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Verband Deutscher Papierfabriken e.V.

Forschungsprojekte im Überblick 2016

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

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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 2016 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 Vielzahl von Kurzbeschreibungen.

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

Für interessierte Firmen besteht jederzeit die Möglichkeit, bei Projekten, die über das Kuratorium für Forschung und Technik gefördert werden, in projektbegleitenden Ausschüssen mitzuarbeiten. Unternehmen können direkt an den entstehenden Forschungsergebnissen partizipieren und diese auch mitgestalten.

In der Forschungsübersicht 2016 wurden Kurzbeschreibungen von über 70 Forschungsvorhaben erfasst und nach Forschungsgebieten geordnet. Am Ende der Broschüre finden Sie ein Schlagwortverzeichnis und eine Themenliste, die das Auffinden bestimmter thematischer Schwerpunkte ermöglichen.

Die Forschungsübersicht 2016 finden Sie auch als Datei im Extranet der VDP-Website https://www.vdp-online.de/de/extranet/startseite-extranet/forschungsuebersichten.html.
Wenn Sie Themen zu einem bestimmten Forschungsgebiet suchen, gelangen Sie durch Anklicken der gewünschten Zeile im Inhaltsverzeichnis auf die erste Seite des betreffenden Forschungsgebietes. Über das Themenverzeichnis am Ende können Sie alle enthaltenen Einzelthemen durchsehen und direkt das Projekt anklicken. Ein Schlagwortverzeichnis führt zu den Schlagworten der einzelnen Projektbeschreibungen.
Weitere gedruckte Exemplare der Forschungsübersicht stellt Ihnen die VDP-Forschungsförderung – e.kloss@vdp-online.de − gerne zur Verfügung.

PRODUKT-ZIELE

Forschungsgebiet
Rohstoffe

Holz
Landwirtschaftliche Nutzpflanzen
Altpapier
Füllstoffe, Pigmente
Chemische Additive

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Forschungsgebiet: Produkt-Ziele

Chemische Additive, Technische Spezialpapiere

Schlagworte:

UV-Sensor, Papierfunktionalisierung, Oberflächenbeschichtung

Topic:
Photochrome Papiere mit UV-Licht responsiven Eigenschaften

Ausgangssituation/Problemstellung

UV-Sensoren sind in der Lage einfallende UV-Strahlung zu messen und werden heutzutage in verschiedensten Bereichen selbstverständlich verwendet. Dazu zählen vor allem chemische und biologische Analytiken, aber auch zur optischen Kommunikation, zur Flammendetektion, oder für astronomische Experimente. Die Anforderungen an diese verwendeten Sensoren sind eine schnelle Reaktion und Recovery, sowie eine hohe Sensitivität gegenüber UV-Strahlung. Um dieses zu gewährleisten werden aktuell vorwiegend Halbleitermaterialien wie ZnO, ZnS, Si, TiO2, Diamant und GaN verwendet. Diese sind jedoch nur durch aufwendige Syntheseprozesse herstellbar und daher sehr teuer. Außerdem benötigen sie weitere Bauelemente in der Peripherie, die den Sensor ansteuern und auslesen. Einfach zu entwickelnde und mit möglichst geringem Instrumentarium einzusetzende Sensoren, auch Einmalsensoren, sind daher von großem Interesse, jedoch bis heute nicht trivialerweise verfügbar.

Forschungsziel/Forschungsergebnis

Aus den oben genannten Gründen sollen neue papierbasierte UV-Sensoren auf Basis lichtresponsiver Polymermodifizierungen hergestellt und untersucht werden. Bedingt durch einen einfacheren (weniger komplexen) Aufbau des optischen Systems, sowie des Wegfallens der Halbleitermaterialen würden solche Systeme deutlich einfacher und daher günstiger herstellbar sein.

Um die vorgenannten Herausforderungen anzugehen, wurden Spiropyranfunktionen in Polymere eingebracht, die darüber hinaus über photoreaktive Benzophenonfunktionen verfügten. Die so synthetisierten Polymere konnten bereits erfolgreich über verschiedene Beschichtungsprozesse auf Filterpapiere aufgebracht und durch Belichtung mit geeigneten Wellenlägen kovalent an die Cellulosefasern angebunden werden. Die fertigen Substrate waren in der Lage über eine stufenlose Verfärbung vom Farblosen zu intensiven Violett sowohl die Intensität von künstlichem UV-Licht als auch das Sonnenlicht zu detektieren. Durch Kontrolle der aufgebrachten Polymermassen ist es zudem möglich die Farbintensität der Substrate reversibel einzustellen, um die Auflösung zu geringen Intensitäten zu erhöhen.

Frau Wie Li hat im Rahmen ihrer Doktorarbeit das Thema kürzlich abgeschlossen. Insbesondere hat sie im letzten Jahr ihrer Arbeit an Lösungen experimentiert, welche den dynamischen Bereich des Sensors und die chemische Stabilität verbessert. Neben ihrer Dissertation hat Frau Li kürzlich noch eine weitere wissenschaftliche Arbeit zur Publikation eingereicht.

Anwendungen/Wirtschaftliche Bedeutung

Als langfristiges Ziel ist die Entwicklung papierbasierter UV-Sensoren, die aufgrund des deutlich günstigeren Herstellungsprozess, sowie der einfacheren Handhabung ein breites Interesse- und Anwendungsspektrum zeigen könnte. Insbesondere im Hinblick auf die Verknappung der Seltenerdenmetalle und den Fokus auf nachhaltige/bio-basierte Produkte können weiterentwickelte Systeme im Alltagsbereich bereits bestehende Sensoren ersetzten, bzw. neue Anwendungsbereiche speziell für den Trägerstoff Papier finden. Im Erfolgsfall können insbesondere Spezialpapiererzeuger und -verarbeiter profitieren und durch diese Anwendungen das Produktportfolio erweitern. Schließlich kann man sich den Einsatz der neu entwickelten Polymere in Sicherheitspapieren sehr gut vorstellen.

Bearbeitungszeitraum: 2012 bis 2016

Bemerkungen

Das Forschungsprojekt wird gefördert aus Mitteln der TU Darmstadt und unterstützt durch ein Stipendium der chinesischen Regierung (Frau Wei Li: CSC Scholar).

Publikationen, die im Rahmen des Projekts entstanden sind, können beim Autor angefordert werden.

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Research area: Product aims

Raw materials // Wood

Key words:

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

TITLE:
Cascading Recovered Wood (CaReWood)

Background/Problem area

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

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

Objectives/Research results

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

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

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

From an environmental point of view, the increased recycling of recovered wood can be seen as a positive evolution because this increases the total volume of CO2 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 WOOD-WISDOM-NET+, a network of European Funding Agencies (4th Joint Call - 2013), and coordinated by Technische Universität München, Lehrstuhl für Holzwissenschaft (TUM) Germany, in cooperation with leading European paper research institutes PTS, Germany; WKI, Germany; AAL, Finland; SRBTP, France; FCBA, France; ESB, France; BOKU, Austria; IAM, Slovenia), and 7 industrial partners: Abelium d.o.o, M SORA d.d., Slovenia; RTT Steinert, Schumann-Analytics GmbH, Olympus Deutschland GmbH, LSA – Laser Analytical Systems & Automation GmbH, Germany; Vanek Tischlerei und Reparatur, Austria; Fédération Française du Bâtiment – Charpente-Menuiserie-Parquets, France.

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Research area: Product aims

Raw materials // Paper for Recyling

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: 01.02.2016 – 31.01.2018

Remarks

The RTD 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

Altpapier

Schlagworte:

Altpapierqualität, DIN EN 6343, Sortieranlagen, Altpapierkreislauf, Qualitätsveränderung, Recyclingpapier

Topic:
New methods to evaluate paper for recycling quality according to the revised DIN EN 643 sorting list

Background/Problem Area

The criteria to be fulfilled by certain paper for recycling grades have been revised and are documented in a new DIN EN 643. New methods shall by applied and enhanced to verify the named quality grade. By doing this an actual status quo of the quality of paper for recycling may be revealed and used to discuss future developments of quality grades.

Objectice/Research Result

Quality evaluation of paper for recycling will be improved by new sensors and new mechanical components in an automatic classifier. The results shall be used for an new study on quality development of recycled fibers. Comparing the obtained results with elder studies will lead to new insights and can be used to predict quality changes in the near future.

An evaluation of sorting plants will be possible. The matching of obtained figures to those given in the DIN EN 643 standard can be examined. This will lead to recommendations for the DIN working group dealing with the description of waste paper grades. Necessary requirements concerning future work on the standard DIN EN 643 will be prepared.

Application/Economic Benefits

Identification of potential efficiency is crucial for small and medium enterprise (SME). Ecological benefits are evident. Grades, traded and paid by mean of the DIN EN 643 grade list, can reliably be evaluated. This leads to quality insurance. The DIN working group on paper for recycling quality will help to distríbute the obtained results.

Project Period: 01.07.2016 – 31.12.2018

Remarks

The IGF-project 19118 N is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Forschungsgebiet: Produkt-Ziele

Rohstoffe // Chemische Addititve

Schlagworte:

Nassfestigkeit, Vernetzer, photoreaktive Polymere

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

Ausgangssituation/Problemstellung

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

Forschungsziel/Forschungsergebnis

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

Anwendungen/Wirtschaftliche Bedeutung

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

Bearbeitungszeitraum: 01.11.2013 − 30.04.2016

Bemerkungen

Es wurden 2 wissenschaftliche Arbeiten in peer-review Zeitschriften daraus veröffentlicht und es entstand eine Doktorarbeit.

Bundesministerium für Wirtschaft und Energie

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

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Forschungsgebiet: Produkt-Ziele

Rohstoffe // Chemische Additive zur Beschichtung

Schlagworte:

Mikrofluidik, Medizinische Diagnostik, Wasseranalytik

Thema:
Neue Barriereschichten auf Basis von Cellulose-Nanokolloiden

Ausgangssituation/Problemstellung

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

Forschungsziel/Forschungsergebnis

Ziel des Forschungsvorhabens war es, die Barriere-Eigenschaften von Papierbeschichtungen, welche aus hydrophoben Cellulose-basierten Nanokolloiden aufgebaut sind, zu untersuchen und daraus abzuleiten, ob diese Beschichtungen eine „nachhaltige“ Alternative für konventionell eingesetzte 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. in Kontakt mit wässrigen Lösungen: die Oberflächen zeigen superhydrophobe Eigenschaften, was auf die partikuläre Natur der Filme, und die damit verbundenen Rauigkeit auf nano- und µm-Skala zurückgeführt werden kann. Barriere-Eigenschaften, wie Wasserdampfdurchlässigkeit, Fettdichtigkeit und Mineralölmigration wurden beim Projektpartner PTS ermittelt. Zentrales Forschungsergebnis ist, dass sich die aus den Cellulose basierten, hydrophoben Nanokolloiden aufgebauten Schichten zwar sehr gut für „superhydrophobe“ Oberflächeneigenschaften nutzen lassen, jedoch weniger gut für Wasserdampfbarrieren und Unterbindung der Ölmigration eignen.

Anwendungen/Wirtschaftliche Bedeutung

Aufgrund der spannenden superhydrophoben Eigenschaften wird das Projekt zum jetzigen Zeitpunkt nach Ablauf der INFOR-Förderung mit eigenen Mitteln weitergeführt und soll in einem IGF Projekt gemeinsam mit der PTS in 2017 verstetigt werden. Anwendungen hierbei können sich im Erfolgsfall z. B. im Bereich des Einsatzes von Papier im Baubereich ergeben.

Bearbeitungszeitraum: 2015 fortlaufend

Bemerkungen

Das Projekt wird aus Landesmitteln des Landes Hessen (Grundfinanzierung der TU Darmstadt) sowie in 2015 aus Mitteln des INFOR (INFOR-Projekt Nr. 185) finanziert

Publikationen, die im Rahmen des Projekts entstanden sind, können beim Autor angefordert werden.

PRODUKT-ZIELE

Forschungsgebiet
Papier, Karton und Pappe

Graphische Papiere
Verpackungspapiere und -karton
Technische Spezialpapiere

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Research area: Product aims

Paper, paperboard and board // graphic and packaging papers

Key words:

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

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

Background/Problem area

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

Objectives/Research results

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

During the project three work packages are to be carried out

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

Application/Economic benefits

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

Period of time: 01.05.2015 – 31.12.2016

Remarks

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

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Research area: Product aims

Paper, paperboard and board // Graphic papers

Key words:

paper evaluation, measuring techniques, measuring methods, sheet-fed offset paper, web offset paper, 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 aims to:

- Comprehensively 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 were procured, covering a broad range of different parameters, and three of them were used in a first printing trial (by project partner SID), varying all print process parameters. The dimensional changes were measured and evaluated by means of a Luchs register measuring system. Printing parameters relevant to dimensional stability were identified, and the results were used to print the other papers whose print quality is currently being analysed.

Moreover, sample papers were produced on the VESTRA pilot coater, using two base papers, coating colour formulations, applicators and technological conditions that are known in detail.

At the same time, work was started to model the penetration behaviour of liquids into coated paper. Two different approaches are being 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 is being funded by German Federal Ministry for 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:

inkjet printing

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

Background/Problem area

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

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

Objectives/Research results

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

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

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

The evaluation methods have already been used to assess the print quality of 21 papers from the following grade groups: uncoated papers with and without inkjet optimisation, pigmented inkjet papers, and coated inkjet papers. The printing station has meanwhile been equipped and tested with two further industrial print heads (M, Y), and can now be used with additionally developed printing plates for four-color HSI printing tests. The latter are currently under way, varying important typographical parameters like colour layout and evaluating the print results. The conventional evaluation of the papers used has already been completed.

The test prints could be compared with industrial print results only qualitatively so far because the test printing plates cannot be used in industrial presses. However, the ranking results of papers printed with industrial print heads in the lab could be compared with those of industrially printed papers.

Application/Economic benefits

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

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

Project period: 01.07.2014 – 30.06.2016

Remarks

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

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Forschungsgebiet // Produkt-Ziele:

Papier, Karton und Pappe // Graphische Papiere

Schlagworte:

Ressourceneffizienz, Altpapier, Papierkette, Prozesssimulation, Lebenszyklusanalyse, Nebenprodukte, Multi-Produktfabrik

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

Background/Problem Area

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

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

Objectives/Research Results

The project has three specific objectives. Firstly, the development of methodologies, models and tools linking together production design and process modeling to determine the economic and technical feasibility of paper mills. These models differ from conventional process models by including both the material quality properties and the resource efficiency indicators. These methodologies, models and tools are required in order to show the possibilities for resource efficient reuse and valorisation along the value chain. Indicators relevant to resource-efficiency and environmental impacts are developed, tested in practical case studies together with the industry and used to further develop standards.

Secondly, the experimental part includes the development of innovative analytical tools to control production processes, demonstrations and integration of the results to a practical guide for decision makers. The results will help complete value chains of paper and board industry, converting industry and end users to decrease their overall waste production, improve resource efficiency and increase competitiveness of paper mills.

In addition to paper as the main outcome of paper production processes, also so called "by-products" are the third focus of the project. The by-streams from recycling processes are regarded as a source of many valuable components. They can be used for the production of additional high value products in addition to paper (multi-product mill concept).

Application/Economic Benefits

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

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

Project Period: 01.11.2013 – 31.10.2016

Remarks

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

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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 hot extensibility up to 50 % and are used for thermoforming experiments in a new trial device at PTS Heidenau. 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 Ethylene Vinyl Alcohol Copolymers, Polyamid-Dispersion, HDPE-Dispersion and modified starches showed best fit to the requirement profile. Suitable foils based on biopolymers (PLA, PBAT and mixtures thereof) were produced using small scale pilot plants for compounding, extrusion and calendering. Within the next steps process conditions will be further improved and antimicrobial agents will be 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

The novel packaging material for trays will open new markets for producers of packaging materials and also fresh food. It is expected that this new packaging solution will penetrate the market through the “green thinking” upper middle class, probably around 10 % of the market in the participating countries (Germany, Belgium and Poland), and then reach the main stream of users.

The target group of this project are firstly 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 German Federal Ministry for Economic Affairs and Energy (BMWi).

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Research area: Product aims

Paper, paperboard and board //
Packaging papers and paperboard

Key words:

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 photo-chemical 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.

Project period: 01.11.2014 – 30.04.2017

Remarks

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

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Research area: Product aims

Paper, paperboard and board //
Packaging papers and paperboard

Key words:

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 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.

First batches of dextrin-based glue formulations show promising results as a highly biocompatible basis for the development of a complex water-based adhesive system, but different composites with varying types of starch or main additives are also evaluated in terms of their potential use in the final product.

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 – 28.02.2018

Remarks

The RTD project FNR-22005515, „Glykopack“, is being funded by 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:

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

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

Background/Problem area

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

Objective/Research results

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

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

The project was roughly divided into three phases. In the first step different materials were screened according to their permeability to oxygen and carbon dioxide. The materials were modified by adding different additives (e.g. cyclodextrines, bentonite, zeolithes and silica). In parallel, a numerical model to calculate the optimal atmosphere of the packed products was developed and this model was verified and optimised by case studies. In phase two, two types of packages, one coated cartonboard based and one plastic based package were produced according to the material study and the computer simulations. With the help of shelf life tests and permeation measurements the model was verified. In the last stage a profitability study and end of life investigations (biodegradability and recyclability) were made.

To the present day a mathematical model was set up successfully, which describes the gas permeation through the package, the respiration of the product and the change of the headspace atmosphere with the help of mathematical equations. Knowledge on metabolism parameters and respiration data of fresh and sensitive food products were gained and implemented in the model.

Extensive knowledge on formulation of aqueous biopolymer dispersions and binary blends for plastic films were acquired. Based on this knownledge several test packages (test trays) were made in the final stage of the project. The materials for the test packages were produced using pilot plants for coating and polymer processing. Production, filling and closing of the test tray were done manually.

Using this test packages it could be shown by storage tests that the EMAP concepts (EMAP = Equilibrium Modified Atmosphere Packaging) works when the permeabilities for O_2 and CO_2 are adjusted in right manner and negative effects like pinholes and microbiological contamination could be neglected.

Application/Economic benefits

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

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

Period of time: 01.05.2014 – 31.07.2016

Remarks

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

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Research area: Product aims

Paper, paperboard and board // Packaging paper and paperboard

Key words:

pulsed laser machining, non-impact process, laser additives

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

Background/Problem

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

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

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

Research objective/Research results

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

The process of machining paper by means of pulsed laser beams is to be sustainably improved by the addition of special additives. The important parameters in this respect are the concentration of the additive and the distributions in the composite material. By evaluating and weighting the various factors contributing to the machining result, the relationships between the laser parameters and the composition of the paper substrate contributing to the technical results can be understood. For lab trials different additives and pigments were already examined, e.g. barium sulphate, different binders and special laser active pigments. All additives showed a good processability. In addition the chosen laser active pigments as well as barium sulphate pigments showed very interesting results, as an enhanced ablation during the laser processes for example. Furthermore different commercial available paper and cardboard substrates were chosen and examined to reveal interactions between paper components and laser radiation. Using the knowledge gathered during the project paper processing without discoloration was possible, as well as fine gravures in paper substrates.

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

Application/Economic benefits

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

Project period: 01.12.2014 – 30.11.2016

Remarks:

The RTD project IGF18421 N is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi) and carried out in cooperation with the Bayerisches Laserzentrum GmbH.

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Research area: Product aims

Paper, paperboard and board //
Packaging papers and paperboard

Key words:

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

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

Background/Problem area

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

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

Objectives/Research results

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

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

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

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

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

The project began with the characterisation and provision of the starting materials (polymeric barrier agents, pigments and substrates). At the same time, the basic components for the analytical work were provided, and a testing procedure was developed to evaluate the barrier effect of coatings on paper. Afterwards temperature-dependent migration tests have been started and evaluated. In the next steps the gained results, based on the migration tests, will be used to formulate pigment-containing coatings.

Application/Economic benefits

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

Period of time: 01.04.2015 – 31.03.2017

Remarks

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

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Research area: Product aims

Paper, paperboard and board //
Packaging papers and paperboard

Key words:

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 project is being carried out by the research institutes TITK, UH and PTS. 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 showed different effects on the viscosity of xylan-starch blends. First results suggest that the varying viscosity characteristics are caused by two effects: the presence of ferulic acid and of enzymes as contaminant in xylan. The research work currently focuses on clarifying these issues.

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

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Research area: Product aims

Paper, paperboard and board //
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 RTD project IGF 18876 BG is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi) and is carried out in collaboration with Prof. Sadlowsky, BFSV Hamburg.

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Forschungsgebiet: Produkt-Ziele

Papier, Karton und Pappe // Verpackungspapiere und -karton

Schlagworte:

Planlage, z-Richtung, Biegesteifigkeit, Elastizitätsmodul, Faserorientierung

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

Background/Problem Area

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

Objective/Research Result:

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

Unfortunately it has been observed that the age of the adhesive on the polymer foils use for sheet splitting influences the quality of splitting. Therefore, a wide range of preliminary tests had to be carried out to deal with this problem.

Now papers with good and bad curling behaviour are compared to see whether a difference in distribution of stiffnees properties in z-direction may be observed,

Hopefully the results can be used to predict curl behaviour with mathematical modelling.

Application/Economic Benefits:

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

Project Period: 01.05.2015 – 31.12.2016

Remarks:

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

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Forschungsgebiet: Produkt-Ziele

Papier, Karton, Pappe // Verpackungspapiere und -karton

Schlagworte:

Zellulose, nachwachsende Rohstoffe, Verpackungen, Barrieren

Thema:
Funktionelle Schichten aus streichfähiger Zellulose

Ausgangssituation/Problemstellung

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

Forschungsziel/Forschungsergebnis

Im Projekt wurden streichfähige, transparente Zellulosesuspensionen ohne Zusatz von Chemikalien bzw. chemische Additive für die Herstellung von Verpackungsmaterialien mit Barriereeigenschaften gegenüber Mineralölen, Fetten, Flüssigkeiten und Gasen aus nachwachsenden, zellulosebasierten Rohstoffen entwickelt. Da die in der Papierindustrie angewendeten papiertechnologischen Beschichtungsverfahren wie Streichen bzw. Sprühen der nano- bzw. mikroskaligen Zellulosesuspensionen sich trotz Umbau der Labor-Streichanlage nicht vollends auf den Labormaßstab übertragen ließen, wurde eine Alternative durch Kaschieren der Barriereschicht aufgezeigt. Durch Modifikation bzw. eine spezielle Behandlung der Zellulose durch extreme Mahlung (Fibrillierung) und durch Zugabe von geeigneten biologischen Hilfsstoffen (z. B. Stärke) wurden die Verarbeitbarkeit und die anschließende plastische Verformbarkeit der Barriereschicht erreicht.

Anwendungen/Wirtschaftliche Bedeutung

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

Bearbeitungszeitraum: 01.04.2014 – 30.09.2016

Bemerkungen

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

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Papier, Karton und Pappe // Verpackungspapiere und -karton

Schlagworte:

Kartonherstellung, Trockenverfahren, Wassereinsparung Papierherstellung, Ressourceneinsparung

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

Ausgangssituation/Problemstellung

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

Aus den genannten Gründen stellt sich nicht erst seit den Zeiten stark steigender Energiekosten die Frage, warum nicht auf Wasser verzichtet werden kann, um Papier bzw. Karton in einem Trockenprozess herzustellen. Ein Vorbild für die geplante Entwicklung bietet die Faserplattenherstellung, deren ursprüngliche Produktion im Nassverfahren nahezu vollständig durch umweltfreundlichere Trockenverfahren ersetzt wurde.

Forschungsziel/Forschungsergebnis

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

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

Wesentliche Bestandteile einer solchen Prozesskette sind neben der Trockenzerfaserung die Vlieslegung mit vorheriger Bindemittelzugabe und das anschließende thermische Pressen zu einem Karton. Auch die Abtrennung von Störstoffen und papierfremden Bestandteilen muss durch geeignete trockene Sortier- und Trennprozesse realisiert werden.

Die Entwicklung eines geeigneten Bindemittels stellt dabei eine der größten Herausforderungen 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 den Bindemittelbedarf ein Großteil der Energieeinsparungen im Trocknungsprozess aufgebraucht werden und somit die Betriebskosten des Trockenprozesses in etwa auf dem Niveau des konventionellen Nassprozesses liegen – und nicht wie erhofft deutlich darunter.

Aktuelle 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 (BMWi) aufgrund eines Beschlusses des Deutschen Bundestages gefördert. Das Projekt wird in Kooperation mit der Kartonfabrik Porstendorf GmbH bearbeitet.

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Research area: Product aims

Paper, paperboard and board // Technical speciality papers

Key words:

electromagnetic compatibility, absorption and reflection of microwave radiation

TITLE:
Functional specialty papers for shielding electromagnetic radiation

Background/Problem area

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

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

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

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

It was also possible to disperse absorbing pigments like carbonyl iron, ferrites or absorbing metals, into calcium carbonate based coating colors, as well as in binders without calcium carbonate. These coating colors could be coated using conventional laboratory rods. Furthermore metal pigments could be incorporated into these coating colors, too. Thereafter both types of pigments have been combined in a single absorbing coating layer. In the end the reflective and the absorbing layers have been be combined in an two layer coating system. At last the technical properties, the commercial aspects, as well as the recyclability were analyzed.

Application/Economic benefits

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

An analysis of the estimated costs shows that this type of coating qualifies as an economic alternative to traditional products whose costs range between 15 €/m² and 40 €/m². In comparison to that, the costs of the newly developed coatings range in the area between 3 and 4 €/m². To apply this coatings conventional manufacturing processes can be used, therefore no or at least just small investments are necessary to adapt this technology.

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

Period of time: 01.02.2014 – 31.01.2016

Remarks

The RTD project IGF18055 BR is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Research area: Product aims

Paper, paperboard and board // Technical specialty papers

Key words:

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

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

Background/Problem area

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

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

Objectives/Research results

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

One part of this project is devoted to developing adapted papery materials for core structures, the non-combustibility on the one hand and the mechanical properties on the other hand being the focus for improving the buckling resistance of the core structure as far as the requirements are concerned. Initial material options were produced on a laboratory scale in a pulp screening. In addition to the type of pulps, fillers were also used to influence the micro structure (expand the volume) and thus bending stiffness. Trials for producing a multi-layer material were successfully conducted.

In order to compare the material and potential core properties of these papery materials, novel and enhanced testing devices as well as enhanced constitutive law for numerical simulation have been suggested. It was possible to determine the mechanical parameters and forecast the mechanical behaviour of sandwich cores made of the new materials. By means of these methods, the best material was identified and optimized based on a three layer paper.

Application/Economic benefits

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

Project period: 01.06.2014 – 30.09.2016

Remarks

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

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Research area: Product aims

Paper, paperboard and board // Technical speciality papers

Key words:

highly filled papers, functional papers, convertability

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

Background/Problem area

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

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

Objectives/Research results

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

For the reinforcement of the fibre structure, low amounts of suitable fortification components shall be used together with the formation of additional fibre-fibre-bonds to optimally use the existing fibre framework. Cellulose-based, synthetic and mineral fibres will be used in combination with special binding components, e. g. thermoplastic fibres to construct the "hierarchic fibre network". Additional measures will be necessary to adapt the different production process steps for implementing the newly-developed custom-tailored microstructure. Basic prerequisite in the development work is the transferability to conventional installations of the paper industry without additional investments.

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. Rapid Köthen laboratory sheets were produced with different amounts of cellulose, functional fillers (for the two application areas "fireproof lightweight construction" and "adsorptive filtration") and strength-increasing compounds. The papers were characterized regarding their relevant paper properties (e. g. grammage, residue on ignition, strength properties) and their formability using a laboratory corrugator. In the trials, the herarchical structure concept could be verified. The paper strength – decreased by the high filler contents of > 75 % – could be significantly improved by the use of polymer fibres based on polyamides and polyvinylalcohol. Additional trials were carried out to asses the suitability of fibrillated natural fibres (hemp and flax) for reinforcing purposes as alternative to organic synthetic polymers. The laboratory trials showed a significant improvement of the strength properties and of the formability. Based on the results of the raw material screening, further trials in laboratory scale are being 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. After completion of the trials in laboratory scale, the results 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 – 30.09.2017

Remarks

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

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Research area: Product aims

Paper and paperboard production // Technical specialty paper

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 on-to paper surfaces.

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

Objectives/Research results

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

Important results achieved until now are:

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

Application/Economic benefits

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

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

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

Period of time: 01.04.2015 – 30.09.2017

Remarks

The RTD project IGF-Koop 18696 BR is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi) and is carried out in cooperation with the Leipnitz-Institut für Polymerforschung Dresden e. V.

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Research area: Product aims

Paper, paperboard and board // Technical speciality papers

Key words:

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

TITLE:
3-D-formable wet-laid media

Background/Problem area

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

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

Objectives/Research results

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

Sheet recipes with various contents of Polyamide 6 acting as thermoplastic matrix were developed in lab-scale and tested concerning thermoforming behavior. Also up-scaling of the lab-recipes to the pilot-paper machine was done successfully. As expected strain values for the thermoplastic samples with PA6 are initially higher than for the duroplastic samples with 90% Basalt fibers. The bending behavior is dominated by the amount and the length of the reinforcing fibers. The duroplastic samples with the high basalt content were even too stiff to be measurable. Characterizations concerning the spunlaced samples are still ongoing.

Application/Economic benefits

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

Period of time: 01.04.2015 – 31.03.2017

Remarks

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

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Research area: Product aims

Paper, paperboard and board // Technical speciality papers

Key words:

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

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

Background/Problem area

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

Objectives/Research results

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

PTS successfully developed wet-laid carbon sheets containing between 45 % and 48 % recycled carbon fibers with 50 % to 55 % Polyamide 6 fibers working as a thermoplastic matrix. Also up-scaling to the pilot paper machine was done successfully. At the moment several combinations of wet-laid nonwoven and airlay nonwoven layers into one composite are tested and characterized concerning material properties.

Application/Economic benefits

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

Also most recycled carbon fibre material quantities show a wide fibre length distribution; this provides chances and challenges as well. The chance of this distribution lies in optimizing the fibre distribution in a composite material. Typically, the tension stress in a material is varying in dependence of a component's shade and load application. Thus, layers with higher and lower tension will occur in each component. By applying long fibres in regions with high stress and layers with short fibers in regions with lower stress allows processing a wide distribution of fibre lengths into one optimized reinforcement fabric.

Period of time: 01.04.2015 – 31.03.2017

Remarks

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

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Research area: Product aims

Paper, paperboard and board // Technical specialty papers

Key words:

moulded pulp structuresfunctional 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 initial laboratory-scale trials have been conducted in terms of a material screening designed to characterise retention and dewatering behaviour.

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 German Federal Ministry for Economic Affairs and Energy (BMWi).

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Research area: Product aims

Paper, paperboard and board // Technical speciality papers

Key words:

air filtration, spunlace

TITLE:
Controlling specific properties of paper-based wet laid nonwovens for air filtration by means of hydro-entanglement

Background/Problem area

Filter materials for air filtration are increasingly made from synthetic or glass fibre-based non-wovens rather than paper. The reason is especially their better dust holding capacity, but also new spunbond-technological manufacturing methods making it possible to produce even nanofiber layers by electrospinning, for example. This has led to a much better filtration efficiency. However, the synthetic or glass fibres used also have some disadvantages, for example 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 filters 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 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 tasks 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

For the first round of investigations, various natural and synthetic pulps were procured and characterized. Selection criteria were their adequate processability in the paper machine and possibility to reorient fibres by hydro-entanglement. The suitability of pulps will be determined by laboratory handsheet forming. The pulps will be used individually and after mixing them with functionalized fibrids.

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: 01.01.2016 – 30.06.2018

Remarks

The RTD project IGF-Koop 18981 BR is being funded by German Federal Ministry for 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 speciality papers

Key words:

additives, PCC, MFC, strength

TITLE:
Production of nanocomposites of cellulose and precipitated CaCO3 for the strength control of paper

Background/Problem area

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

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

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

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

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

Objectives/Research results

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

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

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

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

the retention and filler distribution in paper

the impact on paper strength and

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

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

Application/Economic benefits

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

Period of time: 01.11.2014 – 31.12.2016

Remarks

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

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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: 01.04.2016 – 30.09.2018

Remarks

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

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Research area: Product aims

Paper, paperboard and board // Technical speciality papers

Key words:

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

TITLE:
Development of polish agent carrier and adaptive finishing aids

Background/Problem area

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

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

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

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

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

Objectives/Research results

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

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

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

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

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

As a result of the paper technological testing of the first made papers different samples were selected for a further converting to polishing disks. These were tested to their suitability in polishing trials. As a result of the polishing trials promising paper formulations were identified. Based on this in further trials optimized polishing papers were produced. These will be tested in the further course of their polishing effect.

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-KF 2037925WZ4 is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Papier, Karton, Pappe // Technische Spezialpapiere

Schlagworte:

Mikrofluidik, Medizinische Diagnostik, Wasseranalytik

Thema:
Mikrofluidische Papiere

Ausgangssituation/Problemstellung

Der hochporöse Aufbau von Papieren ist im Hinblick auf den kapillargetriebenen Transport von Flüssigkeiten gleichermaßen ein großer Vorteil, wie auch aus wissenschaftlicher Sichtweise heraus eine große Herausforderung, da z. B. viele Aspekte der Benetzung von Papieren, insbesondere durch komplexe Fluide, wie etwa gelöste Polymere, Emulsionen oder Dispersionen, bis heute nur unzureichend verstanden sind. Ein Anwendungsbereich, in dem die Benetzung eine zentrale Rolle spielt ist der gesamte Bereich der Steuerung sehr kleiner Volumina von Fluiden – der Mikrofluidik. Während in der konventionellen Mikrofluidik diese Volumina mittels Pumpen transportiert werden, kann man sich aber auch sehr gut vorstellen für diesen Transport Kapillarkräfte in porösen Medien auszunutzen. Gerade deshalb erfährt in jüngster Vergangenheit der Einsatz von Spezialpapieren in mikrofluidischen Anwendungen, z. B. für die instrumentenlose Diagnostik in der Medizin eine zunehmende Attraktivität und Aufmerksamkeit. So wurden Arbeiten zum Design derartiger Papiere in den letzten knapp 10 Jahren von verschiedenen Gruppen publiziert, jedoch ist dieses Anwendungsfeld noch sehr jung und viele Herausforderungen, wie etwa die effizienten Herstellung von Mikrofluidikkanälen auf Papier und eine kontrollierte, pumpenlose Steuerung eines Fluids in diesen Kanälen, sind bis heute noch nicht effizient gelöst. Neben der medizinischen Diagnostik gibt es viele weitere Anwendungsmöglichkeiten von mikrofluidischen Papieren in analytischen Bereichen, z. B. zum Nachweis von (toxischen) Stoffen in Trink- und Brauchwasser. Auch wenn es hier am Markt bereits etablierte Systeme gibt, so sind diese nach wie vor auf umfangreiches Auswerteequipment angewiesen und in ihrer Genauigkeit und Auflösungsgrenzen oft limitiert, was nicht zuletzt auch intrinsischen Struktur-Eigenschaftsrelationen von Papieren geschuldet ist, aber gerade durch eine fundamentale Kenntnis des Letzteren in Zukunft lösbar erscheint.

Forschungsziel/Forschungsergebnis

„Mikrofluididsche Papiere“ sind am MAP bereits seit 2012 Gegenstand intensiver Forschungsarbeiten, welche teilweise in Kooperation mit dem PMV und der PTS sowie in jüngster Vergangenheit auch mit der Merck KgaA in Darmstadt durchgeführt werden. Im Rahmen von ersten Doktorarbeiten konnten eine Reihe von Ergebnissen erzielt und auch bereits veröffentlicht werden. Details zu diesen Arbeiten können diesen Publikationen entnommen werden [1-4] Die Arbeiten konzentrieren sich einerseits auf fundamentale Fragen im Zusammenhang mit der Imbibition von Fluiden in Papier, wie z. B. welchen Einfluss haben Fasertyp, -länge und -orientierung auf den kapillargetriebenen Transport. Andererseits setzen wir am MAP die von uns entwickelten mikrofluidischen Papiere auch schon in ersten anwendungsnahen Untersuchungen ein. Beispiele reichen hier von der Entwicklung von Papier basierten Chlor-Teststreifen, über Teststreifen zum Nachweis von Tuberkulose bis hin zu Teststreifen, auf denen lebende Zellen als „Sensoren“ immobilisiert sind. Die Arbeiten werden teilweise auch in Kooperation mit der chemischen Industrie durchgeführt, mit dem langfristigen Ziel „Plattformen“ für eine einfache, schnelle und dennoch sehr genaue Analytik auf der Basis von funktionalen Papieren zu ermöglichen.

Anwendungen/Wirtschaftliche Bedeutung

Anwendungen ergeben sich z. B. im Bereich der instrumentenlosen Analytik und point-of-care Diagnostik, zum Aufbau von Papier basierten Mikroreaktoren und intelligenten Filtern. Auch wenn dieses Gebiet zur Zeit noch sehr wenig beforscht ist, so kann man sich im Erfolgsfall aber auch eine wirtschaftliche Bedeutung im Bereich der Spezialpapiere und damit auch neuen Märkten für Papiere mit sehr hohem Wertschöpfungspotential vorstellen.

Bearbeitungszeitraum: seit 2012 − offen

Bemerkungen

Das Projekt wird aus Landesmitteln des Landes Hessen (Grundfinanzierung der TU Darmstadt) sowie aus Mitteln einer seit 2016 bestehenden Kooperation mit der Fa. Merck finanziert.

Publikationen, die im Rahmen des Projekts entstanden sind, können beim Autor angefordert werden.

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Papier, Karton, Pappe // Technische Spezialpapiere

Schlagworte:

Medizinische Diagnostik

Thema:
Merck-Lab@TUD: „Instrumentenlose Diagnostik und Analytik“

Ausgangssituation/Problemstellung

Mit dem Startschuss der thematischen Neuausrichtung des Merck Lab @ TU Darmstadt am 1. Januar 2016, 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. Standort des Gemeinschaftslabors ist der Fachbereich Chemie im Bereich der Makromolekularen Chemie & Papierchemie des Ernst-Berl-Instituts auf dem Campus Lichtwiese.

Seitens Merck arbeitet ein dreiköpfiges Team unter Leitung von Projektleiter Dr. Gerhard 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.

Forschungsziel/Forschungsergebnis

Das Merck Lab @ TU Darmstadt befasst sich 2016 – 2021 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 papierbasierter, mikrofluidischer Systeme in den Anwendungsbereichen Immundiagnostik und Analytik. Hierbei kommen modernste makromolekulare, biotechnologische und drucktechnische Verfahren zum Aufbau und zur Charakterisierung der mikrofluidischen Systeme zum Einsatz. In Analogie zum vorausgegangenen Merck Lab @ TU Darmstadt „Printable Electronics“, baut die neue Ausrichtung auf die fachübergreifende Kooperation von Chemikern, Biochemikern, Biologen und Ingenieuren auf.

Im Bereich der Forschung und Entwicklung sind am Merck Lab im Hinblick auf Papierforschung aktiv die Gruppen MAP und PMV vertreten. Im Bereich MAP werden im Merck Lab neue Strategien für Papierteststreifen (u. a. Chlor-Analytik sowie Peroxidanalytikteststreifen für Krankenhäuser zum Prüfen der Sterilität von Waschlösungen) erforscht. Dabei arbeitet MAP insbesondere sehr eng mit der Abteilung Merck-Milipore zusammen.

Anwendungen/Wirtschaftliche Bedeutung

Anwendungen ergeben sich im Bereich der medizinischen Diagnostik, und der instrumentenlosen Sensorik der für medizinische Zwecke relevante Analyten. Wirtschaftlich kann dieses Feld in Zukunft sehr bedeutsam für eine Reihe von Sparten werden, die dann auch als Kunden für Papierhersteller und -veredler.

Bearbeitungszeitraum: 2016 − 2020

Bemerkungen

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

Weitere Informationen zum Merck-Lab können bei der Forschungsstelle oder bei Dr. Gerhard Schwall, Leiter Merck-Lab @ TUD, gerne angefragt werden.
http://www.chemie.tu-darmstadt.de/forschung_5/mercklab/tudmercklab.de.jsp

PRODUKT-ZIELE

Forschungsgebiet

Endprodukte aus Papier, Karton und Pappe

Druckprodukte
Schachtelprodukte
Wellprodukte
Sonstige

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Research area: Product aims

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

Key words:

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

TITLE:
Phenomena of printing ink cohesion and standardised evaluation options

Background/Problem area

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

Objectives/Research results

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

Sheet-fed offset prints using six different inks were produced on sample papers. Both unprinted papers and the printed and unprinted areas of prints were examined in terms of surface tackiness, surface topography, pore volume and surface elasticity to document the changes caused by printing.

The market offers many different abrasion testers and procedures which differ considerably in instrument design, loading mechanisms, force application and the aids or tools used. Abrasion tests were performed on the test prints by means of selected instruments to investigate the influence of different test conditions. The abrasion resistance was assessed visually, and then by image analysis after scanning the samples.

Application/Economic benefits

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

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

Project period: 1. Juni 2014 – 30. November 2016

Remarks

The RTD project IGF 18234 BG is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi) and is carried out in cooperation with the Fogra Forschungsgesellschaft Druck e. V.

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Research area: Product aims

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

Key words:

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

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

Background/Problem area

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

Objectives/Research results

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

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

For the theses listed above no adequate and systematic research has been carried out so far, so this project addressed the specified context. Regarding their ability to describe the forces (cohesion and adhesion) in printing inks and coatings resulting in failures when creased and folded various methods were investigated: the dynamic mechanical performance of the printed cardboard was determined using DSC, DMA, and Nano indentation; IR spectroscopy was used to determined crosslinking of the printing inks and varnishes. The aim of the project was to predict the suitability of folding box cartons for a certain print job and reveal possible limitations for these prediction.

Application/Economic benefits

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

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

Period of time: 01.01.2014 – 30.06.2016

Remarks

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

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Forschungsgebiet: Produkt-Ziele

Endprodukte aus Papier, Karton und Pappe // Schachtelprodukte

Schlagworte:

Mineralölbarrieren, Barrierebeschichtungen, Rezyklierbarkeit

Topic:
Assesment of Barrier Coated Paper and Board Product Recyclability

Background/Problem Area:

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

Objective/Research Result:

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

In order to evaluate the behaviour of barrier coatings during the recycling process several test methods will then be applied to the enriched process water. Possible test are for example the micro-sticky content according to PMV, the content of extractable components or an agglomeration method, the absorption behaviour on a rotating wire (ARS-Method). The results will be compared to the process water after the first dewatering step. The difference will be the measure for accumulation.

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

For this project two reference products and sixteen products with a barrier coating were collected. Six of them have a barrier against mineral oil. To evaluate the recycling behaviour using existing methods, all products were tested at the PTS according to the PTS-Method RH 021-97 and at the PMV according the EcoPaperLoop-Method 1 “Recyclability Test for Packaging Products (Leaflet, July 2014)”. Furthermore different processes were investigated for modelling the accumulation process of colloidal and solved substances in the process water during the recycling process.

Application/Economic Benefits:

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

Project Period: 01.05.2014 – 30.04.2015

Remarks:

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

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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

In Germany every year about 2,3 million tons of food packing material are made from recycled fibers. 60 % of folding boxes are used in food contact. About 60 % of them are produced with fibers from recycled paper.

According to article 3 of regulation no 1935/2004 for food contact materials no substances are allowed to 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 ensure conformity with the legal requirements, migration from paper has to be analyzed. Different substances or substance groups, such as mineral oil (MOSH/MOAH), diisopropylnaphthaline (DIPN), phthalates (e.G. DBP, DiBP, DEHP) or benzophenone (BzP) have to be analyzed beacause of specific migration limitations. It´s not possible to analyse all migrating substances by instrumental analysis, especially from recycled fibers. The proof of an efficient universal migration barrier is the most simple way.

Objectives/Research results

With the method developed, effiecency? of barriers for food packing materials made from paper and board against a wide range of migrating substances, especially from recycled paper into foodstuff can be determined. Application of the results to real migration into food (stored in contact with barrier materials) can be evaluated.

The requirements for acceptance of the developed test method as branch-internal standard need to be adressed/fulfilled.

Application/Economic benefits

In a statement of the german "Wellpappenverband" currugated board association (VDW) to the topic migration following comment was given:

„…regarding the complex physically 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 relieable test methods for barrier effiecency against migration of „undesired substances“ in general is obvious especially at SME"

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:

corrugated board, glue line quality of corrugated board packaging

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

Background/Problem area

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

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

Objectives/Research results

During the project an objective and physically correct test procedure for evaluating and testing the quality of the bond strength of corrugated board packaging was developed and checked. The new procedure and test unit for evaluating the bond strength of corrugated board packaging is easy to carry out and performs shearing and peeling loadings on the reference block of a corrugated board.

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

The validation of the test control unit shows generally no significant influence on the measurement result. To ensure an optimal comparability, a standardized procedure to measure the bond strength is recommended.

The measuring equipment ensures a simple, fast and safe measurement of the bond strength. The documentation of the damage symptoms and the fracture behavior are important for the assessment.

Application/Economic benefits

The new objective and physically correct measuring procedure for evaluating the bond strength of corrugated board packaging mean the further development and expansion of PTS testing and consultancy services. A distributable version of the test equipment was developed and presented at the DRUPA 2016.

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

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

Period of time: 01.03.2015 – 29.02.2016

Remarks

The RTD project Bayern-IGF1412-0003 is being funded by Bavarian Ministry of Economics, Media, Energy and Technology STMWMET.

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

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Research area: Product aims

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

Key words:

medium density fibreboard, 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 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 convert 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.

The main focus of this project lies on following spheres of activity:

- Development of the necessary know-how for defined and reproducible production of thin MDF with high homogenity and the required basic properties.
- Formulation of a suitable fibre and additive concept and a necessary system configuration in the MDF manufacturing process.
- Development of technological process conditions for the dimensionally stable forming of thin MDF to wave profiles.
- Preparation and characterization of samples of corrugated board made of lightweight fibreboard.
- Studies on the recyclability of thin MDF for use in the packaging sector.

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: 01.07.2015 – 30.06.2017

Remarks

The RTD project IGF-Koop 18980 BR is being funded by German Federal Ministry for 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:

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

TITLE:
New hydrogel structures for wet end starches

Background/Problem area

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

Objectives/Research results

The aim of this project was to combine the advantages of the effect of the solution structure including charges with the advantages of the particulate structure for the development of new wet end additives based on biopolymers. When interacting with the fibre mat, the products combine the effect of surface charge with the effect of anchorage by the filtration of partially swollen structures. The systematic modification of polysaccharides aimed at developing products with high active component effectiveness to guarantee both high retention in the fibre mat and good drainage behaviour in the paper machine. Furthermore, the project focused on the technological implementation of results in industrial practice. The technology for treating the new wet end starches had to be developed as well, since the paper industry has to be provided with a technological solution for incorporating the newly developed wet end starch in the thin stock without destroying the hydrogel character.

Previous investigations had shown that the particle size distribution of starch derivative hydrogels has a significant impact on starch retention and the strength properties of paper. Therefore the systematic adjustment of the average particle size by varying the modification and shear energy to achieve high retention and high strength properties was a main objective. The newly developed starch derivatives were treated at low temperature with an ultra-turrax or rotor/stator machine, and characterized and tested in the lab. Handsheets were formed with salt water (conductivity: 6000 µS/cm). The changed structure and derivatisation of starch were directly related to the drainage behaviour of the pulp, starch retention and strength properties of the handsheets formed. These results provided the basis for the next systematic change in the structure of starch derivatives. The lab treatment of starch derivatives was scaled up to pilot treatment. Optimized starch derivative samples were screened for their effects on drainage, starch retention and paper strength in the pilot paper machine.

Application/Economic benefits

Starch derivative structures were produced by a suitable combination of physical and chemical derivatisation processes of starch polysaccharides in combination with other biopolymers. These derivatives show a reduced swelling tendency even at high salt loads of the circulating paper mill white water, they interact with pulp fibres via mechanical and electro-static forces and strengthen the fibre network of paper sheets during drying by the gelatinization of available residual inner granular starch structures.

Period of time: 01.07.2013 – 30.06.2016

Remarks

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

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Forschungsgebiet: Produkt-Ziele

Endprodukte aus Papier, Karton und Pappe // Wellprodukte

Schlagworte:

Wellpappe, Festigkeit, BCT, Qualitätsüberwachung

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

Background/Problem Area

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

Objectice/Research Result

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

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

A final presentation of the project has been given to the members of the technical committee at the Leipzig-meeting. The final report is going to be published soon.

Application/Economic Benefits

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

Project Period: 01.07.2014 – 31.03.2016

Remarks

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

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Research area: Product aims

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

Key words:

hydroforming, formability, formable paper, formable board, cardboard

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

Background/Problem area

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

The cooperation partners (PMV Darmstadt , PTS Heidenau) agree that shear deformation capability of cardboard is a key factor for controlling formability. Cardboard usually is a multi-layered material. By 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 scale and 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.

In order to investigate the macroscopic fricitional properties of the different paper materials a friction tester has been put into operation. The microscopic examinations are performed with the UST®-measuring unit. With these friction tests, the forces occuring during hydroforming will be determined.

Application/Economic benefits

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

Period of time: 01.06.2015 – 31.05.2017

Remarks

The RTD project IGF18030 BG is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Research area: Product aims

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

Key words:

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. Deep-drawing experiments with the above materials are currently in progress in the VAT facilities.

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. The evaluation of the molded parts was also further developed. There is now a defined method for analyzing the compressive strength and the shape deviation of the cups. A measurement procedure for the surface roughness is still in progress.

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 – 31.03.2018

Remarks

The RTD project IGF18877BR is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi).

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Research area: Product aims

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

Key words:

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

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

Background/Problem area

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

Objectives/Research results

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

The following sub goals are to be achieved:

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

Application/Economic benefits

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

Period of time: 01.07.2014 – 31.12.2016

Remarks

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

PROZESS-ZIELE

Forschungsgebiet
Faserstofferzeugung

Zellstoffherstellung
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Research area: Product 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.

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: 01.04.2016 – 30.03.2018

Remarks

The RTD projekt IGF 19080 BG is being funded by 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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Research area: Product 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 can vary significantly. The process water parameters have a significant impact on deinking potential of recovered paper. The storage of process water can impact both the process water characteristics and the deinking potential of paper for recycling.

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 – 30.06.2017

Remarks

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

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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 recovered paper delivery. Sometimes these "conspicuous" print products are even noticed visually, but the potential risk for the deinked pulp quality cannot be assessed realistic. Therefore, for paper mills a simple and fast analytical technique is missing to determine the deinkability of print products and reject them if necessary.

Objective/Research Result

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

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

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

Application/Economic Benefits

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

Project Period: 01.11.2014 – 31.10.2016

Remarks

The research project INGEDE 14514 is being funded by INGEDE.

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Faserstofferzeugung // Altpapieraufbereitung

Schlagworte:

Altpapier, Überkritische CO_2-Extraktion, Altpapieraufbereitung, Inhaltsstoffe

Topic:
Extraction of Recovered Paper and Recycled Pulp with Supercritical CO_2 ($scCO_2$) – A Possibility for Removing Harmful Substances from Dry Recovered Paper

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 recovered paper. These products can contain organic non-paper substances. Substances, like pentachlorophenol (PCP), polycyclic aromatic hydrocarbons (PAH) or mineral oils, can arise from paper for recycling and printing or paper converting processes and cannot be removed in the stock preparation of paper mills. PMV tested several methods such as flotation or fractionation to remove harmful substances from recovered paper. But all these methods are not sufficient to remove the substances. Problematic is the migration potential of the substances from the produced packaging material in the packed food. So, the existing harmful substances must be monitored regularly. Because of their toxicological properties they need to be removed from the paper for recycling.

Objective/Research Result

With the use of the $scCO_2$-extraction an innovative and efficient method for removing several harmful substances from different types (newspaper, corrugated board, folding boxboard, ...) of paper for recycling (printed and not printed) was investigated. Altogether there was a high variation of harmful substances (type and quantity) in the reference products between and also within the tested product categories (newspaper, corrugated board, ...). For each harmful substance and each product category, the optimum extraction conditions to remove these substances must be determined individually. Therefore, the main engineering fundamentals for process design were developed. The following parameters were varied at the extraction plant: Extraction time, CO_2-amount, Pressure, Temperature and Moisture content of the paper for recycling.

More than 99 % of the non-polar mineral oils can be extracted from newspapers already at 100 bar and 40°C while using a relatively small amount of CO_2. For the extraction of more polar substances like pentachlorophenol, a pressure of 400 bar and a temperature of 90°C are advantageous. The extraction efficiency of polar substances will further be improved by raising the moisture content. Depending on pressure, temperature, amount of CO_2 and dry matter content, except for Bisphenol A, all measured harmful substances can be extracted almost complete.

The extraction further affected the paper properties and process water properties. Depending on the extraction conditions, mostly positive effects on the papermaking process and the environmental impact were observed. Extraction of paper for recycling with $scCO_2$ has for example no influence on fibre properties like fiber length and no significant influence on dewatering properties. There is partially an effect on fiber strength, but a trend can't be seen. Just for newspaper a negative impact on optical properties, resulting in a reduction of 2.8 percentage points of whiteness was observed. Due to the extraction, there was a positive effect on process water properties, resulting in a reduced chemical oxygen demand. Altogether further tests must be performed in order to confirm these results.

However, due to the batch treatment, only a limited amount of paper for recycling can be extracted at one time. To increase the efficiency of this process, continuous extraction in an extruder will be developed in a further project at PMV.

Application/Economic Benefits:

If the extraction with supercritical CO_2 removes all harmful substances from the recovered paper, there will be no limitation to use paper for recycling for paper and board production, especially in the food industry. According to that it might be possible to substitute virgin fibres with paper for recycling in food contacting products.

Project Period: 01.04.2013 – 31.01.2016

Remarks:

The project AiF 17756 N of the research association Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V. is funded by the AiF in the frame of a program for promotion of common industrial research and development (IGF) by German Federal Ministry for Economic Affairs and Energy (BMWi) on basis of a decision of the German Federal Parliament.

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Forschungsgebiet: Prozess-Ziele

Faserstofferzeugung // Altpapieraufbereitung

Schlagworte:

Altpapieraufbereitung, Deinking, Altpapiermischungen, Druckerzeugnisse, Digitaldruck

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

Background/Problem Area:

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

Objective/Research Result:

The aim of the research project is basically the investigation, assessment and modelling of the deinking behaviour of single print products in a recovered paper mixture. First the deinking behaviour of single print products in a one and a two-loop deinking process is analysed. 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 new two-lop process is used to asses deinkability of different print products, including digital print products that are known to fail the European recovered paper Council (ERPC)-Scorecard when asses with the INGEDE 11 method. Additionally, for all print products the natural and artificial ageing behaviour will be assessed. Subsequently the influence of a single print product in the mixture will be described. For this assessment systematic mixtures of various print products will be assembled and deinked. Based on the deinking results of single products and product mixtures models will be developed to describe the behaviour of recovered paper mixtures.

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

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

Application/Economic Benefits:

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

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

Project Period: 01.07.2014 – 30.6.2017

Remarks:

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

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Forschungsgebiet: Prozess-Ziele

Faserstofferzeugung // Altpapieraufbereitung

Schlagworte:

Stickies, Mikro-Stickies, Labormethode, Messtechnik

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

Background/Problem Area:

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

Objective/Research Result:

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

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

Tests with model suspensions from copy paper with self adhesive labels confirm that the proposed technique can agglomerate microstickes in a way that they can be detected with the INGEDE Method 4.

As one of the dominant factors the usage of deinking chemicals could be identified, whereas speed and shape of the used stirrer played a subdominant role. So far evaluations were done by gravimetric measurement. The next steps will be to compare the gravimetric results of the model suspensions to the conventional optical analysis and then proceed to the usage of industrial pulp.

Application/Economic Benefits:

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

Project Period: 01.12.2014 – 31.05.2017

Remarks:

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

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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 CO_2 ($scCO_2$) 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 recovered paper. These products can contain organic non-paper substances like pentachlorophenol (PCP) or mineral oils, which cannot be removed 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 $scCO_2$-extraction was investigated. Depending on pressure, temperature, amount of CO_2 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 $scCO_2$-extraction process, which was analysed in the previous project IGF 17756 N in batch mode. Therefore the basic development for a continuous $scCO_2$-extraction in an extruder will be investigated at the PMV in cooperation with the plastic centre SKZ.

The basic operation principle of the extraction system will be adapted to the continuous process in an extruder. Because no wide-ranging studies are performed for the use of fibre suspensions in extruders yet, at the beginning of this project, fundamental knowledge about conveying and the material behaviour of different paper for recycling products in an extruder are generated. Therefore different extruder concepts will be used.

Based on this knowledge, a suitable extruder concept will be selected and an extruder unit will be designed and built for investigations on a continuous extraction. Then systematic studies will be done to achieve the necessary framework for an effective extraction (for example: capability of building up high pressure, tightness). For the dosage of the $scCO_2$ established equipment can be used. But for discharging the $scCO_2$, which includes the harmful substances after a successful extraction, 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 analysed 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: 01.10.2016 – 31.03.2019

Remarks:

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

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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: 01.02.2016 – 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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Forschungsgebiet: Prozess-Ziele

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 wachsendes Interesse und befindet sich an der Schwelle einer kommerziellen Nutzung *[1-3]*. Im Zuge des SUNPAP Projektes[1] wurden bereits potentielle industrielle Anwendungen wie z. B. die Verwendung als Additiv im Wet-end und in Streichfarben 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 *[4]*. Eine nach wie vor große Hürde bei der kommerziellen Verwendung von MFC ist jedoch der hohe Energiebedarf für deren Herstellung und die damit verbundenen hohen Kosten *[5]*.

Forschungsziel/Forschungsergebnis

Ziel dieses Forschungsvorhabens ist die energetische Optimierung der Herstellung von MFC sowie die Generierung von eigenem Know-how auf diesem Gebiet. Die Optimierung soll im Wesentlichen mit Hilfe einer enzymatischen Vorbehandlung, vorzugsweise vom Typ Endoglucanase, realisiert werden. Vorarbeiten *[4, 6]* haben bereits das hohe Potential einer solchen Vorbehandlung bei der Produktion von MFC aufgezeigt. Ankerfors zeigt beispielsweise die Möglichkeit auf, mit Hilfe von Endoglucanase eine Reduzierung des Energieverbrauches bei der MFC Produktion um 91 % im Vergleich zu früheren Studien zu erzielen. Der Energiebedarf der MFC Herstellung soll für verschiedene Vorbehandlungsintensitäten evaluiert und das resultierende MFC in Anlehnung an Kangas et al. *[7]* hauptsächlich durch eine Kombination von Viskositätsmessungen, Mikroskopie und Transmissionsmessungen klassifiziert werden.

Bisher (Juni 2016) wurden die Arbeitsaufteilung mit der PTS durchgeführt sowie in Abstimmung mit den Industriepartnern zwei Sulfitzellstoffe als Ausgangsmaterialien ausgewählt. Nachdem zunächst eher gröbere MFC-Qualitäten hergestellt werden sollen, erfolgt die Klassifizierung mit Hilfe eines handelsüblichen Fibre Image Analyser. Das für das Vorhaben benötigte Mahlaggregat wurde bestellt und wird voraussichtlich ab September 2016 verfügbar sein.

Anwendungen/Wirtschaftliche Bedeutung

Die Forschungsaktivitäten im Zusammenhang mit MFC konzentrieren sich hauptsächlich in Finnland (KCL, VTT), Schweden (Innventia/KTH), Frankreich (ctp, LGP2) und Japan. Die deutsche Papierindustrie hat trotz ihrer internationalen Bedeutung auf diesem Gebiet bisher wenig vorzuweisen. Im Rahmen des SUNPAP-Projektes wurden bereits einige Anwendungsmöglichkeiten für MFC identifiziert. Diese umfassen die Verwendung von MFC als Rheologie-Modifizierer in Streichfarben, als Festigkeit steigerndes Additiv im Wet-end sowie als Additiv in Beschichtungen mit Barrierefunktion. Eine wirtschaftliche Nutzung von MFC hängt jedoch stark vom Energiebedarf bei der Herstellung ab, weswegen dieser im Rahmen dieses Forschungsvorhabens weiter gesenkt werden soll. Das Projekt soll die Möglichkeiten aufzeigen, mit Hilfe eines kostenoptimiertes Verfahrens mikrofibrillierte Cellulose als neues, vielfältiges Additiv der Papierindustrie zur Verfügung zu stellen. Besonderes Potential wird hierbei im Bereich der Festigkeitssteigerung und Barriereeigenschaften erwartet.

Bearbeitungszeitraum: 01/2016 – 03/2017

Bemerkungen

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

Literatur zu [1] – [7] kann beim Autor nachgefragt werden.

[1] Gefördert durch das siebte Rahmenprogramm zur Finanzierung europäischer Forschung und technologischer Entwicklung der Europäischen Kommission (CORDIS)

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:

cavitation, broke treatment, sonotrode, venturi

TITLE:

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

Background/Problem area

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

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

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

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

Objectives/Research results

Aim of the research project is the use of hydrodynamic and acoustic cavitation effects for efficient desintegration of wet strength paper broke. In that way a new technology alternative for breaking down wet strength paper flocs into single fibers is tested. Suitable working parameters for lab scale devices for acoustic and hydrodynamic cavitation are worked out. Possible side effect can be the reduction of optical brigthener in the final paper by detaching these substances from fibers surface by cavitation effects.

The corresponding effects of acoustic and hydrodynamic cavitation processes will be compared to assess their economic efficiency as basis for future investment decisions. First results showed a fast flake reduction by acoustic and hydrodynamic cavitation.

Application/Economic benefits

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

Project period: 01.07.2015 – 30.09.2016

Remarks

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

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Research area: Process aims

Paper and paperboard production // Stock preparation

Key words:

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

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

Background/Problem area

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

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

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

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

Objectives/Research results

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

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

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

Application/Economic benefits

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

Period of time: 01.01.2014 – 31.12.2016

Remarks

The RTD project IGF 17939 BG is being funded by German Federal Ministry for Economic Affairs and Energy (BMWi) and carried out in cooperation with Fraunhofer Institute for Environmental, Safety, and Energy Technology UMSICHT and Institute of Earth and Environmental Sciencies - Geology University of Freiburg.

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Research area: Process aims

Paper and paperboard production // Stock preparation

Key words:

reactive extrusion, fibre modification, thermoplastic properties, fibre composites

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

Background/Problem area

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

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

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

Objectives/Research results

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

Application/Economic benefits

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

Period of time: 01.02.2015 – 30.06.2017

Remarks

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

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Research area: Process aims

Paper and paperboard production // Papermaking

Key words:

organic conductors, sleekness

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 produc ed 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.

In work package (WP) 2, wet-laid nonwovens were made from selected pulps of WP 1, and their paper physical properties were tested. The pulps came from different preparation stages and were used in various mixing ratios. The use of binders for incorporating inert fibres like basalt and carbon in the paper matrix was analysed. They are necessary to give the wet laids a certain strength for processing them in the paper machine. For this study, it was decided to use a fibrous binder such as PVA fibres.

In WP 3 promising recipes were used for producing wet laid nonwovens by a combination of inclined wire technology and downstream spunclace treatment at the end of the wire section. The spunlace treatment had to be carried out by means of the available equipment, which meant with one jet strip and varying water jet pressures. As a result of the spunlace treatment, significant changes in physical paper properties were observed. The air permeability was increased as expected, which can be attributed to the micro fine perforation by water jets. Z-strength (Scott bond) and dynamic strength (tearing resistance, CD) were increased by more than 100 % compared to untreated papers.

The impregnation behaviour of produced wet laids will be analysed in WP 4. It is intended to evaluate an analysis method which makes it possible to show how the resin absorption can be controlled by means of water jet treatment.

Application/Economic benefits

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

Period of time: 01.04.2015 – 31.03.2017

Remarks

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

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Forschungsgebiet: Prozess-Ziele

Papier- und Kartonherstellung // Papierherstellung

Schlagworte:

Prozesswasser, chemische Additive, Retentionsmittel, Nassfestmittel

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

Background/Problem Area

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

Objective/Research Result

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

Application/Economic Benefits

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

Project Period: 01.01.2015 – 31.12.2016

Remarks:

The research project INFOR 175 is being funded by Kuratorium für Forschung und Technik der Zellstoff- und Papierindustrie im VDP e. V.

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Forschungsgebiet: Prozess-Ziele

Papier- und Kartonherstellung // Papierherstellung

Schlagworte:

Primärfaserstoffe, Überkritische CO_2-Extraktion, Trocknung, Bleiche

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

Background/Problem Area:

Supercritical CO_2 extraction is a widely used technique for many applications: decaffeination of coffee, extraction of hops, herbs, spices; removal of mineral oils from contaminated soils, textile dyeing, impregnation and other processes. Within the last 10 years other interesting research work has been published: Drying of textiles (made of cotton or silk), dewatering of sapwood and others. An ongoing project at PMV deals with the supercritical CO_2 extraction of paper for recycling to remove contaminants as mineral oils and others. In November 2011 CEPI launched the Forest Fibre Industry 2050 Roadmap. As one of the eight breakthrough technology concepts to reduce the fossil-based CO_2 emissions, drying with supercritical CO_2 was pointed out. By using supercritical fluids for drying of pulp and paper a lot of heat and steam could be saved. To take CO_2 in a supercritical state only little energy is required due to the moderate critical point of CO_2 (temperature > 31°C, pressure > 74 bar [7,4 MPa]). $ScCO_2$ shows interesting chemical and physical properties. The viscosity is in the range of the gaseous state, the diffusion coefficient and the density are similar to a liquid matter. Due to these properties $scCO_2$ has a high dissolving power, very interesting penetration and transport properties. In the supercritical state CO_2 has no boundary surface and no interfacial tension. Therefore $scCO_2$ shows outstanding wettability of surfaces and complete diffusion into the pores.

Objective/Research Result:

At PMV a high pressure test rig in lab scale is running for experiments with $scCO_2$. This project has shown the general feasibility to dry virgin pulp with supercritical CO_2 from a dry content of 40 % – 50 % to nearly 100 %. Because of the polarity of $scCO_2$ (nonpolar), the drying potential of polar water is limited. The achieved results reflect the values from the literature, if the present water in the fibre structure is free and can be extracted directly. If the bounded water in the fibre structure is extracted, the drying efficiency decreases. The solubility of water is improved with increasing pressure and increasing temperature and especially the temperature is deciding. For example, the solubility of water in CO_2 (at 400 bar and 90°C) is at the beginning of the drying process around 6 g water in 1 kg CO_2 and decreases with increasing dry content of the sample.

Due to the intensive strain on the fibres during the extraction at high temperatures up to 90°C and high pressure up to 400 bar, the strengths are partially affected. However, a clear trend can't be seen. There is no significant influence on dewatering and fibre properties like the fibre length. The extraction has no effect on the whiteness of the unbleached and bleached pulp, but reduces the whiteness of unbleached TMP. On the other hand, the extraction decreases the chemical oxygen demand in process water of the extracted TMP. A significant influence of extraction on the effectiveness of retention agents and the bleaching behaviour of TMP could not be found.

A first estimation of the needed energy demand shows that drying with $scCO_2$ is at the recent state of research no alternative for the paper industry compared to conventional drying.

Application/Economic Benefits:

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

Project Period: 01.07.2014 – 30.06.2015

Remarks:

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

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Research area: Product aims

Paper and paperboard production // Converting

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: 01.07.2016 – 30.06.2017

Remarks

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

PROZESS-ZIELE

Forschungsgebiet
Weiterverarbeitung

Trennen
Verbinden/Fügen
Umformen
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Forschungsgebiet: Prozess-Ziele

Weiterverarbeitung // Umformen

Schlagworte:

Formteile, Zellulose, nachwachsende Rohstoffe, Umformverfahren

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

Ausgangssituation/Problemstellung

In der Verpackungstechnik haben sich die Packstoffe wie Papier und Karton weltweit besonders in Form von Faltschachteln und Dosen etabliert und sind auch unter dem Aspekt der Umweltfreundlichkeit nicht zu ersetzen. Das mehrdimensionale Umformen von Papier und Karton stellt somit ein interessantes Verfahren dar, um aktuellen Entwicklungstendenzen, wie hohe Stabilität und Formhaltigkeit, Individualität und Flexibilität der Formgestaltung, Rechnung zu tragen und der Substitution des Materials als Rohstoff vorzubeugen bzw. eine Substitution von Kunststoffen in verschiedenen Segmenten zu ermöglichen, in denen es die Anforderungen zulassen.

Aktuell sind die Einsatzmöglichkeiten für zellulosebasierte Formteile beschränkt, da diese entweder die gestellten Anforderungen nicht erfüllen oder aufgrund der Beschränkungen der Umformverfahren in der gewünschten Form oder Größe nicht herstellbar sind. Diese Tatsache führt zu einer eklatanten Lücke bezüglich der notwendigen Materialien und Technologien und damit zu erheblichem Forschungsbedarf in Bezug auf die Verbesserungen der Einsatz- und Nutzungsmöglichkeiten von faserbasierten Formteilen. Mit diesem Projekt soll ein wichtiger Teil dieser Lücke geschlossen werden und zellulosebasierte Formteile innerhalb konkreter Anwendungsbereiche zu vermarktungsfähigen Produkten und Konzepten etabliert werden.

Forschungsziel/Forschungsergebnis

Innerhalb der Projektbearbeitung hat sich relativ früh gezeigt, dass sich ein konkretes Anwendungsbeispiel bzw. Produkt abzeichnet, welches aus dem entwickelten Zellulosematerial gefertigt werden kann. Damit bestand die Möglichkeit, sowohl die Stoffrezeptur, als auch die Urformtechnologie sowie die gesamte Prozesskette sinnvoll zu konkretisieren und zielorientiert zu entwickeln. Mit dieser Festlegung bestand die Ausgangssituation des Projekts bestand darin geeignete Materialien und Prozesse für die Herstellung von 3-dimensionalen Cellulose-basierte Zapfsäulenfilterdeckel zu entwickeln und iterativ zu optimieren. Dabei konnte das ursprüngliche Ausgangsmaterial, welches phenolhaltige Inhaltstoffe besitzt, durch eine nachhaltige Alternativlösung erfolgreich getestet und ersetzt bzw. ergänzt werden.

Anwendungen/Wirtschaftliche Bedeutung

Im Ergebnis ist ein neuer Zapfsäulenfilterdeckel als Produkt entstanden, welches wesentliche Eigenschaftsvorteile gegenüber dem ursprünglichen Produkt hat. Das liegt in erster Linie an einem neuentwickelten Material, welches die Anforderungen erfüllt und zusätzlich deutlich stabiler, umweltverträglicher sowie nicht gesundheitsgefährdend ist. Im weiteren Verlauf bestehen außerordentlich gute Chancen, die zur Markteinführung der neuen Zapfsäulenfilterdeckel notwendigen Arbeiten in Angriff zu nehmen.

Bearbeitungszeitraum: 01.12.2013 – 30.04.2016

Bemerkungen

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

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Forschungsgebiet: Prozess-Ziele

Weiterverarbeitung // Umformen

Schlagworte:

Formteile, Zellulose, 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: 01.05.2016 – 30.04.2018

Bemerkungen

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

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Forschungsgebiet: Prozess-Ziele

Weiterverarbeitung // Umformen

Schlagworte:

Werkstoffverbunde

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

Ausgangssituation/Problemstellung

Ebene multifunktionale metallische und metall-keramische Verbundwerkstoffe mit definierten Funktions- und Strukturmerkmalen gewinnen für verschiedene Anwendungen immer mehr an Bedeutung. So wird z. B. intensiv an ihrem Einsatz als Membranen in der Umwelttechnik gearbeitet, da sie die notwendigen funktionellen Anforderungen bei hoher Schadenstoleranz erfüllen. Solche Verbundwerkstoffe sind bisher nur sehr aufwendig und mit Blechdicken bis min. 0,3 mm herzustellen.

Inhalt des Forschungsvorhabens ist es, die Herstellung von Metall-Keramik-Endlosfolien (Grünfolien) über einen massentauglichen papiertechnologischen Fertigungsprozess zu demonstrieren sowie für ausgewählte Werkstoffkombinationen eine effiziente Verfahrenstechnik zu entwickeln.

Forschungsziel/Forschungsergebnis

Versuche zeigten, dass es mit papiertechnologischen Verfahren möglich ist, metallische Schichten auf Keramikschichten zu applizieren. Dabei können funktionelle Verbundwerkstoffe im Bereich weniger Mikrometer hergestellt werden.

Die gefertigten Grünfolien wurden in einem weiteren Verarbeitungsschritt umgeformt und anschließend einer Co-Sinterung unterzogen.

Vorteile gegenüber der etablierten Technologie zur Herstellung von großflächigen keramischen Bauteilen sind:

- Verringerung der Dicke bis auf 0,05 mm – 0,2 mm
- 50 % – 75 % weniger Materialeinsatz
- Steigerung des Abscheidegrades
- effizientere Fertigung durch die Nutzung vorhandener Produktionstechnik.

Für mitschwindende Sinterunterlagen (MSU) ergibt sich eine Verbesserung der Formstabilität von keramischen Bauteilen beim Sinterprozess.

Anwendungen/Wirtschaftliche Bedeutung

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

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

Bearbeitungszeitraum: 01.12.2014 – 31.05.2017

Bemerkungen

Das Projekt wird in Kooperation mit dem Fraunhofer Institut für Keramische Technologien und Systeme (IKTS) bearbeitet.

Bundesministerium für Wirtschaft und Energie

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

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Research area: 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 colours we focus on the applicaton 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 fiels 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: 01.01.2016 – 30.06.2018

Remarks

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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 modifies binders it should be possible to reduce the amount of binder to obtain the same properties in barrier or injekt 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: 01.01.2016 – 30.06.2018

Remarks

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

PROZESS-ZIELE

Forschungsgebiet
Messen/Steuern/Regeln im Prozess

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Research area: Process aims

Process measuring and control technology

Key words:

analytics, analytical methods, mineral oil, monitoring

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

Background/Problem area

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

Objectives/Research results

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

- WP1: Drawing up a requirements profile as the basis for assessing any eligible methods
- WP2: Literature searches for potentially suitable methods
- WP3: Collection and evaluation of the search results
- WP4: Determination of benchmark figures for the technical implementation of correspondingly suitable measuring instruments

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

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

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

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

In the course of the literature searches, many mobile devices were found that are easy and simple to handle and already contain the three basic components listed above.

In the course of the project work several suppliers of measuring devices were selected and contacted. With selected devices of these suppliers test measurements were conducted using paper samples analysed for their mineral oil content by conventional gas chromatographic method. The results are evaluated at the moment. It becomes apparent that themoextraction methods coupled with gas-chromatographic detection could be the wanted solution.

Application/Economic benefits

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

Period of time: 01.04.2015 – 31.03.2016

Remarks

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

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Research area: Process aims

Process measuring and control technology

Key words:

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

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

Background/Problem area

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

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

Objectives/Research results

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

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

A fast software-based evaluation of the results out of raw data as well as a visualisation have been made. Based on one-dimensional and two-dimensional deformed paper samples comparisons of THz data and deformation pattern could be performed. Finally 3-dimensional samples were measured. Action have been taken to make the measurement more fast and insensitive against mechanical influences. Last steps had been the unification of deforming processes and THz measurement to get internal stress state date while stressing the material.

Application/Economic benefits

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

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

Project period: 01.11.2014 – 31.10.2016

Remarks

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

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Research area: Process aims

Process measuring and control technology

Key words:

quality monitoring, defect detection, web inspection

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

Background/Problem area

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

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

Objectives/Research results

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

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

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

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

Application/Economic benefits

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

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

Period of time: 01.08.2014 – 31.12.2016

Remarks

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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 finishing 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 is 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 (microformation)
- 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.) must be determined on one and the same measuring surface or part of the measuring surface to identify interactions. To fully utilise the advantages of the new measurement device, it is necessary to generate a data base of structural paper characteristics for the device as well as for competitive products within the scope of this research project.

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 typographical tests are about to be completed. To be able to compare the evaluation results of the new device with those of commercially available single-parameter devices (measuring just one characteristic), the topography of papers was comprehensively assessed also by optical methods.

Application/Economic benefits

The fast and reproducible identification of important paper characteristics is a key prerequisite for modern 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: 01.04.2014 – 31.03.2016

Remarks

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

QUERSCHNITTS-ZIELE

Forschungsgebiet
Energie

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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.

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: 01.05.2016 – 30.04.2019

Remarks

The RTD project BMBF ‘ElektroPapier’ is being funded by 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)
- Koehler Greiz GmbH & Co. KG
- Papiertechnische Stiftung (PTS)
- Technische Universität Braunschweig/Institut für Ökologische und Nachhaltige Chemie (IÖNC)
- Technische Universität Braunschweig/Institut für Siedlungswasserwirtschaft (ISWW)

QUERSCHNITTS-ZIELE

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Umwelttechniken

Wasser
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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 should be devoted to studying the practicability of the co-fermentation of paper technological sludges by laboratory testing. For this purpose, the batch trials should be 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. In addition, there are also issues concerning the practicability and handling of the paper sludges being used. In addition, the mineral oil and the fluorinated compounds (PFC) content in the deinking sludges to be used should continue to be observed. These measures are intended to ensure the scale-up of the process to large-scale production in a conventional MBA.

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 primary and secondary 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: 01.04.2016 – 31.03.2017

Remarks

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QUERSCHNITTS-ZIELE

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Research area: General aims

Resource saving

Key words:

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

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

Background/Problem area

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

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

Objectives/Research results

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

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

Application/Economic benefits

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

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

Period of time: 01.11.2013 – 31.10.2016

Remarks

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

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Research area: 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 show, that starch introduced in the process water by paper for recycling can be preserved for the duration of paper production (approx. 2 to 5 hours) by suitable methods to become usable as recycled starch and substitute for fresh starch in surface starch and corrugated board adhesive production.

In this context, it has yet to be investigated how process water ingredients – especially starch – must be treated and separated to become usable as recycled materials (starch) for surface treatment or corrugated board adhesives. To improve the methods and approaches already available for this, the following questions must be answered:

- Are the chemicals and methods investigated so far capable of preventing starch metabolism in process waters for significantly longer periods than the present 2 to 5 hours? To be usable as surface starches or in corrugated board adhesives, starches must be stabilized for one day. This time is necessary to recover them from process waters and preserve them for further processing and use.
- Is it possible to use the positive – i.e. inhibitory and preserving – effects of tannin also in the paper industry? The production of food and wood materials involves many similar processes and media - it is therefore likely that some of them could be modified and transferred to paper production.
- Which process is capable of removing the process water for starch accumulation in an economically efficient and technically feasible way? Are fines and impurities detrimental to starch recycling? Is it necessary to separate the ingredients into single fractions?
- How much recycled starch can be substituted for fresh starch in surface starches and corrugated board adhesives without quality losses?
- How must recycled starches be treated and preserved to meet all relevant requirements?

Objectives/Research results

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

To begin with, it is hypothesized that:

- starches introduced by paper for recycling are capable of replacing fresh starch in surface starches or corrugated board adhesives without thermal or chemical modification,
- it is possible to treat starches introduced by paper for recycling to prevent them from being destroyed by microorganisms until they will be removed from process waters,
- other process water ingredients can be separated by fractionating filtration prior to recycled starch use, because water reduction is a key prerequisite for the usability of recycled starch
- tannin, being a natural raw material that is capable of preserving and cross-linking substances like starch, holds the key to practically feasible formulations for surface starch products and corrugated board adhesives based on recycled starch.

The first 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.

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

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