrid semi-finished materials based on recycled carbon fibers for use in structural lightweight design

Background/Problem area

It was shown in previous research projects (e.g. FullCycle) that the wet-laid process is an effective processing route for short cut carbon fibers, especially for recycled carbon fibers. Those fibers, especially if they result from pyrolysis are weaken and brittle after the high-temperature treatment and tend to shortening and dusting during further processing. As mixing of the fibers takes place in aqueous solution, hereby fiber shortening is decreased and dusting is minimized as long as there is residual moisture content. On the other hand, it was also seen that the mechanical performance of such nonwoven-reinforced composites is limited due to the limited fiber length that is processable in the wet-laid formation (max. 30mm). Hence, the approach of this project is, to combine rCF-nonwoven media with unidirectional fiber tapes (UD-Tapes based on virgin fibers). This combination enables a layer-wise design of the composite structure, using the UD-Tapes in layers with high expected loads and using the rCF-nonwoven e.g. as highly homogenous surface layer.

Objectives/Research results

Aim of the project is the development of a novel hybrid composite material consisting of recycled carbon fibers immobilized in nonwoven layers and UD-Tapes based on virgin carbon fibers. The thermoplastic matrix will be PA6 (fibers in case of the nonwoven, film/foil in case of the UD-Tape). The material shall be given as a thin thermoplastic prepreg which can be consolidated via heat pressing into 3-dimensional organo-sheet products.

The development of the wet-laid media has already started, hereby recycled carbon fibers from CarboNXT are used in different fiber length and mixtures thereof. A static heat press can be used to determine the optimum ratio of carbon and PA6 fibers for the consolidation step (homogeneous wetting of the carbon fibers with PA6) and mechanical parameters of the sheet material will be measured. Besides this the cetex institute is using virgin carbon fibers from Mitsubishi to develop the UD-Tapes. Afterwards the parameters for producing the multi-material composite needs to be investigated. Up-Scaling of the developments in pilot-scale is planned in 2018. Data collection as basis for the simulative calculations has started and will be continuous ongoing to provide representative parameters for the single materials as well as for the multi-material composite. And the end it should be possible to predict material performance as a function of number and type of the combined layers (e.g.”x” layers nonwoven in combination with “y” layers UD-Tape resulting in performance “z”).

Application/Economic benefits

Lightweight components are on the rise above all technical fields, e.g. vehicle and aircraft construction. Due to a more flexible manufacturing process and lower cycle times are in particular thermoplastic composites a constantly growing product group. The amount of CFRP (carbon-fiber-reinforced-plastics) waste from manufacturing and end-of-life components will drastically increase. Recycling processes based on pyrolysis are realized in industrial scale, but the bulk of resulting fiber fractions is <60mm in fiber length and therefore not interesting for many textile processing procedures. The wet-laid process is an appropriate route of transforming short recycled carbon fibers into a processable raw material – but combination with long-fiber materials is mandatory to obtain composite materials with competitive mechanical properties.

Period of time: 01.01.2017 – 30.06.2019

Remarks

The RTD project IGF 19281 N is being funded by the Federal Ministry of Economic Affairs and Energy (BMWi) and is carried out in cooperation with the Cetex Institut für Textil- und Verarbeitungsmaschinen gGmbH, Chemnitz.

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Research area: Product aims

Paper, paperboard and board // technical specialty papers

Key words:

metal paper, PEM-electrolysis, renewable energy

Title:
Ti-Paper-Electrode – Development of porous paper-based Titanium-electrodes for PEM-Electrolysis

Background/Problem area

The production of hydrogen via electrolysis is a forward-looking method to store renewable energy. Concerning performance, installation engineering and maintenance is the PEM-electrolysis (Polymer-exchange-membrane) a competitive process to the well-established KOH-electrolysis. The industrial occurrence of this technology requires cost-efficient electrolysis systems. State-of-the-Art power distributors in such PEM-cells are based on Titanium (sintered materials or webs), are very expensive and so far not optimized for this special application. Based on the “Paper-derived powder metallic materials” which PTS developed together with the Fraunhofer IFAM, it is possible to convert highly metal filled papers into porous metal structures. Using titanium-hydride (TiH_2) it is also possible to obtain a porous titanium material. Based on this approach it should be possible to develop a function-optimized, cost-efficient power-distributor to be used in PEM-Electrolysis-cells.

Objectives/Research results

The work will start with choosing and characterization of available titanium-hydride-particles. Possibly available powders need to be grinded down to proper particle sizes <30µm. The paper development will focus on high filler content, homogeneous formation and adjustable porosity (by means of fiber content, particle sizes). Retention rates <99% are aimed to avoid any migration of TiH_2 in process water. The lab papers will be characterized concerning mechanical strength, roughness and pore size distribution. Paper lab-sheets will be used to investigate the de-bindering and sinter parameters for this material in small-scale. In cases of cracking or inhomogeneous sintering the paper recipes will be further improved in s second lab cycle (e.g. by calandering). First functional tests will be done by ZBT in Duisburg to estimate the performance of the material. It needs to be investigated how thickness, porosity and pore size of the sintered material influence the effectiveness of the power distributor within the PEM-cell. Not till then further material optimization can be realized. Up-Scaling trials on the pilot paper machine will be done with optimized recipes.

Application/Economic benefits

Possible applications of PEM electrolyzers range from small laboratory gas generators to decentralized hydrogen generators for hydrogen fueling stations and central gas production units for so-called power-to-gas applications for the storage of excess power generated from renewably resources.

Period of time: 01.05.2017 – 31.10.2019

Remarks

The research project IGF 19526 BG is done in cooperation with the Fraunhofer IFAM Dresden (Fraunhofer Institute for Manufacturing Technology and Advanced Materials) and the ZBT Duisburg (The hydrogen and fuel cell center) and is funded by the German Federal Ministry of Economic Affairs and Technology (BMWi) within the “research alliance energy revolution” AiF.

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Research area: General aims

Paper, paperboard and board // technical specialty papers

Key words:

old papers, works of art, paper documents, paper analysis, spectroscopy, authentication

TITLE:
Development of New Spectroscopic Measurement Methods for Authentication of Documents and Works of Art on Paper

Background/Problem area

Usually, paper is a cheap mass product. However, as a support for historic or important documents and works of art, paper can be of high value. Hence, paper objects are more and more subject to art forgeries and fraud. In most cases, the detection of forgeries can not only be done on the basis of scientific art expertise. Therefore, chemical analytical methods also have to be employed.

The complex composition of papers still today presents a great challenge to chemical analysis, especially when the used methods have to be non-destructive and paper components are only present in low concentrations. Raman microscopy offers new opportunities to chemical paper analysis. Raman measurements have a high chemical specifity and the use of an excitation laser and an optical microscope provides for a very high spatial resolution of up to 1 µm. In addition, Raman spectroscopy is particularly suited to paper analysis because of the weak Raman activity for OH groups. As numerous OH groups are present in cellulose these vibrations are not dominating in the Raman spectra of paper, like they do in the infrared spectra. Instead, characteristic Raman bands of other paper components can be easier identified.

Despite the great potentials of Raman microscopy for paper analysis, so far, only few Raman studies have been reported on paper which is used as a support of documents and works of art. There are many publications dealing with the analysis of color pigments and printing or writing inks on paper but not with the paper itself.

Objectives/Research results

By using the Raman imaging technique, the chemical structure, that means the presence and distribution of different paper components on the surface or along the cross-section, are detected and visualized. This includes different fibers, filler pigments, sizing compounds and others. Beside the intentionally added components to the paper, also other substances that came as trace particles with the main components in the paper or were formed during the production process can be detected and identified. The working hypothesis behind our studies is that the presence and the distribution of different paper compounds including the trace particles contain information about the potential production year and production place of the paper and its treatments. Eventually, the Raman images could be used as “finger prints” of different papers and can give objective indications of the authenticity of works of art or documents on paper.

Beside the Raman spectroscopy, the complementary techniques infrared and near infrared spectroscopy are also used. In the course of the project over 150 dated paper samples from a time period 1500 to the present will be investigated and analysed.

Application/Economic benefits

In the project the new possibilities of Raman microscopy to analyse chemical components and additives in paper will be used. This spectroscopic method makes high-resolution and high specific paper analysis possible in a way that was not feasible before. This allows new insight in the chemical composition and structure of old papers and could considerably support the combat against forgery and fraud of documents and works of art on paper.

Period of time: 01.04.2017 – 30.09.2018

Remarks

The RTD project IK-MF 150045 is funded by German Federal Ministry of Economic Affairs and Energy (BMWi).

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Research area: Product aims

Paper, paperboard and board // technical speciality papers

Key words:

surface structure, wetting behaviour, release, non-sticky, emptying

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

Background/Problem area

It is known that beside surface chemistry the individual surface structure is highly influencing wetting behaviour. Meanwhile various top-down and bottom-up approaches are known to create distinct surface properties by modifying the structure. Never the less most of them are not feasible to be executed on paper substrates due to incompatibilities in chemistry and/or required manufacturing conditions. As a new approach the company IOT GmbH has developed resin formulations which can be photochemical cross-linked and structured (folded in micrometer scale) at once by excimer treatment.

In similarity to self-cleaning surfaces, a limited wetting behaviour can also show advantages in terms of emptying packages. 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 (increased efficiency).

Objectives/Research results

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 liquid, viscous or pasty packed goods. Prerequisite therefore, is to acquire basic knowledge about interaction of resin formulations and paper substrates as well as behavior during curing. Beside required adhesive properties also the stability as well as the recyclability of resulting composites has to be evaluated. The company IOT GmbH will develop the resin formulations for coating and the excimer treatment for folding; PTS will develop the pre-coat and adjust the required 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 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, fine-tuning of the method and definition of parameters describing the folding result.

Application/Economic benefits

The envisaged, surface structured paper based composites 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.

Period of time: 01.11.2014 – 30.04.2017

Remarks

The research project ZIM-KF 2037920 SL4 is being funded by the Federal Ministry of 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 // 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.

The experimental design for full-scale trials was based on two PTS papers. The polishing results were good, the abrasion properties even very good. In polishing trials it emerged that the polishing wheels should be treated with glycerine afterwards to generate the desired results. However, glycerine had to be added already during manufacture because a subsequent glycerine treatment cannot be realized at the company Lenk. The first full-scale trial was done with papers of 120 g/m² and 150 g/m² because of their good results in the preceding polishing tests.

The papers were then used in automated polishing trials. The surface quality of the polished tool was equal to or even better than that obtained with a standard cotton fabric. Temperature development and emulsion demand were comparable to the cotton fabric. A very negative aspect was the service life of the paper-based polishing wheels - it was very low for both paper grades. Compared to cotton fabric, the abrasiveness of paper-based wheels is lower. The paper formulation was therefore readjusted in the mill to compensate for these effects and generate acceptable polishing results. More specifically, the paper grammage and additive use were varied. Among other, synthetic and biopolymer-based plasticizers were used instead of glycerine, and strength aids were added to compensate for plasticizer-induced strength losses. The use of pigments in combination with a strength aid was tested as well.

The removal performance and surface qualities obtained were good. The technological parameters of polishing machines could be positively influenced as well: among other, the speed, pressure and advance of polishing wheels could be reduced.

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

The RTD project ZIM-KF2037925WZ4 is being funded by German Federal Ministry of Economic Affairs and Energy (BMWi).

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Forschungsgebiet: Produkt-Ziele

Papier, Karton und Pappe // Technische Spezialpapiere

Schlagworte:

Mikrofluidik, Medizinische Diagnostik, Wasseranalytik

Thema:
Merck Lab @ TU Darmstadt: „Instrumentenlose Diagnostik und Analytik“

Ausgangssituation/Problemstellung

Mit dem Startschuss der thematischen Neuausrichtung des Merck Lab @ TU Darmstadt am 1. Januar 2017, geht die mittlerweile mehr als zehnjährige, erfolgreiche Zusammenarbeit der TU Darmstadt und der Merck KGaA in die Verlängerung. Das Labor ist dabei Teil einer langwährenden, strategischen Partnerschaft zwischen dem Unternehmen Merck und der TU Darmstadt. Das Merck-Team arbeitet unter Leitung von Dr. G. Schwall vor Ort eng mit zwei Forschergruppen aus dem Fachbereich Chemie und drei weiteren Arbeitsgruppen aus dem Fachbereich Maschinenbau zusammen, was eine effiziente Verknüpfung von Grundlagenforschung und direktem Anwendungsbezug erlaubt. Da die Struktur-Eigenschaftsbeziehungen von Papier in Hinblick auf Mikrofluidik nur unzureichend verstanden ist, ist diese Verknüpfung essenziell, um wissensbasierte Strategien zur Herstellung empfindlicher Diagnosetools zu nutzen, um letztlich extrem komplexe Fluidsysteme wie Blut oder Urin zu untersuchen.

Forschungsziel/Forschungsergebnis

Das Merck Lab @ TU Darmstadt befasst sich mit innovativer Forschung auf dem Gebiet der „Low-instrumented Diagnostics & Analytics“ und erforscht u. a. kostengünstige Verfahren zur Diagnose von Krankheitserregern sowie Optimierungen im Bereich instrumentenloser, analytischer Nachweismethoden. Ein Fokus liegt dabei u. a. auf der Entwicklung mikrofluidischer Systeme aus Papier und Papier-Nitrocellulose-Hybridmaterialien in den Anwendungsbereichen Immundiagnostik und Analytik. Insbesondere geht es dabei um die Steuerung der Mikrofluidik, um gezielt sog. *lab-on-paper-Devices* mit definierten Eigenschaften herzustellen. Bei den Forschungsarbeiten kommen modernste makromolekulare, biotechnologische und drucktechnische Verfahren zum Aufbau und zur Charakterisierung der mikrofluidischen Systeme zum Einsatz. Zur besseren Untersuchung der dynamischen Papier-Fluid-Wechselwirkungen wurde im Rahmen dieses Forschungsprojekts kürzlich ein neues Konfokalmikroskop eingerichtet.

Anwendungen/Wirtschaftliche Bedeutung

Anwendungen ergeben sich im Bereich der medizinischen Diagnostik und der instrumentenlosen Sensorik der für medizinische Zwecke relevanten Analyten. Wirtschaftlich kann dieses Feld in Zukunft sehr bedeutsam für eine Reihe von Sparten werden, die dann auch auf die Zulieferung von Papierherstellern und -veredlern angewiesen sind.

Bearbeitungszeitraum: 2017 – 2020

Bemerkungen

Das Projekt wird gemeinsam aus Mitteln der TU Darmstadt sowie aus Mitteln der Fa. Merck finanziert.

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Papier, Karton und Pappe // Technische Spezialpapiere

Schlagworte:

Mikrofluidik, Medizinische Diagnostik, Wasseranalytik

Thema:
Mikrofluidische Papiere

Ausgangssituation/Problemstellung

Durch den kapillargetriebenen Transport von kleinsten Flüssigkeitsvolumina (Mikrofluidik) bietet Papier ein großes Potenzial in Bereichen wie instrumentenloser medizinischer Diagnostik oder Wasseranalytik. Aus wissenschaftlicher Sicht heraus sind viele ablaufende Prozesse, insbesondere in der Benetzung durch komplexe Fluide wie etwa Polymerlösungen, durch die extrem komplexe Papierstruktur eine große wissenschaftliche Herausforderung und deshalb bisher nur unzureichend verstanden. Seit ca. 10 Jahren arbeitet eine Reihe von Wissenschaftlern an der Entwicklung verbesserter mikrofluidischer Papiere. Die kontrollierte Steuerung des Kapillarflusses oder die gezielte Retention bestimmter Analyten, z. B. zur Steigerung der Empfindlichkeit/Genauigkeit, ist dabei bisher nicht oder nur wenig effizient gelöst. Eine fundamentale Kenntnis der Struktur-Eigenschaftsbeziehungen von Papier kann dazu genutzt werden wissensbasierte Konzepte für die Verbesserung mikrofluidischer Papiere zu entwickeln, so dass diese Anwendung in den genannten Bereichen finden können.

Forschungsziel/Forschungsergebnis

Mikrofluidische Papiere sind in der Gruppe von Prof. Biesalski bereits seit 2012 Gegenstand intensiver Forschungsarbeiten, welche teilweise in Kooperation mit dem PMV und der PTS sowie mit Merck KGaA in Darmstadt durchgeführt werden. Im Rahmen von ersten Doktorarbeiten konnten eine Reihe von Ergebnissen erzielt und auch bereits veröffentlich werden. Die Arbeiten konzentrieren sich einerseits auf fundamentale Fragen im Zusammenhang mit der Imbibition von Fluiden in Papier, wie z. B. welchen Einfluss Fasertyp, -länge und -orientierung auf den kapillargetriebenen Transport haben, andererseits werden mikrofluidische Kanäle gezielt chemisch modifiziert, um z. B. die Retention von Analyten zu kontrollieren oder Analyten in bestimmten Bereichen der Kanäle aufzukonzentrieren. Des Weiteren umfassen die Forschungsarbeiten die Entwicklung neuer Verfahren zur Herstellung mikrofluidischer Kanäle.

In Zukunft werden sich die Forschungsarbeiten im Rahmen von zwei weiteren Doktorarbeiten verstärkt auf die Untersuchung mikrofluidischer Papiere in biologischen Sensoranwendungen (in Kooperation mit Prof. Kolmar, TU Darmstadt) sowie auf die Untersuchung mikrofluidischer Sensoren auf Basis von ionischen Flüssigkeiten für die Metalldetektion (in Kooperation mit Prof. Etzold, TU Darmstadt) konzentrieren.

Anwendungen/Wirtschaftliche Bedeutung

Anwendungen ergeben sich insbesondere im Bereich der instrumentenlosen Analytik und *point-of-care*-Diagnostik, zum Aufbau von papierbasierten Mikroreaktoren und intelligenten Filtern. Auch wenn dieses Gebiet zurzeit noch wenig beforscht ist, kann man sich im Erfolgsfall eine große wirtschaftliche Bedeutung im Bereich der Spezialpapiere vorstellen. Damit würde ein neuer Markt für Papiere mit sehr hohem Wertschöpfungspotenzial geschaffen.

Bearbeitungszeitraum: Seit 2012 – offen

Bemerkungen

Das Projekt wird aus Mitteln des Landes Hessen (Grundfinanzierung der TU Darmstadt) sowie aus einer seit 2017 bestehenden Kooperation mit der Fa. Merck finanziert. Aus dem Forschungsprojekt wurden Ergebnisse in >10 wissenschaftlichen Arbeiten seit 2012 in *peer-review*-Zeitschriften veröffentlicht.

PRODUKT-ZIELE

Forschungsgebiet
Endprodukte aus Papier, Karton und Pappe

Druckprodukte
Schachtelprodukte
Wellprodukte
Sonstige

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Forschungsgebiet: Produkt-Ziele

Endprodukte aus Papier, Karton und Pappe // Druckprodukte

Schlagworte:

Druckerzeugnisse, Deinkbarkeit, Rezyklierbarkeit

Topic:
Deinkability Evaluation 2017

Background/Problem Area

The graphic paper market is shrinking and rapidly changing, resulting from the changing advertising strategies and options. It seems there is a long term trend towards worse deinkability of paper for recycling. The focus of the deinkability tests of INGEDE has been mainly on digitally printed products from future or new printing technologies for many years. But an actual overview on the development of print products which contribute mainly to the volume on the market is missing. The last large investigation on the deinkability of mass relevant print products in paper for recycling was performed by PMV in the INGEDE project 10005 (Recyclability Survey) in the period 2005-2008.

Objective/Research Result

Main target of this project is to study the deinkability of a selected range of printed products which are decisive for the deinkability of the mixture in the paper for recycling grade 1.11.00. Additionally, print product categories, relevant for the production of improved deinked pulp for brighter paper grades should be evaluated. The deinkability is studied by using INGEDE Method 11 in the updated version of 2017 with modified pulping conditions.

In contrast to the former INGEDE project (10005) it was decided to perform the deinking trials not on a single paper product, but on a typical paper product category. This means that a single deinkability test is not performed on a magazine (e. g. Spiegel), but on a product category offset heatset magazines on LWC paper consisting of a variety of 5 to 10 print products. The first product categories defined are:

- BILD offset coldset newspapers from various printing shops
- Waterless offset coldset newspapers from KBA Cortina printing machines
- Regional offset coldset newspapers from various printing shops
- Nationwide offset coldset newspapers from various printing shops
- Offset heatset magazines on SC papers
- Rotogravure magazines on SC papers
- Offset heatset magazines on LWC papers
- Rotogravure magazines on LWC papers
- Offset heatset magazines on SC papers with UV cured or dispersion varnish covers
- Rotogravure magazines on SC papers with UV cured or dispersion varnish covers
- Offset heatset magazines on LWC papers with UV cured or dispersion varnish covers
- Rotogravure magazines on LWC papers with UV cured or dispersion varnish covers
- Rotogravure catalogues
- Offset catalogues
- Various advertisement mixtures, separated by printing process and paper grade, with and without Blue Angel signet.

Application/Economic Benefits

The results are necessary for decisions about future lobby work (Standardization, Ecolabels), and also about finding options for joint development projects with producers of ink, varnishes and machinery. The results also may initiate public funded projects towards improved deinkability.

Project Period: 01.07.2017 - 31.12.2017

Remarks

The research project 15317 is funded by the International Association of the Deinking Industry (INGEDE).

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Forschungsgebiet: Produkt-Ziele

Endprodukte aus Papier, Karton und Pappe // Schachtelprodukte

Schlagworte:

Mineralölbarrieren, Barrierebeschichtungen, Rezyklierbarkeit

Topic:
Assesment of the Recyclability of Barrier Coated Paper and Board Products

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 coat-ings 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 repulpability, 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

First, the recyclability of 18 paper and board products were tested, using the PTS method RH 021/97 as well as the recyclability test method EcoPaperLoop-Method 1 (ZM method RECO 01/2014). Two of the tested products could not be recycled during the evaluation according to ZM method RECO 01/2014. According to PTS method RH 021/97, five products were classified as non-recyclable. Three of them were coated with a barrier against mineral oils. One sample was classified as conditionally recyclable and 12 products were classified as recyclable. Four of these 12 products had a barrier against mineral oils.

Furthermore, a method has been developed to simulate a possible accumulation of colloidal or dissolved constituents of barrier material in dewatered filtrate. The filtrate, which had previously been generated during dewatering, was used for the respective disintegration. In the filtrate no micro- and macro-stickys were measured, so the tackiness of the filtrate was also investigated using the adsorption method on a rotating sieve (ARS method)[11] with addition of a precipitant. Depending on the barrier type, a higher amount of adhesive impurities in the filtrate was usually measured by the coated sample com-pared to the reference sample. An exception was a non-synthetic barrier, where no increase in adhesive impurities com-pared to its reference sample was measured. Furthermore, the multiple disintegration of some barrier-coated samples ap-pears to lead to an accumulation of adhesive impurities in the filtrate. However, this must be verified by further tests with different barrier types.

With the data obtained, it is not yet possible to determine evaluation criteria for the recyclability of barrier coatings. More samples have to be investigated and the parameters for evaluating the recyclability have to be expanded. Also the existing results must be verified.

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 -- 30.04.2017

Remarks

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

[1] Based on: Hamann, A.: Untersuchung des Ablagerungsverhaltens klebender Verunreinigungen bei der Papierherstellung aus Altpapier. Technische Universität Darmstadt, Institut für Makromolekulare Chemie, Dissertation, 2003

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Forschungsgebiet: Produkt-Ziele

Endprodukte aus Papier, Karton und Pappe // Schachtelprodukte

Schlagworte:

Planlage, z-Richtung, Biegesteifigkeit, Elastizitätsmodul, Faserorientierung, TSO/TSI, sheet-splitting

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. The resulting structure profile showing different properties of top and down side with regard to mechanical and dimensional behaviour may lead to remarkable 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 curl problems still occur repeatedly and are assumed to be significantly influenced by the stiffness and fibre orientation distribution in thickness direction, an effect that has not been evaluated yet in detail.

Objective/Research Results

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 using a conventional TSO/TSI tester.

During the project three steps are to be carried out:

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

It has been observed that the age of the adhesive on the polymer foils used for sheet splitting influences the quality of splitting significantly. Therefore, a large variety of preliminary tests was carried out to consolidate the new method. The method then was applied to characterize and to compare paper samples with good and bad curling behaviour regarding differences within the distribution of stiffness properties in z-direction. However, the difference in the obtained figures could not be evaluated as significant. In addition, strain-field analysis has been carried out for the splitted sheets to gain more information about the behaviour of the different layers. These tests could be used to feed a finite-element-model to calculate the influence of moisture asymmetry on curling. The results are not sufficient yet to predict curling from paper properties, but a further step has been made to a better understanding of curling phenomenoa.

The final report is in process.

Application/Economic Benefits

Paper grades that are used for box board and corrugated board often have to deal with curl problems. But office or printing papers (especially when sheeted) are faced as well with this phenomenon. Knowing more about curling reasons and get-ting more instruments to act against it may help to optimize the product quality in these cases significantly. Thus economic effects for paper manufacturers are to be expected from better product quality, improved productivity during converting and less production wastage and complaints.

Project Period: 01.05.2015 –30.06.2017

Remarks

The research project INFOR 191 is 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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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

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 flexible connection of single layers 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 by 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.

Within the project papers including thermoplastic and friction reducing additives in a multilayer approach have been produced in laboratory and pilot scale as well. The generated materials were formed in a hydroforming process under room and elevated temperature. Multilayering as well as the addition of thermoplastic additives led to improved formability of those materials. Out-of-plane shear deformation has been investigated showing decreased shear moduli for modified paper materials.

As friction between paper and clamping device takes place during the hydroforming process, the coefficient of friction has been determined on a macroscopic scale. The measurement was carried out with a self-developed device, which can apply high forces and different temperatures. To get an impression whether small scale variations in the coefficient of friction may be of importance, a micro-friction tester delivered by UST was used. However, the results don't reveal any significant differences between boards good to form or those getting wrinkles and cracks.

In addition, the UST-device enabled the possibility to observe the elastic-plastic deformation behaviour at the paper-surface of the hydroformed samples. The obtained results still have to be interpreted, but conclusions concerning the stress-state at different locations in the paper during the forming-process are expected,

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-dimensionally formed end-products. These packaging innovations shall strengthen the market position of small and medium enterprises.

Period of time: 01.06.2015 – 31.11.2017

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 PMV Darmstadt and the PTS Heidenau.

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Research area: Product aims

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

Key words:

creasing, creasing parameter, creasing tools, folding box board, cardboard, water-based coatings, numerical simulation model

Title:
Development of a comprehensive concept for optimal creasing of cardboards with water-based coatings

Background/Problem area

Accurate creasability is an important property that coated cartons must meet during processing. Creases are used for the preparation of bending positions and are performed simultaneously with the blanking. During creasing, the cardboard and the coating are deformed strongly. There is a risk that the barrier layer may be damaged. While the creasing process is currently predominantly mastered for extrusion-coated and foil-laminated cartons, problems are frequently encountered with water-applied coatings. It is unclear, in particular, under which conditions an exact creasing can be achieved.

Compared to extrusion coatings, water-based coatings have different structures and thus other deformation properties of the polymer film. This is due to the different processes involved in film formation. Unlike film forming in plastic melts, converge and entanglement of the polymer chains in water-based systems occur only in the final phase of drying. Moreover, depending on the residual water content, aqueous polymer solutions result in soft to brittle films (polyvinyl alcohols, starch), that can also be problematic during creasing.

Objectives/Research results

The aim of the project is to create a comprehensive concept for the creasing of cardboards equipped with water-based barrier coatings, so that they are free of defects. The concept takes into account the involved materials (cardboard and coating) and the process conditions (creasing parameters and creasing tools). Suitable creasing parameters and new geometries for creasing tools are to be determined and investigated based on finite elements models. The results should be summarized for practice in the form of creasing recommendations. This leads to the following sub-objectives:

- With regard to the coatings, the minimum properties are to be determined which lead to sufficient faultless creases. This includes the application weight and the ductility of the coating.
- For the raw carton, the required mechanical properties should be defined and the feasible creasing parameters should be determined.
- The influence of the creasing tools and creasing parameters is to be examined intensively and varied with the aim of achieving the best possible creasing result. It is proposed to use creasing knives, creasing geometries and creasing grooves which are not part of the current standard. In order to be able to carry out an optimization, numerical simulation models need to be developed and applied.

Application/Economic benefits

For the first time, the main influencing factors on the creasability of cardboards with water-based barrier coatings are systematically recorded and the results will be implemented into recommendations for precise creases. The recommendations contain detailed instructions which can be applied directly in practice. In addition, a simulation model for the creasing process is provided, which allows identifying the optimal creasing geometries faster and better than the empirically determined equations which often provide only a rough orientation and hardly reduce the extent of necessary preliminary tests. The industries that benefit from this include the manufacturers of paper, cardboard and articles thereof, the chemical supplier industry, the production of packaging and their supplier industry.

Currently only the visual appearance of the creasing lines and the reduction of the folding moment are tested. The results of the project may be the basis for further evaluation procedures (e.g. permeabilities of fluids and gases at the creasing lines).

Period of time: 01.02.2017 – 31.01.2019

Remarks

The research project IGF 19313 BG is being funded by the Federal Ministry of 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

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

Key words:

barrier efficiency, analytics, fast test method

TITLE:
BarriereFIT- Fast Innovative Testing - Fast and universal test method of barrier layers against migrating substances from food packing papers made of recycled paper

Background/Problem area

About 2,3 million tons of food packing material are made from recovered fibers. 60% of folding boxes are used in food contact. About 60% of them are produced with addition of recovered fibers.

According to article 3 of regulation no 1935/2004 for food contact materials substances may not migrate into foodstuff in amounts that may endanger human health, bring about an unacceptable change in the composition of the food or bring about a deterioration in the organoleptic characteristics thereof.

To show compliance with food law requirements, migration from paper needs to be analyzed. Different substances or substance groups, such as mineral oil (MOSH/MOAH), phthalates (e.g. DBP, DiBP, DEHP) or benzophenone (BzP) have to be analyzed to proof conformity with specific migration limits. Furthermore many not identified contaminants are present in recovered paper raw materials. Analyses of all present and potential migrating substances by instrumental analysis is not feasible. The proof of an efficient universal migration barrier is the best possible way to provide confidence in the product´s performances. This is of great importance in order to strengthen the market share of recovered paper and board within the packaging segment.

Objectives/Research results

With the developed method the efficiency of barriers for food packing materials made from recovered paper and board materials towards a wide range of migrating substances can be determined.

Evaluation of the results is done by comparison with real occurring migration into food (stored in contact with barrier materials). The acceptance of the proposed test method as kind of an industrial standard and convention agreement needs to be addressed.

Application/Economic benefits

As stated by the German corrugated board association ("Wellpappenverband" VDW):

„…Regarding the complex physical relations between filling and packing material […] no general working barrier-material can be explicitly recommended. Barrier effenciency always depends on filling, film thicknesse, conditions of filling and storage, contaminants etc. and has to be checked in every single case.

An official list with registered materials with barrier effect is missing as well as definitions and analytical methods to evaluate barrier efficiency of barrier layer. Also practical tests for influence on filling material (e.g. water- and steam permeability, migration behaviour) are needed.“

The need for an universal and reliable test method for barrier efficiency against migration of distinct as well as unknown substances of recovered paper and board that may cause trouble in the future is obvious - especially for SME. The economic benefit is evident due to saving of analytical costs as well as avoiding customer complaints.

Period of time: 01.01.2017 -30.06.2018

Remarks

The RTD project IK-MF 140205 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 // Corrugated products

Key words:

medium density fiberboard, wave structure, corrugated board, lightweight construction

Title:
Development of wave structures made of thin medium density fibreboard to be used in lightweight construction and packaging

Background/Problem area

Lightweight construction is an important topic of paper and wood materials industry. In general laminar materials made of natural fibres are quite light. The density of paper, board and even medium density fibreboard is obviously below 1.0 g/cm³. The most important transport packaging is made of paper or rather board. For this purpose multi-layered corrugated board (heavy duty corrugated board) is produced. The usage of paper-based honeycomb plates made of corrugated board or hexagonal expansion honeycomb in lightweight construction of furniture, panelling and dividing walls reduces the components' weight significantly and helps to make the handling during processing and transport easier. However the amount of material costs of corrugated board production is about 50 % of the total production costs. Accordingly it is of great interest to reduce the material usage especially when there are further positive additional effects expected for example a better moisture resistance and a positive CO_2 footprint.

A for this purpose potentially usable material is very thin medium density fibreboard (MDF). This material can be produced quite cheap and is able to reach up to 50 % higher specific rigidity values compared to common paper. Furthermore it is produced in a dry-process in contrast to the wet method which is commonly used for paper and board production. Because of that the water consumption of the production of thin MDF is about 75 % lower. Regarding thermal and electrical energy the production technique of thin MDF creates energy savings of about 5-10 %. If it succeeds to create thin MDF with an identical grammage, homogeneity and temperature deforming as paper including a comparatively higher elastic modulus, significant material savings of packaging and lightweight construction can be realised.

Objectives/Research results

The aim of the project is to produce high strength thin medium density fibreboard with a grammage between 100-200 g/m². The thin MDF should have a homogeneous material distribution and should be able to be converted into wave structure with common corrugating machines. The field of application of the produced thin MDF should be inside light building boards and heavy duty corrugated boards.

In the project progression the following results have been achieved so far:

- Production of the fiber grades required especially for thin MDF production. A 50/50 mixture of beech and pine, which is decomposed with a pressure digestion of 8 bar in the laboratory refiner, seems to be particularly suitable.
- Production of thin MDF samples, which have a sufficient defibering behavior, so that the recyclability in the paper circuit is ensured, whereby the circulation water load has to be considered when selecting the binder.
- Performing the non-woven forming process by means of an airlaid system and hot-pressing stage of thin MDF, which could be subsequently, formed into sinusoidal wave profiles.
- Extensive characterization of different samples of varying fiber-adhesive-combinations and comparison of their properties with those of conventional corrugated paperboard (base material and after lab scale wave forming).

The substance of the next project steps is the verification of scale-up and industrial relevance:

- Investigation of the transferability of the optimal process and recipe parameters developed for the production of thin MDF from basic research into a larger scale.
- Investigation of the formability of the thin MDF produced under industrial conditions under practice-relevant operating conditions (corrugation formation process).

Application/Economic benefits

Due to the significant increased rigidity values of thin medium density fibreboard compared to conventional corrugated board it should be possible to realize considerable material and cost savings in the final product.

This results in new approaches for paper converter for product development in material reduced heavy corrugated MDF.

For MDF manufacturers new markets are getting established for innovative MDF products in the packaging industry and in lightweight construction for wall coverings and perspective in the furniture industry.

Period of time: 01.01.2017 - 30.06.2018

Remarks

The RTD project IGF-Koop 18980 BR is being funded by the Federal Ministry of Economic Affairs and Energy (BMWi) carried out in cooperation with the Institut für Holztechnologie Dresden (IHD).

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Research area: Product aims

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

Key words:

corrugated board, starch, borax-free adhesives, Stein-Hall-System

TITLE:
"BORAWELL" - borax-free corrugated board production

Background/Problem area

Borax (sodium tetraborate) is used for cross-linking starch molecules in starch pastes and controlling the rheological and adhesive properties. Since 2010, boric acid and sodium borates have been classified as CMR (carcinogenic, mutagenic and reproduction-toxic) substances of very high concern (SVHC) by the European Chemical Agency (ECHA). In 2011 REACH imposed even more stringent classification criteria, leading to all boron compounds being classified as Substances of Very High Concern and making it mandatory to label any product containing at least 0,1 % boron compounds. If the EU imposes even more stringent classification requirements for boronic substances or completely withdraws its authorization to use borax in adhesives for corrugated board production, corrugated board producers will no longer be able to use commercial starch-based adhesive products. Because starch-based adhesives cannot be produced without boron compounds by means of state-of-the-art technology, starch producers could lose one of their main markets when their customers from the corrugated board sector have to resort using petrol-based adhesive products instead.

Objectives/Research results

Aim of the research project is to develop a novel starch-based corrugated board adhesive by substituting borax in Stein Hall systems by borax-free starch-based solutions without losses in adhesion and converting properties. Alternative cross-linking systems will be defined and tested to scale-up borax-free Stein Hall adhesive solutions for industrial implementation, taking into account the typical service life of corrugating machines as well as economic aspects. To assess the suitability of the new adhesive system, it will be benchmarked against the performance spectrum of established borax-containing adhesive systems.

Application/Economic benefits

A complete ban of borax would affect the economic situation of the starch industry. Without alternative cross-linking additives, starch adhesives would no longer be competitive compared to synthetic binders. The starch manufacturers would lose substantial amounts on corrugated board market. Therefore the aim of the project is to counteract this dangerous trend.

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 corrugated board, the use of starch in corrugated board bonding systems 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: 01.11.2015 – 30.04.2018

Remarks

The RTD project FNR 22027314 "BORAWELL" is being funded by German Federal Ministry of Food and Agriculture BMEL

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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. While 140 g/m^2 was a common paper weight when McKee derived his equation to predict BCT-values from corru-gated board samples, todays grammages may reach 80 g/m^2. In consequence some of the so far common paper quality parameters like CMT or SCT do no longer lead to reliable results in BCT. Paper suppliers and box manufacturers have difficulties to define the correct quality values needed in order to get the desired strength of the box.

Objective/Research Result

The approach of this project was to carry out screening trials with different papers, varying in grammage, fi-bre orientation, and delivering paper machine. The different papers have been used for manufacturing of FEFCO 0201 boxes with B-flute on different corrugating machines. Relevant paper parameters have been measured as well as board parameters and the BCT-value. Aim of this project was to revise or extend the well-known “McKee formula”.

Results obtained show that the McKee-formula still gives a prediction within a range of ± 10 % for the BCT-values finally achieved. SCT-values of the paper in MD have the highest impact on the BCT, but the influ-ences of paper formation, of the fluting machine and of the box-forming machine have to be taken into ac-count. If RCT is used instead of SCT to predict ECT-values (and, in consequence, BCT-values), the influence of paper formation is already included. Therefore, it may be esti-mated that the influence of fluting and box-forming is in the range of 10 % of the end-value.

However, SCT is the preferred parameter, as it is much easier to determine and more reproducible. But to in-sure that the CD-value (mainly corresponding with edge-load properties as measured during the BCT-test) is not overemphasized, it is recommended to take the geometric mean of the CD and the MD value as a quality reference.

A final presentation of the project has been given to the members of the technical committee. The final report has been distributed in April 2017.

Application/Economic Benefits

It’s crucial for the customer-supplier relationship to define values for the delivered paper that are stable con-cerning 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 - 31.03.2017

Remarks

The project was funded by Vereinigung Pack- und Wellpappenpapiere (VPWP) and Verband der Wellpappenindustrie e. V. (VDW).

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Research area: Product aims

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

Key words:

deep-drawing, formability, formable, cellulose functionalization, hydrogel, extensibility

TITLE:
Controlling Fibre Web Bonding and Forming Process for Achieving Dimensional Stable and Complex Shaped Packaging Goods. (Intrinsische Steuerung des Bindungsverhaltens von Fasernetzwerken und deren Umformungsprozesse für formstabile und komplexe Packmittelgeometrien)

Background/Problem area

The packaging is one of the important steps in distribution of different produced goods. The goods are saved and labelled by the packaging and the distribution costs and the sustainability are influenced by the packaging material and the converting processes. Hence attractive packaging processes and a cost-saving use of recyclable materials are neccessary.

Within the last years deep-drawing has been proven as an efficient process for conversion of flat paperboard into three dimensional shapes. High quality cylindrical samples were produced within IGF 16578BR out of multilayered paperboard containing partly synthetic fibres. However more complex shapes were not accessible due to insufficient paper extensibility and the dimensional stability of formed products was generally low.

Objectives/Research results

This research project faces the above problems by means of improving paper extensibility that in turn should be generated via increased drying shrinkage and use of chemically modified pulp material. Different chemical modifications of pulp such as stearoylation, hexanoylation or hydroxypropylation were realized yielding pulp materials partly suitable for papermaking. Increased drying shrinkage could be afforded via application of hydrogels such as agar, gelatin, carrageenan and gellan onto paper. Furthermore the effect of drying temperature has been investigated. It has been shown that particularly gellan allows a high temperature drying without loss of shrinking effect.

Therefore a cup format was developed, which causes defined stress in the material (strain, bending, compression) and thus facilitates a comparison of the materials with respect to their formability. New evaluation techniques for the properties of the molded cups were developed. There is now a defined method for analyzing the buckling strength and the shape deviation of the cups. A measurement procedure for the surface roughness is still in progress.

Over 80 different types of paper were produced, tested and compared to find the most promising ones for further investigations.

Application/Economic benefits

3D-shaped packaging products could be used for a wide range of applications. Currently most products are packed in folding boxes, composite cans or containers made from plastic. The production of folding boxes and composite cans needs many effortful production steps such as punching, embossing, folding, and gluing. The deep-drawing on the other hand is a direct 3D-shaping procedure with only one step but has the disadvantage that to this day only special paperboards can be used, most of which contain a significant amount of mineral oil-based components. The research aims at reducing these components while maintaining and even enhancing the material properties.

The deep-drawing technology together with newly designed paperboards have the ability to significantly decrease the amount of mineral oil-based materials in the packaging process and to enhance the product range of recyclable and sustainable paper based packaging.

Period of time: 01.10.2015 – 31.09.2018

Remarks

The RTD project IGF18877BR is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi) and carried out in cooperation with the TUD/Processing Machines and Processing Technology.

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Research area: Product aims

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

Key words:

paper-polymer-composites, additive manufacturing, tool-free production, functional folded box

Title:
Additive manufacturing on paper substrates

Background/Problem area

Nowadays different approaches to Paper-Polymer-Composites are available on the market. Blister cards and cartboard headers on plastic pouches without metal clips are only a few examples. Material and technological developments as well as further improvements in process stability have made additive manufacturing methods an increasingly attractive option also for the (small) batch production of plastic components. In order to achieve a tool-free production the use of laser creasing is implemented. Laser creasing leads to a stability reduction in the folding boxes which can be compensated by the addition of stabilizing polymeric structures.

Objectives/Research results

The project aims to develop the scientific basis for the production of paper-polymer composites by means of additive manufacturing methods (extrusion process/fused deposition modelling FDM). Selected paper substrates and polymers will be characterized to realize an optimized composite. Based on this, the project partners will analyze the compatibility of materials in terms of adhesion and dimensional stability. In order to achieve reproducible results measuring technics have to be adapted to the new material combinations and measuring standards have to be defined. The results will be used to demonstrate the potential of the manufacturing approach for the example of a folding carton with reinforcing framework.

Application/Economic benefits

In particular the growing trend towards mass customization with its associated small production quantities requires the economic use of these technologies. This makes not only the rapid manufacturing of demonstrators and (semi-) functional prototypes, but also the production of ready-to-use functional and structural components an important application area of additive manufacturing methods.

A growing demand for customized products can also be observed in the packaging sector: small lots of folding cartons that meet special functional, regional, seasonal or advertising requirements or follow a current trend are increasingly popular in the market.

Period of time: 01.02.2017 – 31.01.2019

Remarks

The RTD project IGF 19315 N Additive manufacturing on paper substrates of the associations Papiertechnische Stiftung PTS (Heidenau/München) and German Plastics Center SKZ (Würzburg) is being funded by the 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:

insulation, renewable raw materials

Title:
More than just insulation – Additional benefits of insulation materials made from renewable raw resources

Background/Problem area

Insulation materials made from renewable raw materials help to relieve pressure on the environment by conserving resources and also make a significant contribution towards a reduction in CO_2 emissions. Under the leadership of the Fraunhofer WKI, a consortium of twelve research institutes is conducting interdisciplinary research into holistic solutions in order to significantly increase the application of insulation materials made from renewable raw materials

Objectives/Research results

The project aims at determining the material parameters which, for example, can reduce complex component testing in sound insulation and fire protection. Furthermore, the project intends to remove real application constraints. This applies, for example, to standards and other building regulations which came into being in times in which insulation materials made from renewable raw materials barely existed. A further objective is therefore the development of measurement procedures which take better account of the specific properties of insulation materials made from renewable raw materials. In order to demonstrate the additional benefits of the insulation materials, the project participants also carry out sustainability evaluation.

The six working areas of the project, “Fire protection”, “Sound insulation”, “Thermal insulation”, “Sustainability evaluations”, “Moisture protection” and “Emissions”, lead to a holistic overview of the subject. PTS is involved in the working area “Thermal insulation”. Here the project partners investigate the moisture-dependent thermal conductivity and verify possibilities for reducing this.

Application/Economic benefits

The project results will foster the applicability of these insulation materials for manufacturers, planners and processors.

Period of time: 01.12.2017 – 30.11.2019

Remarks

The research project FNR 22005016 is being funded by the German Federal Ministry of Food and Agriculture BMEL.

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Forschungsgebiet: Produkt-Ziele

Endprodukte aus Papier, Karton u. Pappe // Sonstige

Schlagworte:

Papier, Materialeigenschaften, Bauen, Temporäre Bauten

Topic:
Building with Paper – BAMP! (Bauen mit Papier)

Background/Problem Area

Natural materials such as wood or paper have been used in the building industry for thousands of years and still play an important role in modern building and interior construction. Examples range from plywood slabs and gypsum fibreboards through to laminates. In contrast to wood, there is hardly any scientific basis for paper in these fields of application concerning for example the mechanics of paper-based constructions. The available products are mainly based on the experience of the manufacturers. Thereby paper offers excellent potential for biobased applications in the building industry. It is inexpensive to produce, consists mainly of renewable raw material, offers very good strength properties in relation to its own weight, can be produced as a sheet material but also with high porosity or even as a foam and is relatively easy to chemi-cally functionalize.

Objective/Research Results

Key aspect of the joint research project BAMP! is to provide scientific and technical basic principles for the use of paper in building applications and to develop new approaches to solutions. For this purpose, the material properties of paper have to be adapted to the new requirements and further developed (e. g. high strength, water resistance), the possibilities for individualized shaping with paper materials have to be investigated (e. g. processing in deep drawing processes) and design approaches for the building components and buildings as well as the dimensioning and technical design are to be worked out.

The production of beam and area elements on paper basis will be developed model-wise. Scientifically proven methods will thereby make the construction suitable for new structures made of paper. The focus is on buildings for temporary use (so-called “flying buildings”), which are according to building requirements, if necessary, equipped with smaller technical requirements.

The research team consists of ten doctoral students from different disciplines: Mechanical and Process Engineers, Architects, Chemical engineers, Civil engineers and Paper engineers.

In the first iteration step, a demonstrator was built as a frame construction made of paper tubes. Conventional tools such as screws and wood were used to make the connection between the elements. In the further course of the project, the demonstrator house will be constructed entirely from paper. The construction of the demonstrators helps the team to reunderstand the material paper in the context of building, to identify problems and to present the research in a vivid manner.

Application/Economic Benefits

Various current trends, e. g. the frequent need for emergency accommodation or the need for accommodation for refugees, but also the need for flexible constructions or "temporary living space" with low consumption of embodied energy, demonstrate the medium- and long-term relevance of the topic for sustainable construction.

The industry will directly and indirectly benefit from BAMP! as the wood, paper and construction industries are very important economic sectors for the country, which will receive new impetus.

In the long-term, BAMP! will create the prerequisites for a new economic sector with an internationally visible focus in Hessen.

Project Peroid: 01.01.2017 – 31.12.2020

Remarks

The Focus „BAMP! – Bauen mit Papier“ (Building with Paper) is financed in framework of the 9. founding period of „Landes-Offensive zur Entwicklung wissenschaftlich-ökonomischer Exzellenz (LOEWE)“ by the federal state government of Hessen.
The TU Darmstadt, for which the PMV acts as coordinator, is involved in the project with several institutes (Faculty Architektur: Plastisches Gestalten/Faculty Bau- und Umweltingenieurwissenschaften: Statik, Fassadentechnik/Faculty Chemie: Makromolekulare Chemie und Papierchemie/Faculty Maschinenbau: Produktionstechnik und Umformmaschinen, Papierfabrikation und Mechanische Verfahrenstechnik). In addition, the Hochschule Darmstadt (h-da) and the Technische Hochschule Mittelhessen (THM) are participating with their institutes for „Funktionsintegrierten Leichtbau“ and „Mechanik und Materialforschung“.

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Forschungsgebiet: Product aims

Final products of paper and paperboard // Other

Key words:

composite materials, energy-efficient construction, thermal insulation

Topic:
Energy-efficient construction with composite materials with paper - KOMPAP

Background/Problem Area:

Mineral wool, such as glass and rock wool, and mineral oil-based foams are currently used for the acoustic and thermal insulation of buildings. Paper can play an important role as a renewable and sustainable resource within this field of application. The basis for the development of functional, needs-based and energy-efficient solutions for the insulation of buildings with paper is missing so far. It includes the optimization of materials and structures for applications in the field of thermal insulation, studies on material composites or sandwich structures with paper and concrete or cement and ways to simulate the mechanical properties of these components.

Objectives/Research Results

The aim of the joint research project is to develop new, particularly energy-efficient concepts with composite materials based on paper, mineral materials and plastics for functionalization (e. g. bonding or hydrophobing). These concepts are intended to provide energy-efficient components, for example for building envelopes. The energy efficiency refers both to the thermal insulation properties during application in the building as well as to the material production itself.

Within the framework of this project, plate- or disk-shaped composites are developed, which consist of modified basic components. As a development platform, demonstrators are used on a semi-technical scale for the respective composite materials.

Application/Economic Benefits

On the part of the industry there are still no corresponding cooperations and networks for the development of composite materials consisting of paper and mineral materials for energy-efficient construction solutions. For the industry, this area offers a wide range of possibilities for sophisticated, innovative products. This applies to small companies with innovative high-tech products as well as to large companies producing special fibers or searching for new markets and fields of application for paper products. In focus of this project are both the development of innovative composite materials for construction applications between paper and paper structures, mineral materials and plastics, which lead to cost reductions and increased efficiency levels compared to conventional solutions and the development of high-performance insulation structures, which can also perform static functions.

Project Period: 01.03.2017 – 29.02.2020

Remarks

The joint project is funded by the Federal Ministry of Economics and Energy (BMWi) within the scope of the 6th Energy Research Program from the funding section "Research for Energy-Optimized Building - EnOB" and supervised by project sponsor Jülich (PtJ). The TU Darmstadt, for which the PMV acts as coordinator, is involved in the project with several institutes (macromolecular chemistry and paper chemistry, constructive lightweight construction and construction, statics and construction). In addition, the research institutes PTS in Munich and the Fraunhofer Institute for Operational Stability and System Reliability in Darmstadt, the companies Glatfelter Gernsbach GmbH in Gernsbach, Moritz J. Weig GmbH in Mayen, Papier- u. Kartonfabrik Varel GmbH in Varel, SWAP Sachsen GmbH in Frankenberg, SE Tylose GmbH in Wiesbaden, Borit Leichtbau-Technik in Herzogenrath and „Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V.“ in Bonn and the Vereinigung Pack- und Wellpappenpapiere in Darmstadt are involved in the project.

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Forschungsgebiet: Produkt-Ziele

Endprodukte aus Papier, Karton und Pappe // Sonstige

Schlagworte:

Isolationsmaterial, Styroporersatz, Versandkühlung, Faseraufbereitung, Verpackungsmaterial, Ressourceneinsparung, neue faserbasierte Produkte

Thema:
IsoPack – Eine nachhaltige Alternative zum geschäumten Polystyrol als Isolationsmaterial zur thermischen Isolation von Versandverpackungssystemen.

Ausgangssituation/Problemstellung

Für den Lebensmittelonlinehandel wird in den kommenden Jahren ein starkes Wachstum prognostiziert. Entsprechend steigt der Bedarf an Isolierverpackungen. Eine Analyse der verfügbaren Produkte am Markt hat jedoch gezeigt, dass gegenwärtig kein bestehendes Konzept eine sichere, nachhaltige und bezahlbare Isolationsverpackungslösung darstellt. Dies liegt vor allem daran, dass gegenwärtig als Isolationsmaterial hauptsächlich expandiertes/extrudiertes Polystyrol eingesetzt wird (Styropor/Styrodur). Diese Werkstoffe müssen jedoch aufgrund ihrer nicht zeitgemäßen Ressourcennutzung und der unzureichenden Umweltverträglichkeit in absehbarer Zeit komplett ersetzt werden.

Nicht nur in der Verpackungsindustrie, sondern v. a. in der Bauindustrie ist Polystyrol als Isolationsmaterial zunehmend in die Negativschlagzeilen geraten. Dort wurde das sehr gut brennbare Material teilweise mit giftigen Flammschutzmitteln behandelt, so dass es jetzt bereits als Sondermüll einzustufen ist. Darüber hinaus ist erdölbasierendes Styropor nicht biologisch abbaubar und nur mit hohem Aufwand recycelbar, weshalb es bisher vorwiegend deponiert bzw. zur Energieerzeugung unter Freisetzung giftiger Verbindungen verbrannt wurde. Hinzu kommt, dass bereits die Herstellung umweltbelastend und energieaufwendig erfolgt, womit Styropor im heutigen Sinne keine moderne und nachhaltige Isolationslösung mehr darstellt. Diese Haltung ist auch in der Öffentlichkeit so wahrzunehmen. Ein neues Konzept für zukünftige Isolationsmaterialien muss daher zahlreiche Anforderungen erfüllen, um langfristige Marktchancen zu besitzen und eine umweltverträgliche Alternative zu bieten.

Forschungsziel/Forschungsergebnis

Ziel des Vorhabens ist es demnach ein biogenes, recyclingfähiges Isolationsmaterial zu entwickeln, welches zu 100 % aus Cellulose basiertem Fasermaterial besteht und gegenwärtig verwendete Isolationsmaterialien sowohl in seiner Umweltkompatibilität als auch seinen thermischen Isolationseigenschaften deutlich übertrifft. Dieser hohe Anspruch soll im Laufe der Entwicklung erfüllt werden, wobei es neben der Materialentwicklung gleichermaßen um den Aufbau der so genannten „IsoPacks“ sowie um ein entsprechend effizientes Herstellungsverfahren geht. Nur die komplette Abbildung von neuem Material, Konstruktion und zugehöriger Technologie ist in der Lage ein Produkt bzw. eine Produktfamilie mit großen Marktchancen zu entwickeln.

Als innovative Kernpunkte bzw. Meilensteine sind demnach aufzufassen: Entwicklung des Cellulosefaser basierten Isolationsmaterials aus Recyclingquellen und deren Aufbereitung im Trockenverfahren, Entwicklung von geeigneten Fasermischungen, die in der Lage sind dauerhaft Lufteinschlüsse zu bilden und die Luftzirkulation und Konvektion zu verhindern. Die Konstruktion eines Faserbehälters aus biogenem Material, welcher flexibel und hinreichend strapazierfähig ist und dabei das Fasermaterial so lokal fixiert, dass keine Inhomogenitäten und keine Wärmebrücken erzeugt werden. Der Herstellungsprozess von der unaufbereiteten Faserquelle bis hin zum fertigen IsoPack mit den Forderungen einer gleichbleibend hohen Produktqualität sowie einem sehr hohen Output. Im Gesamtergebnis muss das IsoPack auch der gegebenen Kostenstruktur der Konkurrenzprodukte genügen. Auch das stellt bei dieser Neuentwicklung eine große Herausforderung dar.

Anwendungen/Wirtschaftliche Bedeutung

Der Bedeutungsgewinn des E-Commerce ist der bestimmende Trend im Einzelhandel in den letzten Jahren. Nach starkem Wachstum werden in Deutschland mittlerweile mehr als 30 Mrd. € im Onlinehandel erwirtschaftet. Während diese Vertriebsform im Bereich der Nonfood-Gebrauchsgüter bereits eine feste Größe darstellt, hat der interaktive Handel im Bereich der schnelllebigen Verbrauchsgüter und kühlpflichtigen Lebensmitteln bisher keine nennenswerten Marktanteile erobern können. Dies liegt in der fehlenden Möglichkeit, die Frische der Produkte vor dem Kauf überprüfen zu können, aber auch an der Skepsis bezüglich der Einhaltung der Kühlkette sowie am hohen Anteil der nicht recycelbaren Versandabfälle. Aktuell werden nur 0,8 % des Lebensmittelhandels in Deutschland für E-Commerce Produkte ausgegeben. Im Vergleich zu Europa liegt Deutschland damit deutlich unter dem Schnitt. Aktuelle Studien belegen jedoch, dass sich der Anteil deutlich steigern wird. Somit ist davon auszugehen, dass sich der Lebensmittelonlinehandel bis 2020 mit einem prognostizierten Volumen in Höhe von 20 Mrd. € verzehnfachen könnte. Gerade der Bereich der „Spezialitäten“, also Produkten die nicht flächendeckend verfügbar sind, werden hier überdurchschnittliche Wachstumsraten erwartet. Bei nahezu allen Versandoptionen besteht die Notwendigkeit einer passiven, für den Endkunden kommissionierten Kühlkette, die durch Kühlelemente und Isolationsverpackungen gewährleistet wird. Da sich die durchschnittliche Bestellmenge der erworbenen Güter je Einkauf auch künftig nicht signifikant verändern wird, ist auch hier von einer Verzehnfachung der benötigten Umverpackungen auszugehen.

Bearbeitungszeitraum: 01.04.2017–31.03.2019

Bemerkungen

Das ZIM-Projekt ZF4100916CM7 wird über die AiF Projekt GmbH vom Bundesministerium für Wirtschaft und Energie aufgrund eines Beschlusses des Deutschen Bundestages gefördert. Das Projekt wird in Kooperation mit der easy2cool GmbH bearbeitet.

PROZESS-ZIELE

Forschungsgebiet
Faserstofferzeugung

Zellstoffherstellung
Holzstoffherstellung
Altpapieraufbereitung
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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.

The tests regarding the impact of storage of process water samples on process water properties and the deinking potential of paper for recycling were carried out with process water from DIP lines. Process water properties of different deinking plants vary significantly. The storage of process water can impact both the process water characteristics and the deinking potential of paper for recycling. Deinking results regarding are relatively narrow in bandwidth. An exception is the filtrate from a deinking plant for newspaper production with a very high solids content which leads to a high brightness of the undeinked and deinked pulp, the highest dirt specks area and filtrate darkening. Unfortunately, there are no clear correlations to the investigated process water parameters.

Purification experiments were carried out by centrifugation, filtration and flotation. Regarding the reduction of dirt specks centrifugation and filtration are more effective than flotation. On the other hand, the flotation of the process water seems more suitable for filtrate darkening than centrifugation or filtration. The latter processes apparently remove fillers and enrich printing ink particles.

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 – 31.07.2017

Remarks

The research project IGF IGF18698N is being funded Federal Ministry of Economic Affairs and Energy (BMWi) and carried out in cooperation with the TU Darmstadt (Paper Technology and Mechanical Process Engineering)

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Research area: Process aims

Pulp production // recovered paper treatment

Key words:

deinkability, mineral oil-free printing inks

Title:
Use of mineral oil-free, deinkable inks in (coldset) offset printing to reduce the amount of mineral oils introduced in recycling cycles

Background/Problem area

The fact that mineral oil components are present in measurable quantities in food packaging paper and board was first made public by Grob et al . For economic and ecological reasons, using 100% fresh fibres for packaging paper and board to eliminate all possible sources of mineral oil can be no option. What can be done – and has meanwhile been realized by most producers – is avoiding mineral oil-containing additives in papermaking. State-of-the-art cleaning methods are not capable of removing all mineral oil components from recycled fibres. Inner bags or barrier coatings are only short-term solutions. A study on mineral oil reduction performed in an INFOR project has demonstrated that substituting mineral oil-free offset inks for mineral oil-containing ones is the most effective measure by far. In Germany, this has become common practice in food packaging production.

“Preventing unwanted components like aromatic mineral oils from entering the paper cycle“ will soon become an award criterion of the Blue Angel for print products. Another requirement for the sustainability of print products is deinkability, i.e. the product must be made in such a way that its fibrous materials can be recycled and reused without problems.

In coldset web offset printing, mineral oil-free inks are being used in isolated cases and for test purposes only today. It is not certain if the products available on the market really represent the state of the art in terms of optimum deinkability, improved “rub-off” or optimum “runnability” on industrial printing machines.

Objectives/Research results

Aim of the project is to reduce the amount of mineral oils introduced in the recycling cycle by using deinkable, mineral oil-free news inks. Another aim is to ensure the compliance with the Blue Angel award criteria for print products.

Deinkable mineral-oil free news inks will be developed by optimising the ink composition for the use of mineral oil-free oils. The runnability of mineral oil-free inks in printing presses will be ensured by adapting the printing parameters to the composition of printing ink and paper.

Deinkability tests with mineral oil-free offset inks on different newspapers showed fair to good deinkability, with one exception. In this case the dirt specks area > 250 µm in the deinked pulp was too high. This leads to a negative evaluation.

Application/Economic benefits

The project results will help to enable the production of deinkable mineral oil-free printing products. For the printing industry, it is possible to obtain its "certificates" that underline a recyclability of the product.

Period of time: 01.04.2017 – 31.03.2018

Remarks

The RTD projekt IGF 19080 BG is being funded by the German Federal Ministry for Economic Affairs and Energy (BMWi) and carried out in cooperation with the SID - Sächsisches Institut für die Druckindustrie GmbH, Leipzig.

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Forschungsgebiet: Prozess-Ziele

Faserstofferzeugung // Altpapieraufbereitung

Schlagworte:

Altpapieraufbereitung, Deinking, Altpapiermischungen, Druckerzeugnisse, Digitaldruck

Topic:
Synergistic and Antagonistic Effects during Deinking of Paper for Recycling Mixtures

Background/Problem Area

New printing technologies will change the composition of paper for recycling mixtures in the future. More digital print products and less conventional offset newsprint has to be expected in paper for recycling used in deinking applications. Unfortunately, the influence of changed paper for recycling mixtures on the efficiency of deinking processes 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. In addition the effects of digital prints in paper for recycling needs to be evaluated systematically.

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 paper for recycling mixture. First, the deinking behaviour of single print products in a one and a two-loop deinking process was analysed. Therefore a two-loop deinking process was developed. The parameters of the two-loop process where determined by matching the three considered lab processes (1st flotation, dispersing, 2nd flotation) to four industrial two-loop plants. The deinkability of different products (newspapers, magazines as well as Indigo-, toner- and inkjet testprints) were analysed using the INGEDE Method 11 as well as the new 2-loop process. Additionally, for some selected print products the natural and artificial ageing behaviour was assessed. Subsequently the influence of single print products in the mixture was described. For this assessment systematic mixtures of various print products were assembled and deinked. Based on the deinking results of single products and product mixtures models were developed to describe optical properties of paper for recycling mixtures. To improve the 2-loop process additionally tests were done by integrating bleach-ing steps after dispersing and 2nd flotation. In order to evaluate the deinkability, pulp samples were taken from industry and the optical properties were compared with the results from this project.

Application/Economic Benefits

Sorted graphic 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. Sorted graphic paper for deink-ing is always o mixture of different print products. The deinking behaviour of single print products using the 1-loop deinking process was already well known. With the results of this project, the deinking behaviour of single print products and paper for recycling mixtures are known, using the 1-loop as well as the new developed 2-loop deinking process. Also influences of digital testprints on the deinking behaviour of mixtures are identified and optical properties of mixtures can be modelled from the known results of the individual products. Paper mills are able to produce the optimum deinked pulp from the used paper for recycling mixture.

The knowledge can also be used from paper for recycling sorting plants to produce a particular composition of paper for recycling mixture for deinking, adopted to the requirements of the customers. This enables the use of more paper for recycling for example in higher graphic paper grades.

Project Period: 01.07.2014 – 30.6.2017

Remarks

The project AiF 18288 N of the industrial research association „Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V.“ is funded by AiF within a program for promotion of industrial collective research (IGF) of the Federal Ministry for Economic Affairs and Energy (BMWi) on the basis of a decision by the German Bundestag.

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Forschungsgebiet: Prozess-Ziele

Faserstofferzeugung // Altpapieraufbereitung

Schlagworte:

Mikro-Stickys, Labormethode, Messmethode, Altpapier

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 centre 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 Results

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.

After testing successfully the agglomeration of stickys in model suspensions from copy paper with self adhesive labels and the help of deinking chemicals, the influence of the single chemical and its influence on the surface tension have been investigated. Furthermore, the method has been tested with industrial pulp and other model suspensions. Hereby the gravimetric analysis has been passed over to the conventional optical analysis.

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 Peroid: 01.12.2014 – 30.11.2017

Remarks

The project AiF 18521 N of the industrial research association „Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V.“ is funded by AiF within a program for promotion of industrial collective research (IGF) of the Federal Ministry for Economic Affairs and Energy (BMWi) on the basis of a decision by the German Bundestag.

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Faserstofferzeugung // Altpapieraufbereitung

Schlagworte:

Altpapier, Überkritische CO_2-Extraktion, kontinuierlich, Extruder, kritische Inhaltsstoffe

Topic:
Development of a Process for a Continuous Extraction of Harmful Substances from Recycled Pulp by Supercritical CO2 (scCO2) using an Extruder

Background/Problem Area

Paper for recycling is the most important raw material for the German paper industry. Especially for packaging papers the paper for recycling utilisation rate is very high. Also in the food industry, many products are sold in packaging products which completely or at least partially contain paper for recycling. These products can contain organic non-paper substances like pentachlorophenol (PCP) or mineral oils, which cannot be removed sufficiently in the stock preparation of paper mills. Problematic is the migration potential of the substances from the produced packaging material in the packed food because of their toxicological properties. In the previous project IGF 17756 N, an innovative and efficient method for removing several harmful substances from paper for recycling with the use of scCO2-extraction was investigated. Depending on pressure, temperature, amount of CO2 and dry matter content, all measured harmful substances except for bisphenol A could be extracted almost completely. However, due to the batch treatment, only a limited amount of paper for recycling could be extracted at one time.

Objective/Research Result

The main targets of this project are to improve the extraction of harmful substances from paper for recycling for a potential industrial application with continuous processing and to increase the efficiency of the scCO2-extraction process, which was analysed in the previous project IGF 17756 N in batch mode. Therefore the basic development for a continuous scCO2-extraction in an extruder will be investigated at the PMV in cooperation with the Kunststoff-Zentrum SKZ in Würzburg.

The basic operation principle of the extraction system will be adapted to the continuous process in an extruder. So far, no wide-ranging studies were performed for the use of pulp in extruders yet. Hence, at the beginning of this project, fundamental knowledge about conveying and the material behaviour of recycled pulp with different stock consistencies was gener-ated using different extruder concepts.

Based on this knowledge, a suitable extruder concept was selected and an extruder unit will be designed and built for in-vestigations on continuous extraction. Then systematic studies will be done to achieve the necessary framework for an ef-fective extraction (for example: capability of building up high pressure, tightness). For the dosage of the scCO2 established equipment can be used. But for discharging the scCO2, which includes the harmful substances after a successful extrac-tion, an appropriate system has to be developed and investigated within the trials.

To evaluate the extraction efficiency in the extruder, the content of different polar and non-polar substances will be ana-lysed before and after the extraction/extrusion process.

In addition to the removal of harmful substances in the extruder, the effects of the extraction and extrusion on the quality of recycled fibres must be investigated. Therefore different paper properties like fibre properties, dewatering behaviour, paper strength as well as optical properties of the pulp will be investigated.

Application/Economic Benefits

After a successful course of the project, the general feasibility of a continuous extraction of recycled fibres in an extruder should be validated. Due to the extensive investigations in this project, the generated knowledge is intended to promote the establishment of an industrial and efficient system for the removal of harmful substances. This is especially interesting for SMEs of the papermaking industry.

Project Period: 01.10.2017 – 31.03.2019

Remarks

The project AiF 19148 N of the industrial research association „Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V.“ is funded by AiF within a program for promotion of industrial collective research (IGF) of the Federal Ministry for Economic Affairs and Energy (BMWi) on the basis of a decision by the German Bundestag.

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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 paper for recycling 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 needed to identify difficult to deink 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 paper for recycling. This measurement technology can also be used for paper for recycling quality control. 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. However, with the proposed measurement NIR technology the assessment and eventually necessary refusal of a paper for recycling delivery is not envisaged or possible, respectively. Small amounts of difficult to deink print products are only to measured 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 wave-length (= lower energy) and the measuring method (attenuated total reflection – ATR) the penetration depth of the radiation into the sample is limited to 3 to 5 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.

By means of the FT-IR investigations print products with film-forming printing inks and varnishes (for example UV varnished products, Indigo printed products) and paper products with an additional plastic layer on the surface (PE, PET,...) may be identified. Other printing inks/printing technologies like offset and flexo printing are not detectable due to the absorption of the printing inks in the mass of the paper. In these cases the IR spectra show no differences to the investigated pulp as raw material. Within the project a database has been created that contains the IR spectra of different print products as well as the results of deinkability tests, if available. For the investigation of unknown samples this database can be used to com-pare the current IR spectra with the IR spectra already recorded. In that way it is possible to identify critical print products.
A direct correlation between signals of the IR spectra and a good or poor deinkability does not exist. Previous knowledge and experience are necessary to assess the identified print products concerning their influence on the deinking behaviour. In the everyday practice additional IR spectra and information about the investigated sample may be added to the database. The work in the INGEDE project has created the basis for the identification of critical paper for recycling by means of FT-IR. By adding more and more reliable IR spectra from known printing products to the database the identification of unknown products will be even better.

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 paper for recycling mixture can have heavy impacts on paper quality. A simple method for detection of critical print products in a paper for recycling delivery offers the paper mills the possibility to decline problematic paper for recycling deliveries, to control these deliveries more in detail or to mix problematic deliveries with unproblematic paper for recycling to avoid problems with the deinking result.

Project Period: 01.11.2014 – 31.08.2017

Remarks

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Forschungsgebiet: Prozess-Ziele

Faserstofferzeugung // Altpapieraufbereitung

Schlagworte:

Stoffaufbereitung, Flexodruck, Deinking, Kreislaufwasser

Thema:
Ergänzendes Filtrations-Deinking

Ergänzendes Deinking-Verfahren zur effizienten Entfernung von Resten schwer deinkbarer Druckfarben aus Kreislaufwässern Altpapier aufbereitender Papierfabriken durch Mikrofiltration mittels kostengünstiger keramischer Hochleistungsmembranen

Ausgangssituation/Problemstellung

Das weltweit dominierende Verfahren zur Druckfarbenentfernung bei der Altpapieraufbereitung ist die Flotation, welche für den Großteil der Druckprodukte einwandfrei funktioniert. Doch es kommen mit steigender Tendenz Druckverfahren zum Einsatz, deren Produkte im konventionellen Flotations-Prozess erhebliche Probleme verursachen.

Zu den schlecht bzw. nicht-deinkbaren Druckverfahren zählen digitale Druckverfahren und das Flexodruckverfahren, deren kleine und hydrophile Druckpartikel sich weder durch Flotation noch durch mechanische Trennverfahren entfernen lassen. Sie verbleiben im Kreislaufwasser und führen somit zu einem signifikanten Abfall der Helligkeit im Endprodukt.

Die derzeitige Lösung besteht in einer Aussortierung der kritischen Druckprodukte und bedeutet einen Verzicht auf hochwertige Rohstoffe. Dies und die positiven Aspekte von Flexodruckfarben – umweltschonend, kostengünstig, keine Mineralöle – zeigen den Bedarf an geeigneten Deinking-Verfahren.

Ein möglicher Lösungsansatz ist eine zusätzliche, effiziente Kreislaufwasserreinigung durch eine Filtration mit kostengünstigen, keramischen Hochleistungsfiltermembranen. Bevor das Kreislaufwasser in den Prozess zurückgeführt wird, soll – ab einer definierten Belastung mit Flexodruckfarben – eine separat zuschaltbare Filtration die feinen Farbpigmente entfernen und dieses somit wieder entfärben.

Ein Vorversuch im Labormaßstab hat bereits die prinzipielle Anwendbarkeit von Filtrationsverfahren zur Reinigung belasteter Kreislaufwässer nachgewiesen. Die kritischen Farbpigmente konnten über das Konzentrat abgetrennt werden.

Forschungsziel/Forschungsergebnis

Ziel ist die Durchführung umfangreicher Filtrationsuntersuchungen, die belastbare Daten für eine spätere industrielle Anwendbarkeit generieren können. Im Mittelpunkt steht dabei die Auslegung und Anwendbarkeit innovativer, kostengünstiger, keramischer Flachmembranen und des entsprechenden Filterprinzips und Reinigungsverfahrens.

Anwendungen/Wirtschaftliche Bedeutung

Durch die neue Möglichkeit der Entfernung von Druckfarben aus den Kreislaufwässern Altpapier aufbereitender Fabriken erschließt sich eine neue Quelle hochwertiger Rohstoffe zur Herstellung graphischer Papiere. Die Nutzung von bisher nicht-deinkbaren Papieren für diese Aufgaben spart die Kosten für die Aussortierung dem Aufbereitungsprozess, ebenso wie den Chemikalieneinsatz zur Eliminierung der entstehenden Grauschleier.

Bearbeitungszeitraum: 01.01.2017–30.06.2019

Bemerkungen

Gefördert durch:
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

Das IGF-Vorhaben 18664 BR 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. Das Projekt wird in Kooperation mit dem Fraunhofer IKTS Dresden bearbeitet.

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Faserstofferzeugung // Altpapieraufbereitung

Schlagworte:

Altpapieraufbereitung, Fraktionierung

Thema:
Entwicklung eines neuen kombinierten Sortieraggregates zur qualitativen Selektion von zellulosebasierten Recyclingfasern zur Herstellung höherwertiger Papiere und Kartonagen

Ausgangssituation/Problemstellung

Der Papierkreislauf geht nicht spurlos an den Zellulosefasern vorüber. In jedem neuen Zyklus werden die Fasern aus dem Papiergefüge gelöst, in Suspension gebracht und gequollen, gegebenenfalls auch deinkt, sowie anschließend mechanisch und thermisch getrocknet. Der sich wiederholende Aufbereitungsprozess geht mit einer Kürzung der Faserlängen einher.

Von der Faserlänge werden jedoch zahlreiche Festigkeitseigenschaften des Papiers entscheidend bestimmt. So lassen sich aus langen Zellulosefasern Qualitätspapiere mit deutlich höheren Festigkeiten herstellen.

Eine Fraktionierung des Sekundärfaserstoffes in lange und kurze Fasern würde es ermöglichen, die Fasern getrennt einzusetzen, um höherwertigere und festere Recyclingpapiere zu produzieren. Zudem ermöglicht eine Fraktionierung, dass nur längere Fasern energiesparend einer Mahlung unterzogen werden, die zusätzliche Bindungsstellen schafft und die die Festigkeit des Papiers nochmals steigert.

Forschungsziel/Forschungsergebnis

Das Forschungsziel besteht darin, mit Hilfe eines zu entwickelnden Aggregates in die Sortieralgorithmen der klassischen Altpapieraufbereitung einzugreifen, um online lange von kurzen Fasern zu trennen (Online-Fraktionierung).

Das zu entwickelnde Aggregat soll folgende Funktionen ermöglichen:

- Aussortierung von Störstoffen und Verunreinigungen
- Fraktionierung in einen langfaserigen Überlauf- und kurzfaserigen Durchlaufstoff
- Messung der wichtigsten Faserstoffeigenschaften zur Charakterisierung der Rohstoffqualität und zur Verbesserung der Qualitätskonstanz
- veränderliche Trennelemente zur direkten Beeinflussung der Papiereigenschaften
- Entwicklung eines Kombigeräts mit leistungsgeregeltem Hauptantrieb

Das Aggregat soll modular aufgebaut sein (Kombigerät), so dass eine Anpassung an verschiedene Einsatzanforderungen, die im Wesentlichen von der schwankenden Qualität des Altpapiers abhängen, möglich ist. Die Module sind je nach Anforderung in das Kombigerät integrierbar und erfüllen separate Funktionen.

Der Lösungsansatz basiert auf einem speziellen Drucksortierer mit unterschiedlichen Öffnungsgraden und Geometrien.

Ein Kombigerät, welches durch den modularen Aufbau mehrere technologische Schritte in sich vereint, ist bisher noch nicht verfügbar.

Anwendungen/Wirtschaftliche Bedeutung

Besonders interessant ist das Prinzip der Online-Fraktionierung für mehrlagige Papiere aus Sekundärfaserstoff. Die Fraktionierung würde es erlauben, die kürzeren Fasern in der Mittellage zu platzieren und die längeren, gegebenenfalls noch gemahlenen Fasern als Außenlagen zu verwenden. Damit können sehr feste Papiere, die zusätzlich noch eine hochwertige Oberfläche aufweisen, erzeugt werden.

Aber auch vor dem Hintergrund steigender Altpapierpreise und/oder sinkender Altpapierqualitäten ist die effiziente Nutzung des angebotenen Rohstoffs besonders wichtig.

Bearbeitungszeitraum: 01.02.2017–30.11.2017

Bemerkungen

Das Kooperationsprojekt (ZF4100901CJ5) wird über das Zentrale Innovationsprogramm Mittelstand (ZIM) des Bundesministeriums für Wirtschaft und Energie (BMWi) gefördert. Kooperationspartner sind die Maschinenfabrik Raschau GmbH und die TU Dresden.

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Faserstofferzeugung // Faserstoffbehandlung

Schlagworte:

Mikrofibrillierte Cellulose, enzymatische Vorbehandlung

Thema:
Energetische Optimierung der Herstellung von mikrofibrillierter Cellulose durch enzymatische Vorbehandlung

Ausgangssituation/Problemstellung

Mikrofibrillierte Cellulose (MFC) genießt seit Mitte der 90er Jahre ein weltweit wachsendese Interesse und befindet sich an der Schwelle einer kommerziellen Nutzung. Es wurden bereits potenzielle industrielle Anwendungen in der Papierindustrie sowie Möglichkeiten zur großtechnischen Produktion untersucht. Aufgrund seiner Fähigkeit zur Wasseraufnahme gibt es auch Konzepte zur Verwendung von MFC als Komponente in medizinischen Filmen und Gelen. Eine nach wie vor große Hürde bei der kommerziellen Verwendung von MFC ist jedoch der hohe Energiebedarf bei der Herstellung und die damit verbundenen hohen Kosten.

Forschungsziel/Forschungsergebnis

Ziel des Forschungsvorhabens war die energetische Optimierung der Herstellung von MFC sowie die Generierung von eigenem Know-how auf diesem Gebiet. Die Optimierung sollte im Wesentlichen mit Hilfe einer enzymatischen Vorbehandlung realisiert werden. Dabei sollte der Energiebedarf bei unterschiedlichen Vorbehandlungsintensitäten evaluiert und die resultierende MFC durch eine Kombination verschiedener Messverfahren charakterisiert werden.

Die Anschaffung und Inbetriebnahme des benötigten Mahlaggregates (Grinder) und die Implementierung einer Messung der benötigten Energie war langwieriger als ursprünglich vorgesehen, konnte jedoch erfolgreich durchgeführt werden. Für die Versuche wurden zwei Sulfitzellstoffe (Fichte und Buche) mit und ohne enzymatischer Vorbehandlung (mittels einer Mischung aus Endo- und Exoglucanasen) verwendet und mit dem Mahlaggregat zu MFC verarbeitet. Dabei zeigte sich, dass durch die enzymatische Vorbehandlung des Fichten-Zellstoffs eine Energieeinsparung von etwa 50 % im Vergleich zu nicht vorbehandeltem Zellstoff möglich ist, bei dem verwendeten Buchen-Zellstoff von ca. 25 % (jeweils Gesamtenergie, d. h. Leerlauf- und Mahlenergie).

Eine alternative Faserstoffbehandlung mittels Extruder wurde von der Papiertechnischen Stiftung (PTS) realisiert. Auch hier wurde mit und ohne enzymatische Vorbehandlung gearbeitet, als Faserstoff wurde der Fichten-Sulfitzellstoff eingesetzt. Durch die enzymatische Vorbehandlung konnte auch hier eine Energieeinsparung von etwa 50% (Gesamtenergie) realisiert werden. Im Vergleich des Gesamtenergieeintrags zeigte sich, dass die Behandlung im Extruder deutlich weniger Energie benötigt als die Mahlung im Grinder. Dabei ist jedoch auch zu beachten, dass entsprechend der Definition von MFC in diesem Forschungsprojekt mit der Extruderbehandlung keine MFC produziert wurde.

Zur Anwendung der MFC wurde der Einsatz im Wet-end-Bereich untersucht. Hier wurden die produzierten MFC-Typen sowie die extrudierten Faserstoffe mit Einsatzmengen von 10 % und 20 % zu einem auf 28°SR gemahlenen Eukalyptus-Zellstoff gegeben und verschiedene Papiereigenschaften bewertet. Bei allen Produkten zeigte sich eine Verringerung der Dicke und damit des spezifischen Volumens, eine etwas rauere Oberfläche sowie eine geringere Luftdurchlässigkeit. Bei den untersuchten Festigkeitseigenschaften ist eine deutlich höhere Gefügefestigkeit hervorzuheben - diese kann auf bis zu 60...90 %Punkte des Wertes für reinen Eukalyptuszellstoff steigen. Bei den anderen Festigkeitseigenschaften (Weiterreißfestigkeit, Bruchkraft) zeigten sich Unterschiede in den produzierten Faserstoffen. Während bei der mit dem Grinder produzierten MFC beide Festigkeiten leicht anstiegen, blieben bei Einsatz der extrudierten Faserstoffe die Festigkeiten bei Zugabe von 10 % eher gleich (im Vergleich zu reinem Eukalyptus-Zellstoff), bei 20 % Zugabe kam es zu einem leichten Rückgang beider Festigkeiten.

Ein signifikanter Einfluss der enzymatischen Vorbehandlung der mit dem Grinder produzierten MFC-Qualitäten auf die Papiereigenschaften konnte nicht festgestellt werden.

Anwendungen/Wirtschaftliche Bedeutung

Die Forschungsaktivitäten im Zusammenhang mit MFC konzentrieren sich hauptsächlich in Finnland, Schweden, Frankreich und Japan. Die deutsche Papierindustrie hat trotz ihrer internationalen Bedeutung auf diesem Gebiet bisher wenig vorzuweisen.

Anwendungsmöglichkeiten für MFC sind z. B. Rheologie-Modifizierer in Streichfarben, festigkeitssteigernde Additive im Wet-end sowie in Beschichtungen mit Barrierefunktion. Eine wirtschaftliche Nutzung von MFC hängt jedoch stark vom Energiebedarf bei der Herstellung ab, weswegen dieser im Rahmen dieses Forschungsvorhabens gesenkt werden sollte. Mit Energieeinsparungen für Fichten-Zellstoff im Bereich von etwa 50% durch enzymatische Vorbehandlung konnte hier ein wichtiger Beitrag geleistet werden.

Das Projekt zeigte Möglichkeiten auf, mit Hilfe eines kostenoptimierten Verfahrens MFC als neues Additiv in der Papierindustrie einzusetzen, das Potenzial im Bereich der Festigkeitssteigerung, vor allem in der Gefügefestigkeit, aufweist.

Bearbeitungszeitraum: 01/2017 – 06/2017

Bemerkungen

Das Projekt INFOR Nr. 192 wird über das Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V. gefördert.

PROZESS-ZIELE

Forschungsgebiet
Papier- und Kartonherstellung

Stoffaufbereitung
Papierherstellung
Oberflächenbehandlung

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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 upscaling 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 beside the thermoplastic cellulose fibres and thermoplastic polymer matrixes also anionic (carboxymethylated) fiber materials can be produced in a pilot-plant scale twin screw extruder. The anionic fiber materials may be thereafter converted into paper sheets. Because of the anionic character of the fibres, the strengthening properties are increased.
Also the paper porosity as well as the air and water permeability decrease. 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 – 30.06.2017

Remarks

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

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Forschungsgebiet: Prozess-Ziele

Papier- und Kartonherstellung // Stoffaufbereitung

Schlagworte:

Trockenverfahren, Ressourceneinsparung, Wassereinsparung

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 traditionell in einem Nassprozess. Dabei sind die notwendigen Teilprozesse mitunter so wasser- und energieintensiv, dass die Papierindustrie zu den größten Energieverbrauchern des produzierenden Gewerbes zählt. Hauptgrund hierfür ist vor allem der Gebrauch von Wasser, da dieses zusätzlich zu den Fasern gepumpt und gefördert werden muss. Vor allem aber muss das Wasser auf mechanischen und später thermischen Weg wieder entfernt werden, wobei insbesondere die Trocknung den energieintensivsten Produktionsschritt 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.

Forschungsziel/Forschungsergebnis

Das Forschungsvorhaben zielt ab auf die wissenschaftlich-technologische Entwicklung eines neuen innovativen Verfahrens zur nahezu wasserlosen und energiesparenden Produktion von Karton. Voraussetzung hierfür ist die Entwicklung einer trockenen Prozesskette, 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 pressen.

Untersuchungen in Labor und Technikum haben gezeigt, dass die Kartonherstellung im Trockenverfahren unter wirtschaftlichen und qualitativen Gesichtspunkten grundsätzlich möglich ist und die erzielten Festigkeitseigenschaften mit denen konventionell hergestellter Kartons vergleichbar sind. Darüber hinaus können Produkte mit besonders hohen flächenbezogenen Massen hergestellt werden, die im konventionellen Prozess zu Entwässerungs- und Trocknungsproblemen führen würden. Nachteilig bei diesem Verfahren ist jedoch der Einsatz eines Bindemittels, da durch den weitgehenden Wasserverzicht keine klassischen Wasserstoffbrückenbindungen erzeugt werden können.

Die Entwicklung eines geeigneten Bindemittels stellte sich als größte Herausforderung des Projekts dar, da neben den produktspezifischen Eigenschaften auch noch andere Faktoren eine entscheidende Rolle spielen. Anfängliche Versuche mit typischen Bindemitteln der Faserplattenindustrie (Kondensationsharze, Isocyanat) konnten die grundsätzliche Machbarkeit zwar nachweisen, jedoch nicht die Anforderungen hinsichtlich der Wirtschaftlichkeit und insbesondere der Rezyklierbarkeit erfüllen. Erst durch die Entwicklung eines speziellen stärkebasierenden Bindemittels war es möglich, neben den qualitativen Zielvorgaben an das fertige Produkt auch dessen Rezyklierbarkeit zu gewährleisten. Nachteilig ist allerdings, dass durch die Kosten des Bindemittels ein Großteil der Energieeinsparungen im Trocknungsprozess aufgebraucht werden und somit die Betriebskosten des Trockenprozesses nach jetzigem Stand etwa auf dem Niveau des konventionellen Nassprozesses liegen – und nicht wie erhofft deutlich darunter.

Weiterführende Forschungsarbeiten zielen daher auf eine Reduzierung des Bindemittelbedarfs ab. Dies soll einerseits durch eine optimierte Bindemittelverteilung und andererseits durch eine Modifizierung des Bindemittels realisiert werden.

Anwendungen/Wirtschaftliche Bedeutung

Durch die Entwicklung eines kontinuierlichen Trockenprozesses soll 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 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 // Papermaking

Key words:

spunlace, wet laid, fiber reinforced materials

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. The impregnation behaviour of wet-laid nonwovens was investigated in WP 4, evaluating also a test method that makes it possible to assess the resin absorption of paper. Papers with and without spunlace treatment were impregnated by means of the same method, and their resin absorption was assessed.

In the further course of the project, the industrial users showed a heightened interest in thermoplastic materials. The latter make it possible to dispense with time-consuming additional impregnation steps. Because thermoplastics melt under heat, the wet-laid nonwovens could directly be pressed into semi-finished fibrous parts. For this reason, nonwovens made from matrix and reinforcement fibres (e.g.a basalt-polyamide (PA) 6- combination) were included in the study by way of example.

Semi-finished parts were selected and used to identify the characteristics relevant to fibre composites. The semi-finished parts were processed into multi-layer composite components whose characteristics were then determined to identify corresponding material properties. The interactions between wet-laid nonwovens and matrix materials were evaluated, and the effect of spunlace treatment was identified.

The variation of raw materials and technological parameters for the production of spunlace-treated wet-laid nonwovens, their processing into semi-finished parts for fibre-based composite components and the identification of corresponding characteristics of semi-finished parts and structural components had paved the way for the development of product concepts. These product concepts were developed and evaluated in interdisciplinary cooperation with mechanical, materials and textile engineering specialists. The properties of nonwovens obtained in WPs AP 2-5 were then used to identify three typical product areas for the use of spunlace-treated wet-laid nonwovens jointly with relevant institutions or companies.

Final project step was the overall assessment and cost analysis of results, estimating the specific cost of fibre-reinforced components made from semi-finished parts based on spunlace-treated wet-laid nonwovens to identify potential savings in comparison to similar components made by means of conventional reinforcement pulps.

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 was funded by German Federal Ministry of Economic Affairs and Energy (BMWi).

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Research area: Process aims

Paper and paperboard production // Papermaking

Key words:

flatness deviation, process control, process optimization, structural analytics, waviness

Title:
Avoidance of wavy flatness deviations during paper manufacturing process

Background/Problem area

Flatness defects are a phenomenon every papermaker is dealing with. Those undesired effects occur, when the surface of a paper web deviates from a mathematical flat area, whereas the appearance of these defects can vary to a great extent. Besides curl, cockling and baggy webs, the specific defect wavy structures is causing problems over the last few decades, but still the main cause of this flatness deviations has not yet been clarified. It is unclear so far if, e.g., fluid mechanic phenomena in the headbox resulting in inhomogeneities in the paper structure cause wavy structures, or if the operational condition of the paper machine is responsible for this problem. Although it is possible to produce faultless paper with the machine-given setup, wavy structures still cause a significant amount of broke due to the fact that the defect is visible at the earliest when the paper web is wind up at the end of the paper machine. In order to get a better understanding of this major defect and its origin, it is necessary to investigate this topic scientifically.

Objectives/Research results

The overall objectives of this research project can be described as follows:

- Introduction of an definition of the flatness deviation wavy structures to be able to classify the defect and separate it from similar looking ones
- Development of machine, material and process parameters, which have a direct influence on the occurrence of wavy structures
- Introduction of a model that allows the production of paper on existing paper machines without the defect of wavy structures

In order to investigate the origin of wavy flatness deformations it is necessary to be able to quantify them. Therefore a novel method to quantify the dimension and appearance of the defect was developed using the raw data gained by a topographical measurement. Besides that an algorithm was introduced, which allows the user to differentiate between faultless and defective paper samples in an objective way. Those techniques are the basis of further investigations, which will help to clarify the root cause of wavy structures. Since the exact position and dimension of the defect are now accessible each pixel can be assigned to the results of different analyzing methods. Highly resolved measurements, e.g., fiber orientation, thickness and area related mass will now be used to execute correlation analysis and identify possible structural differences. In addition profiles over the entire width of a paper machine will be obtained and compared with different types of process data.

Application/Economic benefits

With the aid of the final developed model the manufacturing process in general and the quality of the final paper product can be optimized. Reducing/avoiding the appearance of wavy structures results in the following potential savings:

- Reduction of broke
- Savings in energy and raw materials
- Extra earnings by reducing the downtime of the paper machine
- Reduction of customer complaints
- Decrease of personnel expenses
- Higher availability of the equipment during further processing (e.g., cross and plan cutter)
- Lower storage costs

Period of time: 01.01.2017 – 31.12.2018

Remarks

The RTD project IK-MF 160068 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 the 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 optimum 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. By closure of water circuits, increasing use of paper for recycling 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: 01.01.2015 – 30.11.2017

Remarks

The research project INFOR 175 is beeing 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 //Ssurface treatment

Key words:

inkjet printing, packaging, corrugated board, coating, aqueous inkjet

TITLE:
High quality Inkjet for small-lot Packaging applications on corrugated board substrates

Background/Problem area

The packaging sector is one of the driving fields in paper industry. Due to increasing online and mail order the demand for packaging solutions is also increasing. State of the art flexo printing is not able to give a high image quality in order to transport marketing information already at the packaging, whilst offset printing does not allow serializing or individual sujets.

Hence, the market is strongly demanding for an individual, high quality print, directly at the corrugated board surface via inkjet. Up to now, quality is not sufficient, since it is influenced by the interplay between substrate, process and ink, which is not totally understood.

Objectives/Research results

In this project we want to better understand the process of ink penetration into the substrate. Therefore we will develop a measurement devise which is able to observe the penetration process and analyze wetting and penetration processes via high speed camera system. Further we will optimize the printing parameters, like dropsize, piezo wave, etc. in order to see the influence on the print quality. To evaluate the quality we will use and futher develop automatical image detection software from PTS. Additionally we plan to optimize surface coating for ink fixation, by use of several inkjet suitable pigments.

Application/Economic benefits

By understanding the inkjet printing process better and by optimizing this process, we should be able to increase the image quality on corrugated board substrates. A systematic process design with ink, substrate and process matching together should save time and money during production since the amount of reject is lowered. This should help the inkjet to gain market share and open new fields in the design of packaging solutions.

Period of time: 01.01.2017 – 31.12.2018

Remarks

The RTD project IGF 18767 is being funded by the German Federal Ministry for Economic Affairs and Energy (BMWi).

PROZESS-ZIELE

Forschungsgebiet

Weiterverarbeitung

Trennen
Verbinden/Fügen
Umformen
Beschichten

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Forschungsgebiet: Prozess-Ziele

Weiterverarbeitung // Umformen

Schlagworte:

Formteile, Cellulose, nachwachsende Rohstoffe, Herstellungsverfahren, Formgebung, Trocknung

Thema:
Entwicklung eines Verfahrens zur Herstellung 3-dimensionaler Formteile aus nachwachsenden und biologisch abbaubaren Rohstoffen

Ausgangssituation/Problemstellung

Die gesellschaftliche Entwicklung folgt den globalen Trends wie Bevölkerungswachstum, zunehmenden Wohlstand und steigenden Ressourcenbedarf. Dies führt aktuell zu vielen politischen Maßnahmen hinsichtlich Nachhaltigkeit, was insbesondere einen effizienten Umgang mit den vorhandenen Ressourcen bedeutet. Im Zuge dieser Entwicklung rücken nachwachsende Rohstoffe – wie z. B. Holz – sowohl für die energetische, als auch für die stoffliche Nutzung in den Fokus von Forschungsvorhaben und besitzen zukünftig ein großes Potenzial Materialien, die aus fossilen Rohstoffen erzeugt werden und/ oder nicht biologisch abbaubar sind, für eine Vielzahl möglicher Applikationen schrittweise zu substituieren.

Hierbei gewinnt Cellulose als häufigster nachwachsender Naturstoff der Erde, mit einer jährlichen Produktion von 1,5 Billionen Tonnen, zunehmend an Bedeutung, da die Fasern insbesondere durch hohe spezifische Festigkeiten überzeugen. Das größte Einsatzgebiet von Cellulosefasern ist traditionell die Verarbeitung zu flächigen Produkten wie Papier und Karton. Die bisherigen Möglichkeiten dreidimensionale Formteile aus Cellulosefasern herzustellen, die potenzielle Anwendungen im Leichtbau, der Automobilindustrie oder anderen Branchen finden, sind gering.

Derartige hochfeste Formteile aus Cellulose konnten bisher an der Professur für Holztechnik und Faserwerkstofftechnik, TU Dresden, hergestellt und materialseitig charakterisiert werden. Im Labormaßstab ist die Herstellung entsprechender Formen jedoch speziell wegen des hohen Entwässerungswiderstandes und der vorhandenen – jedoch unzureichenden – Gerätetechnik sehr aufwendig und langwierig. Zudem haben die hergestellten Formen oftmals nicht die geforderten Qualitätsansprüche, da sie Lufteinschlüsse und Schwankungen in der Dichteverteilung besitzen, wodurch nur etwa jedes zweite Röhrchen als Produkt anerkannt wird.

Forschungsziel/Forschungsergebnis

Innerhalb des Forschungsprojektes soll ein Funktionsmuster für eine technische Anlage entstehen, die eine industrielle und serienmäßige Produktion von rotationssymmetrischen Formkörpern wie bspw. Rohre aus bis zu 100 % Cellulose realisiert. Die spezifischen Anforderungen, die das Ausgangsmaterial aufgrund seines hohen Entwässerungswiderstandes mit sich bringt und die wesentlichen Einfluss auf den Formgebungsprozess haben, sollen innerhalb des Projektes schrittweise gelöst werden. Mit Abschluss der Projektarbeiten wird dem Anwender ein Verfahren zur Verfügung gestellt, dass die Produktion großer Stückzahlen in geforderter Qualität gewährleistet. Es soll nunmehr es möglich sein Formteile aus Cellulose effizient herstellen zu können und somit das hohe Potenzial für die Anwendung von Naturfasern – außerhalb der herkömmlichen Anwendung Papier – weiter auszuschöpfen und eine höhere Wertschöpfung zu generieren.

Anwendungen/Wirtschaftliche Bedeutung

Die potenziellen Nutzer der angestrebten Projektergebnisse sind grundsätzlich alle Hersteller biogener Cellulosefaserstoffe sowie Produzenten in verschiedenen Marktsegmenten, wie z. B. Leicht- und Automobilbau, denen ein neuartiges, 100 % biobasiertes und recyclingfähiges Material zur Substitution von beispielsweise Kunststoff zur Verfügung gestellt wird. Die wirtschaftliche Bedeutung resultiert zudem auch aus einer marketingstrategischen Ausrichtung zur Nachhaltigkeit und damit verbunden dem Vorgreifen zukünftiger gesellschaftlicher Forderungen und umweltpolitischer Beschränkungen für den Einsatz von Materialien fossilen Ursprungs. Durch die mögliche Anpassung von Materialrezeptur und Herstellungstechnologie können die Produkteigenschaften anwendungsspezifisch angepasst und somit in verschiedensten Marktsegmenten eingesetzt und verarbeitet werden. Potenzielle Applikationen sind Teile in der Elektromobilität und Leichtbau, welche die gestellten Anforderungen an Stabilität, Optik, Haptik erfüllen und gleichzeitig eine umweltschonende und umweltverträgliche Materialalternative sind.

Bearbeitungszeitraum: 01.05.2017–30.04.2018

Bemerkungen

Das ZIM-Projekt ZF 4100904SL6 wird über die AiF Projekt GmbH vom Bundesministerium für Wirtschaft und Energie aufgrund eines Beschlusses des Deutschen Bundestages gefördert. Das Projekt wird in Kooperation mit der OF Stanz- und Dichtungstechnik UG bearbeitet.

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Research area: Process aims

Converting // Coating

Key words:

electron beam, radical chemistry, polymers, coating, surface treatment

TITLE:
Application of electron beam procedure for modification of aqueous synthetic polymer dispersions for reduction of the use of binder in standard and special paper coatings.

Background/Problem area

The coating of paper and board is adding a substantial value to the product and induces several functionalities. A coating color, depending on the desired properties of the product consists mainly of pigment particles. These particles are connected to the paper surface and among each other via a polymeric binder. To adjust properties like viscosity and water retention as well as opacity and whiteness, one can use numerous additives like optical brighteners, co-binder, thickener or rheological modifiers. To meet the requirements of such coating colors one has to use specialized binders or has to stabilizer binders with e.g. defoaming agents which in conclusion raises prizes. Target of this research project is now to modify cheap and simple polymeric binders with certain molecules via electron beam technique in order to obtain the same properties as for expensive special binders.

Objectives/Research results

In this research project we want to modify different standard polymeric binders with two different kinds of modifiers. Via grafting to approach the polymer latices will be functionalized with molecular substances (glucose, PVP, silicones) as well as with other polymeric compounds.

In this context it should be possible to introduce an enhanced hydrophilicity or even hydrophobic surface properties into the polymeric binders. It is then thinkable that the modified binders are used in barrier coatings or in coating for enhancing the printability.

To do so, an electron beam radiation facility is built. Using powers of more than 10 MeV it is possible to irradiate the samples even in substance (up to 7 cm thickness). The target is now to test the influence of the dosage to the polymeric binders in order to pick the best candidates. After that we have to find the best substances for modification and the suiting parameters for the irradiation. In a next big step the modified binders have to be used in a coating color and applied onto paper substrates. The barrier and printability properties have then to be tested and evaluated in relation to standard samples.

Application/Economic benefits

The modification via electron beam has the advantage that no critical side products emerge. For companies it is possible to obtain different specialized binders by modifying a standard polymeric dispersion with various molecules. Using the modified binders it should be possible to reduce the amount of binder to obtain the same properties in barrier or inkjet printability coating. In this context one saves pigments and additives too, which yields to a significant reduction of costs.
Besides saving money, for supplier industry it is possible to hit new markets with such electron beam modified binders.
Especially in the field of barrier coatings and an improved printability for folding board boxes EB-modified binders are promising.

Period of time: 01.01.2017 – 30.06.2018

Remarks

The RTD project IGF 18141 is being funded by the German Federal Ministry for Economic Affairs and Energy (BMWi).

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Research area: Process aims

Converting // Coating

Key words:

coating, surface treatment, sustainability, environmentally friendly, UV, UV-LED, vegetable oils, barrier

TITLE:

Substitution of synthetic binders via chemically modified thermal and UV-curing vegetable oils for application on cellulosic substrates.

Background/Problem area

Paper and board as packaging solutions are of great value for economy and society. Following the latest forecasts there will be further growth in packaging sector. One can observe progressing scarcity of natural resources and increasing costs for resources and production as well as the demand for higher sustainability of products and processes. Facing these issues, energy demanding industries like paper industry has to kind of reinvent its production process. The use of renewable resources can be one step in the direction of a more sustainable production. In this context, the use of modified vegetable oils, which are used for example in wood coatings, should now be tested in the field of paper coatings. The aim of the project is to systematically eliminate drawbacks of oils, preventing their use as natural binders in paper coating. Another goal is the energetic optimization of paper coating technology. For this purpose, both UV/ UV-LED based and thermal curing approaches have to be investigated.

Objectives/Research results

The research project faces the above mentioned challenges by means of modifying several vegetable oils, in order to make them crosslinkable with thermal and UV-curing. They have as well to be functionalized in a way that they build a film on the paper substrate.

Furthermore, the processability of possible components for coatings is of high interest. Gaining knowledge in the kinetic of crosslinking such products is an important result.

In detail, different requirement profiles for certain paper substrates have to be developed. The modified oils have to stand typical processing parameters and have to be integrable in highly specialized coating colours, where they partly or fully substitute synthetic polymer binders. Goals are to achieve good barrier properties, inkjet printability and stability of the paper substrates.

Besides conventional thermal curing of coating colors we focus on the application of UV-LED in our experiments to benefit from a real economically friendly process of paper coating.

Gained knowledge should be also transferred in the field of wood and textile coating.

Application/Economic benefits

The use of renewable vegetable oil based products in the field of paper coating results in versatile benefits. It reduces the dependence of synthetic polymer materials, which are made from petrochemical products. This can in future maybe lead to lower prices for the resources and creates an ecologically friendly image which can in contrast add value to the product. Especially if one thinks of paper in contact with food, the advantage of natural products becomes obvious. With these products one could develop barriers that require less amount of binding material.

It should be possible to develop 100 % systems of the natural binder. Because there is no water, which has to be removed, the demanded energy for the drying process can be saved. Furthermore the application of UV-LED technique for the curing of the oils saves energy.

Period of time: 01.01.2017 – 30.06.2018

Remarks

The RTD project FNR 22012514 is being funded by BMEL (Federal Ministry of Food and Agriculture).

PROZESS-ZIELE

Forschungsgebiet
Messen/Steuern/Regeln im Prozess

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Research area: Product aims

Process measuring and control technology

Key words:

Topography, OBA, NIR, paper structure

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

Background/Problem area

Paper is nowadays produced on machines with a width of up to 10 m and speeds of up to 2000 m/min. Even though some essential paper characteristics can already be measured online, most of them defy online measurement because of the high speeds. However, there is a demand for analysing the outer and inner structures of paper during production quickly, with little effort and in a space-resolved way because they influence the paper quality and converting results such as the print quality of graphic papers. Measurement devices fulfilling these demands in their complexity are currently not yet available in the market.

Objectives/Research results

Aim of the research project was to develop a mobile device to optically measure the inner and outer structures of paper and distribution of main components in coated and uncoated papers close to production in a space-resolved and precise way, focusing on the following characteristics:

- Surface structure (smoothness, topography)
- Internal structure (micro formation)
- Coat thickness variations (indirect measurement) → Determining the structural distribution of optical brightening agents (OBA) in coated paper as an indicator of coat thickness variations
- Structural distribution of components (e.g. binder) using NIR-technology.

The structures or structural distribution of ingredients (OBA, binder etc.) were determined on one and the same measuring surface or part of the measuring surface to identify interactions.

The main requirements to the device were determined jointly with the project partner INNOWEP (requirements specification). Measuring stations were designed and built that are highly flexible in terms of measuring surface and illumination (geometry, UV, IR radiation). Preliminary image acquisition tests were successfully completed at both PTS and the project partner.

The necessary equipment and software concepts were developed.

Various papers (illustration printing and other sheet-fed offset papers, web offset papers) were procured together with the associated print products to test a prototype. Conventional paper tests were performed, and the quality of print products was assessed. To be able to compare the evaluation results of the new multi-parameter system with those of commercially available single-parameter devices (measuring just one characteristic), the topography of papers was comprehensively assessed also by optical methods.

The cooperative research project has led to a mobile optical measurement device for the evaluation of inner and outer paper structures that will be marketed by the project partner INNOWEP.

Application/Economic benefits

The fast and reproducible identification of important paper characteristics is a key prerequisite for real-time quality control and the basis for systematic product and process optimizations leading to significant cost savings for paper producers. In combination with high-precision laboratory systems, the new measurement device will help to significantly improve the assessment of paper structures close to production.

Project period: 01.04.2015 – 31.03.2017

Remarks

The RTD project ZIM KF2037923AB4 was funded by the German Federal Ministry of Economic Affairs and Energy (BMWi).

QUERSCHNITTS-ZIELE

Forschungsgebiet
Energie

Energiegewinnung
Energienutzung

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Research area: General aims

Energy generation

Key words:

bioelectric system, microbial electrode, cation exchanger membrane, effluent treatment

TITLE:
Development of paper-based electrodes for microbial electrochemical effluent treatment

Background/Problem area

Newly developed materials and alternative technological concepts play a central role in the conservation and sustainable use of the resource water. Structures known as bioelectrical systems are an innovative approach in the field of effluent treatment. The degradation of organic constituents in the effluent and the energy produced by microorganisms involved in such degradation are considered to be the ecological and economical solution in the field of effluent treatment. These systems can be operated either as a microbial fuel cell or microbial electrolysis cell. The efficiency of this technology is determined by the efficiency of the individual components. Important elements include the microbial electrode and the cation exchanger membrane. The electrode material should have optimum material and surface properties to guarantee that an electrochemically active biofilm forms whilst at the same time ensuring good electrical conductivity and mechanical stability. A high surface/volume ratio is also required for the necessary system efficiency. A concept for an appropriate electrode material is paper-based materials.

Objectives/Research results

The objective of the research project is to develop paper-based electrodes and hydrocarbon-based cation exchanger membranes to enhance the efficiency of bioelectrochemical systems for use in communal and industrial effluent treatment.

First of all, paper-based conductive surface electrodes and hydrocarbon-based cation exchanger membranes are developed and optimised within the scope of the project. The concept for developing the electrode material is to produce highly filled paper that exhibits high electrical conductivity, is dimensionally stable when used in aqueous media and has been optimised to form electrochemically active biofilms. The microbial electrode is folded to give it a three-dimensional geometry in order to thereby maximise the growth area for microorganisms and at the same time efficiently utilise the reactor volume. The use of the three-dimensional bioelectrode and membrane are to be examined and evaluated by experimental tests and flow simulation. These results are then to be used to design tailored solutions for the operation of a demonstrator in communal and industrial effluent treatment.

In the sub-project on electrode development, a comprehensive laboratory screening was performed to identify a formulation for a suitable paper-based medium, focusing on the contribution of various graphite types to conductivity. High amounts of graphite were bound in the fibre structure and handsheets were formed by means of specific additives, identifying material combinations that lead to high conductivity. First material variations were used to bio-electrochemically characterise the electrodes in a laboratory electrolysis cell. They showed promising characteristics in terms of biofilm growth and energy density.

Application/Economic benefits

Bioelectrical systems (microbial fuel cell / microbial electrolysis cell) present an ecological and economical solution in the field of effluent treatment owing to the degradation of organic constituents in the effluents and the energy produced by the microorganisms that themselves also reproduce. Such a system can replace currently operated, energy-intensive aerobic treatment stages in effluent treatment. This thus pursues a sustainable approach that can make the potentially energy self-sufficient operation of industrial and communal effluent treatment facilities possible.

The materials to be developed will make it possible to provide the required electrodes and membrane surfaces in a cost-efficient manner, thus raising expectations for the economical use of bioelectric systems.

Project period: 01.05.2017 – 30.04.2019

Remarks

The RTD project BMBF ‘ElektroPapier’ is being funded by the German Federal Ministry of Education and Research (BMBF) and conducted in cooperation with:

- EnviroChemie GmbH (Coordinator)
- FuMa-Tech Gesellschaft für funktionelle Membranen und Anlagentechnologie mbH
- Graphit Kropfmühl GmbH
- Helmholtz-Zentrum für Umweltforschung GmbH (UFZ)
- Papiertechnische Stiftung (PTS)
- Technische Universität Braunschweig / Institut für Ökologische und Nachhaltige Chemie (IÖNC)
- Technische Universität Braunschweig / Institut für Siedlungswasserwirtschaft (ISWW)

QUERSCHNITTS-ZIELE

Forschungsgebiet

Umwelttechniken

Wasser
Emissionen
Reststoffe

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Research area: General aims

Environmental technology // Waste and residues

Key words:

paper sludge, deinking sludge, biogas, residues, paper mill, MBT, digestion, fermentation

Title:
Co-fermentation of paper sludges (Phase 2)

Background/Problem area

At present, a search should be made for new recovery routes that make sense from the perspective of energy and climate change and are cost-effective for the paper industry in order to dispose of paper sludges. The disposal routes realised to date for direct spreading and for composting with subsequent spreading will no longer be possible in future. The energy recovery of paper sludges in external incinerators is expensive. The energy/material recovery in brickworks and cement plants is only sensible to a limited extent. Hence, paper mills and disposal contractors are searching for an alternative route for biological recovery.

So, the first phase of the research project was therefore devoted to the objective of making the sludges and organic residues from the paper industry accessible to co-fermentation.

An examination of the composition of the paper sludges during the phase 1 of the project yielded very low heavy metal contents. The contents of organic chlorine compounds were in a range that is commonly found in the contents of the fermenters in fermentation plants. This applies as well to the mineral oil contents of primary sludges and biological sludges. The contents of mineral oil, that is used in papermaking and is found in paper for recovery, concentrate primarily in the deinking sludges. The contents in the deinking sludges, however, do not exceed the concentrations found in printed paper. These results do not suggest any inhibition during fermentation, even if as much as 100 % deinking sludge were added. This has already been verified within the framework of the adapted fermentation and inhibitor tests.

When compared with other fermented substances (e.g. corn silage, organic waste), the results of the gas yield test showed that paper sludges can have similarly high gas yields in some cases. In this context, the types of sludge differ from one another far less than do the individual sludge samples within one type of sludge. The methane contents in biogas, for example, range between 52 % and 70 %.

This means that most sludges of the paper industry are very well suited for co-fermentation and can function as a co-substrate, thus providing a good supplement. The degradation behaviour of the paper sludge in a continuous trial should be analysed in detail in every individual case prior to practical implementation. Moreover, the profitability of this alternative disposal route must also be examined.

Objectives/Research results

Having determined that paper sludges are in principle very well suited for co-fermentation, the next phase 2 was focused to studying the practicability of the co-fermentation of paper technological sludges by laboratory testing. For this purpose, the batch trials were prolonged in the form of continuous trials, in order to clarify whether the positive potentials of the co-fermentation of paper sludges that have been discovered can be implemented in day-to-day operation. An addition of 10 % organic substance by deinking sludge resulted in an additional gas yield of 4.9 % - 6.5 %. An addition of 10 % organic substance by fibre sludge resulted in an additional gas yield of 8.2 % - 9.5 %.

The addition of deinking and fibre sludge resulted in no significant inhibition and smaller gas yields of the standard substrate. Examinations concerning the practicability and handling of the paper sludges have shown that in a commercial realisation the adaptation of the flocculation reagent to reduce viscosity in the process water should be adapted. Furthermore, the contents of heavy metals and mineral oil as well as the fluorinated compounds (Perfluorcarbone, PFC) are in a not critical area.

In a subsequent third phase, the results and findings should then be implemented on a commercial scale in a pilot or demonstration plant.

Application/Economic benefits

The co-fermentation of paper sludges is in a range of average costs comparing with other types of disposal. Therefore, the co-fermentation of numerous fibrous paper sludges can be an economic attractive alternative disposal. If the savings and the benefits of a using of the biogas yields are taken into account, the economic efficiency of this disposal way increase significantly, so that the co-fermentation is also interesting for deinking sludges.

Period of time: 01.04.2017 – 31.03.2017

Remarks

The RTD project DBU Az 30964 was being funded by German Federal Environment Foundation (DBU) and coordinated by PTS, Munich, in cooperation with project partners HAWK Hochschule für Angewandte Wissenschaft und Kunst, Göttingen, Abfallzweckverband Südniedersachsen, Friedland and Schönfelder Papierfabrik GmbH, Annaberg Buchholz).

QUERSCHNITTS-ZIELE

Forschungsgebiet
Ressourceneinsparung

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Research area: General 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.

Objectives/Research results

Aim of the project was to use process water ingredients as so-called recycled starches in surface starch or adhesive products for paper and corrugated board production.

The results show, that short time heating prevents the starch metabolism for 24 - 48 hour, but a temperature more than 75 degree and a treatment time of more than 23 seconds are needed. Also sodium hypochlorite is suitable to get this result. Tannin shows an ambivalent result. The total bacteria count is reduced by 3 power of ten with short time treatment and sodium hypochlorite, but after 24 and 48 hours the bacteria count increase significantly.

The examination showed that recycling starches and medium viscous starches introduced by paper for recycling are capable to replace fresh starch in surface starches and in corrugated board adhesives without thermal or chemical modification. About 10 - 30 % of the fresh native starch can be replaced by recycling starch without product deteriorations and setbacks of the end product properties.

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

Period of time: 01.04.2015 – 31.07.2017

Remarks

The RTD project IGF 18699 N is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Forschungsgebiet: Querschnitts-Ziele

Ressourceneinsparung

Schlagworte:

Ultraschall, Entwässerung, Ressourceneinsparung

Thema:
Verbundvorhaben „Ultra-Dewatering“: Energieeinsparung bei der Papierproduktion durch Ultraschall unterstützte Entwässerung der Papierbahn

Teilvorhaben: Ultraschallgrundlagen

Ausgangssituation/Problemstellung:

In der energieintensiven Papierindustrie ist die Reduzierung des spezifischen Energieeinsatzes ein essentielles Ziel. Ein Ansatz verfolgt die Steigerung des Trockengehaltes durch eine Ultraschallbehandlung der Papierbahn vor dem Erreichen der Trockenpartie, die als größter Energieverbraucher in der Prozesskette der Papierherstellung gilt. Das beabsichtigte Verfahrensprinzip beruht darauf, dass die Papierbahn mit einem Umschlingungswinkel an einem Schwingsystem (Sonotrode) vorbeigeführt wird und durch den Eintrag der Schwingungen eine Entwässerung stattfindet. Das entfernte Wasser tritt als Nebel aus und kann abgesaugt werden, wodurch weniger Wasser thermisch getrocknet werden muss.

Aus dem Stand der Technik sind bereits Möglichkeiten zur Entwässerung der Faserstoffbahn mittels Ultraschall bekannt. Jedoch wird keines der aus dem Stand der Technik bekannten Verfahren bislang in der tatsächlichen Papierproduktion eingesetzt, da mit diesen zu erreichende Trockengehaltsgewinne nicht ausreichend und gleichzeitig die apparativen Voraussetzungen sehr hoch sind. Diese Probleme ergeben sich insbesondere aus einer mangelnden Kopplung des Ultraschalls an die zu entwässernde Papierbahn.

Forschungsziel/Forschungsergebnis:

Das Projekt gliederte sich in zwei Teile. Im ersten Teil wurden im Labormaßstab geeignete Materialien als Bespannungen eruiert. Außerdem eine Ultraschallwirkstelle konzipiert, die Position des Einbauortes im industriellen Umfeld ausgewählt und ein Labor-Versuchsstand entwickelt.

Mit dem entwickelten, diskontinuierlich arbeitenden Labor-Versuchsstand konnten Steigerungen von 3...5 % des Trockengehalts bei max. 70 m/min Bahngeschwindigkeit nachgewiesen werden. Darüber hinaus stehen Bespannungen zur Verfügung, welche eine grundsätzliche Ultraschalleignung aufweisen. Durch das ultraschallgestützte Entwässern ist es möglich, den Energieverbrauch in der Trockenpartie von Papiermaschinen zu verringern. Vor allem die Wechselwirkungen zwischen den zur Verfügung stehenden Amplituden der Ultraschallaggregate (µm-Bereich) und vergleichsweise großen Abmessungen und Bahngeschwindigkeiten einer Papiermaschine sind im industriellen Umfeld noch zu untersuchen. Eine Anpassung der Ultraschalltechnik zur lückenlosen Abdeckung der kompletten Bahnbreite ist durch eine Mehrfachanordnung von Sonotroden möglich.

Die Überführung des Funktionsmusters in ein industrienahes Umfeld zeigte, dass die einwandfreie Funktionsweise und eine gezielte, reproduzierbare Steigerung des Trockengehalts anspruchsvoll sind, jedoch die Ultraschalltechnik das Potenzial dazu bietet.

Anwendungen/Wirtschaftliche Bedeutung:

Mit der Entwicklung der Ultraschall-Wirkstelle sowie dem erarbeiteten Prozesswissen sollten industrienahe Laufversuche der evaluierten Bespannungen und der Zentralkomponente des Labor-Versuchsstands Erkenntnisse zum Einsatz an einer Papiermaschine liefern. Diese Untersuchungen zeigten, dass die Einwirkdauer des Ultraschalls einen entscheidenden Einfluss auf die Entwässerungsleistung hat. Die Auslenkung eines freien Zugs durch die Ultraschall-Sonotrode konnte bei umlaufenden Bespannungen nachgewiesen werden.

Die eingesetzte Ultraschalltechnik ist robust und für industrielle Bahngeschwindigkeiten grundsätzlich geeignet. Die verwendeten Materialien (z. B. Titan-Legierung der Sonotrode) sind verschleißarm und für einen Dauerbetrieb vorgesehen. Weiterhin liegt bei aktivem Ultraschall eine geringe elektrische Leistungsaufnahme vor, welche im Vergleich zu einem möglichen Bedarf an thermischer Energie in der Trockenpartie deutlich geringer ausfällt. Darüber hinaus ist der konstruktive Aufwand zur Implementierung realisierbar.

Jedoch ist die Parametrisierung anspruchsvoll und im Einzelfall zu eruieren. Eine breite Basis an Prozesswissen konnte durch das Projekt erarbeitet werden. Die Führungsgrößen für den Einsatz von Ultraschall zur mechanischen Entwässerung sind u. a. die Einwirkdauer sowie die Amplitude des Ultraschalls.

Projektlaufzeit: 01.08.2014–31.03.2017

Bemerkungen:

Das Verbundvorhaben wurde über den Projektträger Jülich vom Bundesministerium für Wirtschaft und Energie aufgrund eines Beschlusses des Deutschen Bundestages gefördert. Das Projekt wurde in Kooperation mit der Heimbach GmbH (Düren) und der Gebr. Bellmer GmbH Maschinenfabrik (Niefern-Öschelbronn) bearbeitet.

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Ressourceneinsparung

Schlagworte:

Agrarreststoffe, Ressourcenschonung, Kaskadennutzung, trockene Faseraufbereitung, Bio-Verbundmaterial, Bioprodukt, Mehrweg-Besteck

Thema:

Entwicklung einer Prozesskette zur Nutzbarmachung von Fasern aus Agrarnebenprodukten für die Herstellung von Mehrweg-Besteckteilen und haushaltsnahen Gebrauchsgegenständen aus 100 % nachwachsenden Rohstoffen.

Ausgangssituation/Problemstellung

Im Zuge der Entwicklung zur Bioökonomie rücken nachwachsende Rohstoffe – insbesondere auch Nebenprodukte aus der Agrarindustrie in den Fokus von Forschungsvorhaben und besitzen zukünftig ein großes Potenzial Materialien, die aus fossilen Rohstoffen erzeugt werden und/oder nicht biologisch abbaubar sind, für eine Vielzahl möglicher Applikationen schrittweise zu substituieren. Die Kaskadennutzung, in der sich die energetische Nutzung von Biomasse einer stofflichen anschließt, spielt eine übergeordnete Rolle, um eine hohe Wertschöpfung entlang langer, komplexer Wertschöpfungsketten zu generieren und bietet somit enorme ökologische sowie ökonomische Vorteile gegenüber der reinen energetischen Nutzung.

Die Bionatic GmbH & Co. KG hat bereits erfolgreich einen Ansatz im Sinne der stofflichen Kaskadennutzung gefunden. Beim industriellen Anbau und der Ernte von Betelnüssen fallen zahlreiche Blätter der Betelnusspalme ungenutzt an und werden zu Einweg-Geschirr verarbeitet, welches von Bionatic bereits erfolgreich im europäischen Raum vermarktet wird. Im Zuge der Verarbeitung der Blätter fallen dabei erhebliche Mengen Palmenverschnitt an. Die derzeitige Entsorgung (Kompostierung) des Palmenverschnitts ist zum einen mit erheblichen Kosten verbunden und stellt zudem das unwiderrufliche Ende des „life-cycle“ dar. Dabei enthalten diese zu einem großen Anteil hochwertige Naturfasern. Um die Wertschöpfung des Rohstoffes Palmenblatt – sowie auch anderer geeigneter Agrarnebenprodukte – zu erhöhen und damit sowohl die ökologischen als auch die ökonomischen Vorteile zu nutzen, bedarf es der Entwicklung von Aufbereitungsverfahren, die in der Lage sind das restliche Fasermaterial so aufzubereiten, dass sich damit innovative Materialien und Produkte entwickeln lassen, die sich funktionell vom Stand der Technik abheben.

Forschungsziel/Forschungsergebnis

Im Projekt soll ein Bio-Komposit zur Herstellung von Mehrweg-Besteckteilen und anderen End-Consumer-Produkten entwickelt werden, welches alle Maßstäbe der Umweltkompatibilität als auch die Idee der stofflichen Kaskadennutzung erfüllt. Dazu bedarf es der technologischen Entwicklung und des Aufbaus geeigneter Aufbereitungsanlagen. Die Zerfaserung der Nebenprodukte (Palmenverschnitt), welche insbesondere durch ein sehr sprödes Fasergefüge gekennzeichnet sind, sowie die Entwicklung, Materialcharakterisierung und erste Anwendung bakteriell synthetisierter Biopolymere bilden jeweils den innovativen Kern der Teilprojekte. Die Materialkombination und Weiterverarbeitung des entstehenden Verbundwerkstoffes sowie die iterative Rezepturentwicklung in Abhängigkeit der anvisierten Produkteigenschaften bis hin zur Herstellung eines Prototyps für Mehrweg-Besteckteile bilden dazu den Rahmen für das gesamte Projektvorhaben.

Für die Zerfaserung werden zunächst geeignete Trockenprozesse (Prallmühle, Extruder, etc.) auf Ihre Potenziale und Grenzen hinsichtlich der erzeugten Fasermorphologie getestet. Es sollen geeignete Vor- und Nachbehandlung des Fasermaterials entwickelt werden, um das Ausgangsmaterial mit einer gewünschten engen Partikelgrößenverteilung zu zerfasern. Für das Verbund-Biopolymer werden drei Biopolymere in verschiedenen Mischungsverhält-nissen verarbeitet und auf ihre Materialeigenschaften hin untersucht. Die verwendeten Bio-polymere basieren auf bakteriell erzeugter Polyhydroxybuttersäure (PHB) und Poly(3-hydroxybutyrate-co-3-hydroxyvalerate), auch PHBV genannt. Um die bekannten nachteiligen Materialeigenschaften (spröde, nicht flexibel) von reinem PHB / PHBV zu eliminieren, werden das drittes Biopolymer Polyestherurethan (PEU) oder andere chemischen Additive eingesetzt.

Anwendungen/Wirtschaftliche Bedeutung

Mit der Entwicklung der Prozesskette; Aufbereitung des produktionsseitig anfallenden Palmenblattverschnitts – Compoundierung mit dem Verbund-Biopolymer – Weiterverarbeitung; kann eine stoffliche Kaskadennutzung großer Mengen ungenutzter faseriger Agrarnebenprodukte realisiert werden.

Gegenüber dem Stand der Technik können die Agrarnebenprodukte nunmehr ganzheitlich genutzt und zu einem 100 % umweltkompatiblen Material verarbeitet werden. Durch den hohen Faseranteil im Verbund mit Biopolymeren und einen möglichst geringen Einsatz von Additiven erhöht sich die Wirtschaftlichkeit der Produkte. Aus dem zu entwickelnden Material können innerhalb der Verfahrenskette unterschiedliche Produkte hergestellt werden, die sowohl im gewerblichen Bereich als auch in privaten Haushalten Verwendung finden. Neben dem ersten Zielprodukt „Mehrweg-Besteck“ können dies bspw. auch Tischartikel wie Teller, Tassen, Schalen für Catering-Services oder haushaltsnahe Gebrauchsgegenstände wie bspw. Aufbewahrungsbehälter sein.

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Bemerkungen

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THEMENVERZEICHNIS

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Kuratorium für Forschung und Technik
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