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**NASLEDNJA STRAN
PAPIRJA**
THE NEXT PAGE
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Programski in organizacijski odbor za pripravo 29. Dneva slovenskega papirništva:
Petra Prebil Bašin, GZS, Združenje papirne in papirno predelovalne industrije, Ljubljana
Ana Sotlar, Papirnica Vevče d.o.o., Ljubljana
Maruška Cerar Bebar, Muflon d.o.o., Radeče
Gregor Lavrič, Inštitut za celulozo in papir, Ljubljana
Jan Hočevar, Univerza v Ljubljani, Fakulteta za kemijo in kemijsko tehnologijo, Ljubljana
Marko Jagodič, Društvo inženirjev in tehnikov papirništva Slovenije, Ljubljana

Program and Organisation Committee of the 29th International Meeting of Slovene Paper Industry:
Petra Prebil Bašin, GZS, Paper and Paper Converting Industry Association, Ljubljana
Ana Sotlar, Papirnica Vevče d.o.o., Ljubljana
Maruška Cerar Bebar, Muflon d.o.o., Radeče
Gregor Lavrič, Pulp and Paper Institute, Ljubljana
Jan Hočevar, University of Ljubljana, Faculty of Chemistry and Chemical Technology
Marko Jagodič, Pulp and Paper Engineers and Technicians Associations, Ljubljana

Programski odbor 52. Mednarodnega letnega simpozija DITP
Marko Jagodič, Društvo inženirjev in tehnikov papirništva Slovenije, Ljubljana (SI)
Gregor Lavrič, Inštitut za celulozo in papir, Ljubljana (SI)
Rok Šuštar, Papirnica Vevče, Ljubljana (SI)
Ulrich Hirn, Graz University of Technology, Institute of Bioproducts and Paper Technology, Graz (AT)
Wolfgang Bauer, Graz University of Technology, Institute of Bioproducts and Paper Technology, Graz (AT)

Program Committee of the 52st International Annual Symposium DITP:
Marko Jagodič, Pulp and Paper Engineers and Technicians Association, Ljubljana (SI)
Gregor Lavrič, Pulp and Paper Institute, Ljubljana (SI)
Rok Šuštar, Papirnica Vevče, Ljubljana (SI)
Ulrich Hirn, Graz University of Technology, Institute of Bioproducts and Paper Technology, Graz (AT)
Wolfgang Bauer, Graz University of Technology, Institute of Bioproducts and Paper Technology, Graz (AT)

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STRAN 1: NOVE REŠITVE NA PODROČJU PROIZVODNJE PAPIRJA

PAGE 1: NEW PAPERMAKING SOLUTIONS

BIOTEHNOLOGIJA NAMESTO KEMIJE: TRAJNOSTNE REŠITVE ZA UPRAVLJANJE Z VODO V PAPIRNI INDUSTRIJI

Demeter Taraszenko, Lionel Pomade
Servophil AG, Hünenberg, Švica

Podjetje Servophil razvija inovativne rešitve za obdelavo vode v papirni industriji, ki temeljijo na naravnih procesih in uporabi funkcionalnih bakterij. Že več kot šest let se čistilna sredstva S-BACPRO uporabljajo kot alternativa biocidom v vse več aplikacijah za preprečevanje nastajanja organskih oblog v vodnih sistemih. Ti biološki pripravki posnemajo naravne biološke procese ter prinašajo številne prednosti, med drugim manjšo porabo kemikalij, večjo trajnost in večjo varnost za zaposlene ter okolje.

Nedavna študija primera iz papirnice z zaprtim vodnim krogotokom dokazuje velik potencial te biotehnološke rešitve. Po uvedbi novega načina doziranja funkcionalnih bakterij S-BACPRO se je količina organskih oblog občutno zmanjšala, izboljšali sta se čistoča papirnega stroja in stabilnost obratovanja, količina spojin, ki povzročajo neprijetne vonjave, pa se je zmanjšala za do 40 %. Posledično so prenehale tudi pritožbe okoliških prebivalcev. Obdelava z bakterijami je v veliki meri nadomestila predhodno potrebno uporabo oksidativnih kemikalij.

Pomembna prednost tega pristopa je ponovna vzpostavitev stabilnega delovanja vodnih krogotokov, tudi pri velikih proizvodnih obremenitvah. Z ustvarjanjem stabilnega naravnega okolja sistem zagotavlja dolgoročno zanesljivost procesov. Dodatne prednosti vključujejo manjšo porabo kemikalij, manjše potrebe po vzdrževanju, odsotnost tveganja korozije ter večjo varnost tako za zaposlene kot za okoliško skupnost.

Rezultati dokazujejo, kako lahko sodobna biotehnologija v papirni industriji uspešno poveže okoljsko odgovornost z učinkovitostjo obratovanja.

Ključne besede: biotehnologija, upravljanje vode, funkcionalne bakterije, alternativa biocidom, zaprti vodni krogotoki, stabilnost procesov, trajnost.

BIOTECHNOLOGY INSTEAD OF CHEMISTRY: SUSTAINABLE SOLUTIONS FOR WATER MANAGEMENT IN THE PAPER INDUSTRY

Demeter Taraszenko, Lionel Pomade
Servophil AG, Hünenberg, Švica

Servophil has been pioneering nature-inspired solutions for water cycles treatment in the paper industry using functional bacteria. For over six years, the company's S-BACPRO cleaners have been used as an alternative to biocides in an increasing number of applications to prevent organic deposits in water systems. By mimicking natural biological processes, these bio-based treatments offer clear advantages, including reduced chemical use, improved sustainability, and enhanced safety for operators and the environment. A recent case study from a paper mill with a closed water loop demonstrates the transformative potential of this biotechnology. After introducing a new dosing concept with S-BACPRO functional bacteria, organic deposits decreased significantly, machine cleanliness and operational stability improved, and odor causing compounds were reduced by up to 40%, eliminating complaints from the surrounding neighborhood. The bacterial treatment largely replaced previously required oxidative chemicals. A key benefit of this approach is the restoration of stabilized water circuits, even under high production loads. By promoting a stable, natural environment, the system achieves long-term process reliability. Additional advantages include lower chemical consumption, reduced maintenance needs, no corrosion risks, and increased safety for both personnel and surrounding community. Overall, these results demonstrate how modern biotechnology can successfully align ecological responsibility with operational efficiency in the paper industry.

Key words: Biotechnology, Water Management, Functional Bacteria, Biocide Alternative, Closed Water Loops, Process Stability, Sustainability



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KONCEPT SUHE TRDNOSTI, VKLJUČNO Z MERJENJEM GPAM NA KRAJU SAMEM IN SPREMLJANJEM Z MEHKIMI SENZORJI

Mikko Virtanen

Kemira KTM, Helsinki, Finska

Trdnost je najpomembnejša lastnost embalažnega kartona, saj mora embalaža prenesti obremenitve med transportom in zaščititi izdelek v notranjosti. Stroškovno učinkovito ohranjanje in izboljševanje trdnostnih lastnosti z razpoložljivimi sredstvi predstavlja velik izziv, zlasti v Evropi, kjer se kakovost recikliranih vlaken že več let slabša.

Za premagovanje teh izzivov Kemira ponuja najsodobnejši polimer za izboljšanje trdnosti FennoBond™ 5150E. Gre za GPAM, ki se proizvaja neposredno na lokaciji uporabe in je zasnovan tako, da se adsorbira na površino vlaken tudi v zahtevnih pogojih. Rezultat je običajno 15–20-odstotno izboljšanje SCT-CD (kratkotrajne tlačne trdnosti v prečni smeri).

Občutno povečanje trdnosti pri proizvodnji kartona iz recikliranih vlaken omogoča izdelavo visokokakovostnih vrst kartona ob optimiziranih proizvodnih stroških.

FennoBond™ 5150E se proizvaja v reaktorju na lokaciji uporabe iz polimera PAM, ki ga proizvaja Kemira, in glioksala. Izdelek in pripadajoča oprema za pripravo na lokaciji temeljita na več desetletjih Keminih izkušenj s proizvodnjo GPAM. Rezultat je visokokakovosten in stabilen GPAM, pripravljen na lokaciji, ki ima z 5 % najvišjo vsebnost aktivne snovi na trgu. Visoka vsebnost aktivne snovi omogoča uporabo kompaktnega reaktorja in zmanjšuje porabo sveže vode pri proizvodnji na lokaciji.

Uporaba učinkovite kemije za izboljšanje suhe trdnosti je pomemben korak k stroškovno učinkoviti proizvodnji kartona, vendar ne odpravi velikih nihanj trdnosti, ki nastajajo zaradi spreminjajoče se kakovosti surovin in procesnih pogojev.

Sistem za spremljanje KemConnect Soft Sensor omogoča sprotno napovedovanje vrednosti trdnostnih parametrov, ki so sicer običajno na voljo šele po laboratorijskih meritvah. Mehki senzorji ne temeljijo na neposrednih fizičnih meritvah, temveč uporabljajo obstoječe procesne podatke za napovedovanje vrednosti v realnem času. Njihovi izhodni podatki se lahko uporabljajo za ročno ali avtomatizirano vodenje procesa, s čimer se zmanjšujejo nihanja trdnosti in vrednosti nadzorovano približujejo ciljnim vrednostim.

Ključne besede: embalažni karton, izboljšanje trdnosti, GPAM, FennoBond™ 5150E, reciklirana vlakna, mehki senzorji, optimizacija procesov.

DRY STRENGTH CONCEPT INCLUDING ONSITE GPAM AND SOFT SENSOR MONITORING

Mikko Virtanen

Kemira KTM, Helsinki, Finska

Strength is the most important quality characteristic for packaging board: the packaging needs to be strong enough to endure the strains of transport and protect the product inside. Maintaining and improving strength properties in packaging grades cost-effectively with the available means is a challenging task, and this is especially true in Europe where recycled furnish quality has been deteriorating for years. To overcome these challenges, Kemira is offering state-of-the-art strength polymer, FennoBond™ 5150E. It's an onsite produced GPAM, which is designed to adsorb on fiber surfaces even in the demanding conditions resulting typically + 15 - 20 % improvement in SCT-CD. The significant strength boost in recycled board production is enabling the production of high quality grades with optimized production cost. FennoBond™ 5150E is produced in an onsite reactor from a Kemira-manufactured PAM and glyoxal. The product and the related onsite preparation equipment are developed based on Kemira's decades of experience of GPAM manufacturing, resulting in a high quality and stable onsite GPAM that has the highest actives content (5%) in the market. High actives in the product enables compact reactor size and minimizes freshwater consumption in the onsite production. Use of effective dry strength chemistry is one important step towards cost-effective board production but it doesn't eliminate the big strength variation coming from changing raw material quality and process conditions. KemConnect Soft Sensor monitoring is able to provide instant predictions of strength parameters that are typically only available later from lab measurements. Soft sensors don't rely on physical measurements, but using existing process data to predict values in real time. Soft sensor outputs can be used for both manual and automated control to minimize strength variations and to bring the strength values closer to the target in a controlled manner.

Key words: Packaging Board, Strength Improvement, GPAM, FennoBond™ 5150E, Recycled Fibres, Soft Sensors, Process Optimization.

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APNENEC, MARMOR IN KREDA – OD MINERALNE STRUKTURE DO PIGMENTOV GCC

*Blaž Slabajna, Mateja Černešek, dr. Boris Brus, dr. Saide Umerova
Calcit, Stahovica, Slovenija*

Pigmenti na osnovi kalcijevega karbonata sodijo med najpomembnejše mineralne surovine, ki se uporabljajo v papirni industriji, tako kot polnila kot tudi kot premazni pigmenti. Čeprav se različni izdelki iz kalcijevega karbonata pogosto obravnavajo kot medsebojno primerljivi materiali, pomembne razlike izvirajo že iz samega minerala. Apnenec, marmor in kredo se razlikujejo po geološkem izvoru, kristaliničnosti, strukturi zrn, trdoti, poroznosti in mehanizmi lomljenja. Te razlike posledično vplivajo na obnašanje pri mletju, porabo energije, abrazivnost, reološke lastnosti in optične lastnosti končnih izdelkov iz mletega kalcijevega karbonata (GCC).

Predstavitev ponuja primerjalni pregled mineralov kalcijevega karbonata na makroskopski, mikroskopski in submikronski ravni, pri čemer je poudarek na povezavi med mineralno strukturo in funkcionalnimi lastnostmi, pomembnimi za uporabo v papirni industriji. Delo združuje geološka opazovanja, petrografske analize, preučevanje obnašanja pri suhem in mokrem mletju, načrtovanje lastnosti delcev ter karakterizacijo končnih izdelkov GCC.

Posebna pozornost je namenjena razlikam med sistemi GCC na osnovi apnenca, marmorja in krede. Predstavitev obravnava odziv posameznih mineralov na mehanske obremenitve med mletjem, razlike v njihovih mehanizmi lomljenja ter vpliv teh razlik na morfologijo delcev, amorfizacijo, abrazivnost in obnašanje suspenzij.

Ključne besede: kalcijev karbonat, GCC, apnenec, marmor, kredo, mineralna struktura, mletje, morfologija delcev, papirna industrija.

LIMESTONE, MARBLE AND CHALK – FROM MINERAL STRUCTURE TO GCC PIGMENTS

*Blaž Slabajna, Mateja Černevshek, dr. Boris Brus, dr. Saide Umerova
Calcit, Stahovica, Slovenija*

Calcium carbonate pigments are among the most important mineral raw materials used in the paper industry, both as fillers and coating pigments. Although different calcium carbonate products are often treated as comparable materials, significant differences already originate from the mineral itself. Limestone, marble and chalk differ in their geological origin, crystallinity, grain structure, hardness, porosity and fracturing mechanisms, which consequently influence grinding behaviour, energy consumption, abrasiveness, rheology and optical performance of the final GCC products.

This presentation provides a comparative overview of calcium carbonate minerals from the macro-, micro- and submicron-levels, with emphasis on the relationship between mineral structure and functional properties relevant for paper applications. The work combines geological observations, petrographic analysis, dry and wet grinding behaviour, particle engineering and characterization of final GCC products.

Particular attention is given to the differences between limestone-, marble- and chalk-based GCC systems. The presentation discusses how different minerals respond to mechanical stress during grinding, how their fracture mechanisms differ, and how this affects particle morphology, amorphization, abrasiveness and slurry behaviour.

Key words: Calcium Carbonate, GCC, Limestone, Marble, Chalk, Mineral Structure, Grinding, Particle Morphology, Paper Industry

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STRAN 2: NOVI PRISTOPI IN IZDELKI

PAGE 2: NOVEL APPROACHES AND PRODUCTS

RAZVOJ KOMPETENC Z UPORABO UMETNE INTELIGENCE V CELULOZNI IN PAPIRNI INDUSTRIJI: PRIMER DIGITALNE TRANSFORMACIJE

Vera Hallikainen

Finsko združenje inženirjev za gozdne proizvode, Espoo, Finska

Industrije celuloze, papirja in gozdnega biogospodarstva se soočajo s hitrimi spremembami, ki jih spodbujajo trajnostni cilji, zahteve krožnega gospodarstva, nove tehnologije ter vse večja kompleksnost procesov, materialov in produktnih rešitev. Zaradi teh dejavnikov narašča potreba po zanesljivem in aktualnem tehničnem znanju v industriji, izobraževanju in raziskovanju. Umetna inteligenca se vse pogostejše uporablja kot praktično orodje za podporo temu prehodu, če se uporablja odgovorno in temelji na zaupanja vrednih podatkih.

Predstavitev obravnava, kako lahko digitalna okolja za pridobivanje znanja in učenje, podprta z umetno inteligenco, prispevajo k razvoju kompetenc, sprejemanju odločitev in uveljavljanju dobrih praks na področjih, kot so procesi v biorafinerijah, novi materiali in tehnologije, okoljska učinkovitost, ravnanje z odpadki ter uvajanje načel krožnega gospodarstva. Ugotovitve temeljijo na kvantitativnih podatkih iz delujočega digitalnega učnega okolja na področju gozdnega biogospodarstva, dopolnjujejo pa jih praktične izkušnje iz industrijskih, izobraževalnih ter raziskovalno-razvojnih primerov uporabe. Poudarek je na praktični uporabnosti in ne na teoretičnih modelih.

Ključno sporočilo je, da je učinkovitost umetne inteligenca odvisna od kakovosti in preverjenosti vsebin, na katerih temelji. Orodja umetne inteligenca, ki črpajo iz strokovno pregledanega tehničnega znanja, omogočajo zanesljiv dostop do kompleksnih informacij o procesih, materialih, emisijah in krožnih rešitvah. Predstavitev prikazuje, kako lahko takšna orodja podpirajo vseživljenjsko učenje, izboljšajo dostopnost znanja za mednarodno in multidisciplinarno občinstvo ter krepijo odgovorne inovacije in izobraževanje v industriji celuloze, papirja, embalaže in biorafinerij.

Ključne besede: umetna inteligenca, digitalno učenje, upravljanje znanja, gozdno biogospodarstvo, industrija celuloze in papirja, krožno gospodarstvo, trajnost, razvoj kompetenc.

AI-ENABLED COMPETENCE DEVELOPMENT IN THE PULP AND PAPER INDUSTRY: A DIGITAL TRANSFORMATION CASE

Vera Hallikainen

Finsko združenje inženirjev za gozdne proizvode, Espoo, Finska

The pulp, paper and forest-based bioeconomy industries are facing rapid change driven by sustainability targets, circular economy requirements, new technologies, and increasing complexity in processes, materials and product solutions. The drivers are creating a growing demand for reliable, up-to-date technical knowledge across industry, education and research. Artificial intelligence is increasingly being applied as a practical tool to support this transition, provided it is used responsibly and built on trustworthy data. This presentation examines how AI-supported digital knowledge and learning environments can support competence development, decision-making and good practice in areas such as biorefinery processes, new materials and technologies, environmental performance, waste management and circular economy implementation. The insights are based on quantitative data from an operational digital learning environment in the forest-based bioeconomy, complemented by practical experiences from industrial, educational and R&D use cases. The focus is on applied value rather than theoretical models. A key message is that the effectiveness of artificial intelligence depends on the quality and verification of the underlying content. AI tools grounded in expert-reviewed technical knowledge enable reliable access to complex information related to processes, materials, emissions and circular solutions. The presentation demonstrates how such tools can support continuous learning, improve knowledge accessibility for international and multidisciplinary audiences, and strengthen responsible innovation and education in the pulp, paper, packaging and biorefinery industries.

Key words: Artificial Intelligence, Digital Learning, Knowledge Management, Forest-Based Bioeconomy, Pulp and Paper Industry, Circular Economy, Sustainability, Competence Development

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PRIMER OBLIKOVANJA TRAJNOSTNE EMBALAŽE ZA SIBIRSKÉ BOROVNICE

*Tanja Medved, Lana Kastelic, prof.dr. Diana Gregor-Svetec
Naravoslovnotehniška fakulteta, UNI Ljubljana, Ljubljana, Slovenija*

Danes imata celostna grafična podoba in embalaža v agroživilskem sektorju pomembno vlogo pri prepoznavnosti izdelkov. Celostna grafična podoba omogoča jasno predstavitev identitete podjetja, medtem ko embalaža poleg zaščitne funkcije deluje tudi kot pomemben komunikacijski element, saj pogosto predstavlja prvi stik med izdelkom in kupcem. V zadnjih letih se vse več pozornosti namenja tudi trajnostnemu oblikovanju, ki s premišljenimi rešitvami prispeva k zmanjšanju vpliva na okolje. Uredba (EU) 2025/40 o embalaži in odpadni embalaži določa zahteve glede trajnosti v njenem celotnem življenjskem ciklu. Do leta 2030 bo morala biti vsa embalaža zasnovana tako, da bo primerna za recikliranje in da se čim bolj zmanjšata njena teža in prostornina, ob ohranitvi funkcionalnosti. Ekološko oblikovanje, ki vključuje reciklabilnost, večnamenskost in učinkovito rabo materiala, tako postaja ključni element pri načrtovanju embalaže.

Namen raziskave je bil oblikovati prepoznavno in učinkovito vizualno podobo kmetije ter razviti funkcionalno embalažo za pakiranje sibirskih borovnic, ki zagotavlja ustrezno zaščito izdelka in upošteva načela trajnostnega oblikovanja. Razvita je bila celostna grafična podoba za kmetijo Kasthaskap, ki vključuje zaščitni znak, barvno shemo, tipografijo in poslovne tiskovine. Oblikovana vizualna podoba temelji na minimalističnem pristopu in naravnih elementih, ki ustrezno odražajo kakovost pridelka in njegovo naravno pridelavo. Oblikovani in izdelani so bili trije primeri trajnostne embalaže iz dveh vrst nepremazanega FBB kartona, beljenega, z gramaturo 260 g/m² in nebeljenega, rjavega z gramaturo 290 g/m². Embalaže so zasnovane preprosto, v pravokotni obliki, pri čemer se med seboj razlikujejo predvsem v načinu zapiranja in grafični podobi. Za boljše zračenje ima embalaža odprtino v obliki borovnice, ki se vizualno ujema z ostalo celostno grafično podobo kmetije. Embalaže izdelane iz beljenega kartona poleg osnovnih podatkov in simbolov vključujejo tudi dekorativne grafične elemente sibirskih borovnic, medtem ko so embalaže iz rjavega kartona zasnovane bolj minimalistično in vsebujejo zgolj osnovne podatke in logotip. Vse rešitve pa so oblikovane v skladu z načeli ekološkega oblikovanja ter omogočajo preprosto uporabo. Raziskava je pokazala, da je mogoče z ustrezno izbiro materialov in premišljenim oblikovanjem uspešno povezati funkcionalnost, vizualno prepoznavnost in trajnostni pristop.

Ključne besede: celostna grafična podoba, trajnostno oblikovanje embalaže, ekološko oblikovanje, kartonska embalaža, sibirskie borovnice, reciklabilnost, agroživilski sektor

EXAMPLE OF SUSTAINABLE PACKAGING DESIGN FOR SIBERIAN BLUEBERRIES

Tanja Medved, Lana Kastelic, prof.dr. Diana Gregor-Svetec

Faculty of Natural Sciences and Engineering, University of Ljubljana, Slovenia

Today, corporate visual identity and packaging play an important role in product recognition within the agri-food sector. Corporate visual identity enables a clear presentation of a company's identity, while packaging, in addition to its protective function, also serves as an important communication element, as it often represents the first point of contact between the product and the consumer. In recent years, increasing attention has also been devoted to sustainable design, which, through carefully considered solutions, contributes to reducing environmental impact.

Regulation (EU) 2025/40 on packaging and packaging waste defines requirements regarding sustainability throughout the entire life cycle. By 2030, all packaging must be designed to be suitable for recycling and to minimize its weight and volume while maintaining functionality. Eco-design, which incorporates recyclability, multifunctionality, and efficient use of materials, is thus becoming a key element in packaging design.

The purpose of the research was to create a distinctive and effective corporate visual identity for the farm and to develop functional packaging for Haskap berries that ensures adequate product protection while following the principles of sustainable design. A comprehensive graphic identity was developed for the Kasthaskap farm, which includes a logo, color scheme, typography, and business stationery. The designed visual identity is based on a minimalist approach and natural elements that appropriately reflect the quality of the produce and its natural cultivation. Three examples of sustainable packaging were designed and produced using two types of uncoated FBB cardboard: bleached, with grammage of 260 g/m², and unbleached, brown, with grammage of 290 g/m². The packaging is designed simply, in a rectangular shape, differing primarily in their closure mechanisms and graphic design. For better ventilation, the packaging features a blueberry-shaped opening that visually aligns with the farm's overall graphic identity. Packaging made from white cardboard includes decorative blueberry graphics in addition to basic information and symbols, while packaging made from brown cardboard is designed more minimalistically and contains only basic information and the logo. All solutions are designed in accordance with the principles of eco-design and are easy to use. The study demonstrated that, with the right choice of materials and thoughtful design, it is possible to successfully combine functionality, visual recognition, and a sustainable approach.

Key words: Corporate Visual Identity, Sustainable Packaging Design, Ecodesign, Paperboard Packaging, Haskap Berries, Recyclability, Agri-Food Sector

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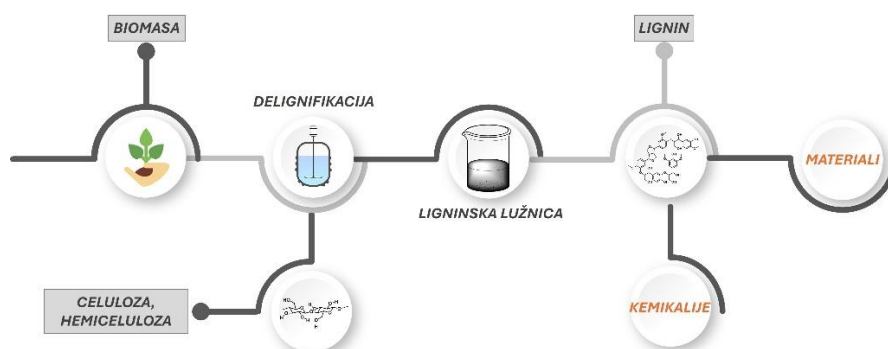
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LIGNIN: NEIZKORIŠČEN KAPITAL PAPIRNE INDUSTRIJE – OD IZOLACIJE DO MODIFIKACIJE

Jan Hočevar, Jelena Papan Djaniš, Jernej Iskra

Fakulteta za kemijo in kemijsko tehnologijo UNI Ljubljana, Ljubljana, Slovenija

Z naraščajočimi zahtevami po trajnostnem razvoju in zelenem prehodu se vse bolj usmerjamo k izkoriščanju obnovljivih virov iz narave za proizvodnjo materialov in kemikalij. Med najpomembnejšimi je biomasa, sestavljena iz celuloze, hemiceluloze in lignina. Lignin, kompleksen aromatski polimer, kljub svoji razširjenosti ostaja v veliki meri neizkoriščen. Na svetovni ravni letno proizvedemo približno 50 milijonov ton lignina, napovedi pa kažejo na znatno povečanje do leta 2030. Kljub temu se danes uporabi manj kot 2 % proizvedenega lignina [1]. Največ ga nastane v papirni industriji, kjer se večinoma sežiga za pridobivanje energije, kar predstavlja nizko dodano vrednost. Takšen pristop spregleda dejstvo, da lignin predstavlja največji naravni vir aromatskega ogljika in ima velik potencial kot surovina za sintezo različnih kemikalij in naprednih materialov (glej sliko). Njegova učinkovita uporaba je zahtevna predvsem zaradi kompleksne in heterogene strukture. Lignin nastane z radikalsko polimerizacijo treh monolignolov, pri čemer se oblikujejo p-hidroksifenilne (H), gvajacilne (G) in siringilne (S) enote, povezane z različnimi etrskimi in ogljik-ogljik vezmi. Med njimi prevladujejo β -O-4 aril etrske vezi, ki pomembno vplivajo na reaktivnost in možnosti razgradnje lignina [2].



Slika: Shema krožnega procesa pretvorbe biomase v uporabne molekule, materiale in kemikalije.

V tej študiji smo raziskali vpliv različnih postopkov delignifikacije in njihovih pogojev na izkoristek ter strukturne lastnosti izoliranega lignina. Lignin smo nato kemijsko modificirali, ga pretvorili v kvantne pike ali nanodelce, mu v strukturo dodali nove funkcionalne skupine oziroma z depolimerizacijo pridobili nizkomolekularne osnovne molekule za nadaljnje procese. Produkto smo celovito okarakterizirali z uporabo 2D HSQC NMR, FTIR ali SEM spektroskopije. Rezultati potrjujejo, da lignin ni le stranski produkt industrijskih procesov, temveč perspektivna surovina za razvoj trajnostnih materialov in kemikalij z visoko dodano vrednostjo.

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LIGNIN: UNTAPPED VALUE IN THE PAPER INDUSTRY – FROM ISOLATION TO MODIFICATION

Jan Hočevar, Jelena Papan Djaniš, Jernej Iskra

Faculty of Chemistry and Chemical Technology, University of Ljubljana, Slovenia

With increasing demands for sustainable development and the green transition, greater attention is being given to the use of renewable natural resources for the production of materials and chemicals. Among these, biomass, composed primarily of cellulose, hemicellulose, and lignin, serves as a key feedstock. Lignin, a complex aromatic polymer, remains largely underutilised despite its widespread availability. Globally, approximately 50 million tonnes of lignin are produced annually, and this amount is projected to increase significantly by 2030. Nevertheless, less than 2% of the lignin produced is currently valorised [1]. The majority is generated in the paper industry, where it is predominantly incinerated for energy, resulting in low added value. This approach overlooks lignin's potential as the largest natural source of aromatic carbon and as a promising raw material for the synthesis of a wide range of chemicals and advanced materials (see Figure). However, its effective utilisation is hindered by its complex and heterogeneous structure. Lignin is formed via the radical polymerisation of three monolignols, yielding p-hydroxyphenyl (H), guaiacyl (G), and syringyl (S) units interconnected through various ether and carbon-carbon linkages. Among these, β -O-4 aryl ether bonds are predominant and play a crucial role in determining lignin's reactivity and degradability [2].

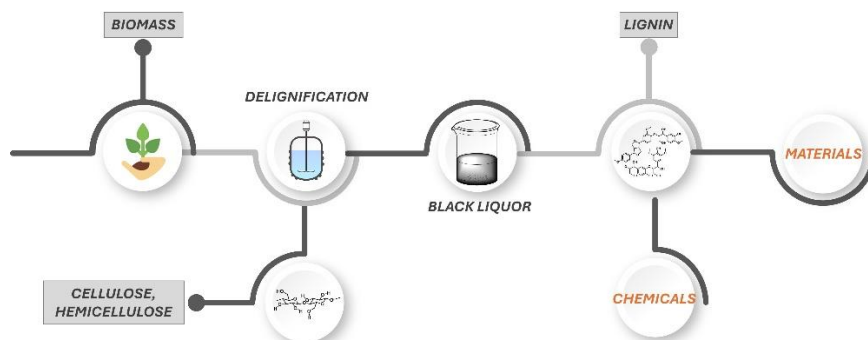


Figure: Schematic illustration of the circular process for converting biomass into value-added molecules, materials and chemicals.

In this study, we investigated the effects of various delignification methods and processing conditions on the yield and structural properties of isolated lignin. The lignin was subsequently chemically modified, converted into quantum dots or nanoparticles, functionalised by introducing new functional groups, or depolymerised to obtain low-molecular-weight platform molecules for further valorisation. The resulting products were comprehensively characterised using 2D HSQC NMR, FTIR spectroscopy, and SEM analysis. The results confirm that lignin is not merely a by-product of industrial processes but a promising feedstock for the development of sustainable materials and high-value chemicals.

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PRIHODNJA ODPORNOST PROIZVODNJE PAPIRJA IN PAPIRNE EMBALAŽE: PRESEGANJE OSNOV

Dr. Igor Karlovits

Inštitut za celulozo in papir, Ljubljana, Slovenija

Spreminjajoče se geopolitične ureditve, ki narekujejo pretok energije in njeno razpoložljivost, spreminjajoče se okolje in podnebje, ki spreminjajo povezane dejavnike tveganja, kot so suše, vročinski valovi in poplave, ter politike, ki obremenjujejo vso proizvodnjo in nestanovitne dobavne verige z dodatno papirologijo in negotovostjo, povzročajo, da se proizvodnja celuloze in papirja premika iz zapletenega v kompleksno situacijsko področje. Proizvodnja papirja in papirne embalaže se odlično odreže pri reševanju zapletenih inženirskih izzivov – optimizaciji OEE, uglaševanju papirnih strojev ter zmanjševanju izgub vlaken in izboljšanju recikliranih vlaken. Vendar pa so podnebne spremembe in ogrožene dobavne verige uvedle kompleksne operativne grožnje, kjer zgodovinski inženirski modeli ne veljajo več. Uporaba umetne inteligence za izboljšanje starih modelov lahko sicer učinkoviteje rešuje težave na operativni ravni, za strateško pa so potrebne nove metrike. Ocena življenjskega cikla (LCA), socialna LCA (S-LCA) in razširjeni ključni kazalniki uspešnosti (KPI) premostijo to vrzel. Z razširitvijo zbiranja podatkov onkraj vrat tovarne in pakirnega obrata ta orodja spreminjajo nepredvidljiva zunanja tveganja v obvladljive inženirske spremenljivke, kar omogoča operativnim ekipam, da proaktivno obravnavajo podnebna tveganja, zaščitijo obratovalna dovoljenja in zagotovijo finančno odpornost tovarne. Ocena življenjskega cikla (LCA) in socialna LCA (S-LCA) sta inženirska diagnostika in ne administrativna dokumentacija. Z razširitvijo zbiranja podatkov onkraj vrat mlina ta orodja nepredvidljiva zunanja tveganja spreminjajo v obvladljive inženirske spremenljivke, kar omogoča operativnim ekipam, da na primer sledijo regionalnemu vodnemu stresu in nestanovitnosti biomase gorvodno, da prilagodijo parametre proizvodnje celuloze in zavarujejo oskrbovalne linije, preden motnje dosežejo tovarno. Z uvedbo S-LCA lahko podjetja dokažejo odgovorno souporabo virov, zaščitijo dovoljenje za delovanje med regionalnimi sušami ali regulativnimi pregledi. S sledenjem ogljičnega in energetskega odtisa v celotnem življenjskem ciklu za zaščito marž pred dohodnimi davki na ogljik in mandati strank za razogljičenje se bo zagotovila stabilnost denarnega toka. Ta predstavitev bo pokazala, kako preseči osnovne ključne kazalnike uspešnosti, da bi bili v kompleksnem sistemu odporni na prihodnost.

PAPER AND PAPER PACKAGING PRODUCTION FUTURE RESILIENCE: GOING BEYOND BASICS

Dr. Igor Karlovits

Pulp and Paper Institute, Ljubljana, Slovenia

The changing geopolitical setups which dictated energy flows and their availability, changing environment and climate which changes the associated risk factors like droughts, heatwaves and floods and policies which pressurize all production and volatile supply chains with additional paperwork and uncertainty make the pulp and paper production moving from complicated to complex situation domain. Paper and paper packaging production excels at solving complicated engineering challenges—optimizing OEE, tuning paper machines, and reducing fiber loss and recycled fiber improvement. However, climate change and endangered supply chains have introduced complex operational threats where historical engineering models no longer apply. Applying artificial intelligence to enhance the old models while can solve problems more efficiently on the operational level, for strategic one's new metrics are needed. Life Cycle Assessment (LCA), Social LCA (S-LCA), and extended KPIs bridge this gap. By expanding data collection beyond the mill and packaging facility gate, these tools turn unpredictable external risks into manageable engineering variables, enabling operations teams to handle proactively the climate risks, to protect operating permits and ensure mill financial resilience. Life Cycle Assessment (LCA) and Social LCA (S-LCA) are engineering diagnostics, not administrative paperwork. By expanding data collection beyond the mill gate, these tools turn unpredictable external risks into manageable engineering variables, enabling operations teams for example trace regional water stress and biomass volatility upstream to adjust pulping parameters and secure supply lines before disruptions hit the mill floor. By deploying S-LCA companies can demonstrate responsible resource sharing, safeguarding license to operate during regional droughts or regulatory reviews. By track full-lifecycle carbon and energy footprints to protect margins against incoming carbon taxes and client decarbonization mandates will ensure cashflow stability. This presentation will show how to go beyond basic KPIs to be future resilient in a complex system.



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STRAN 3: INOVACIJE NA PODROČJU VLAKEN IN PRIPRAVE SUROVINE

PAGE 3: INNOVATIONS IN FIBERS AND STOCK PREPARATION

OPTIMIZACIJA TKIVA IN ZMANJŠANJE STROŠKOV Z UPORABO ENZIMOV

Thomas Brandenburger

Petrofer GmbH, Hildesheim, Nemčija

Sodobna proizvodnja higienskega papirja se vse bolj sooča z izzivom izboljševanja lastnosti izdelkov ob hkratnem zmanjševanju specifične porabe energije in stroškov, povezanih z vlakni. Procesni dodatki na osnovi encimov predstavljajo tehnološko uveljavljeno možnost za doseganje teh ciljev, zlasti pri dveh pomembnih procesnih operacijah: mletju vlaknin v pripravi papirne mase in razpuščanju izmeta. Prispevek obravnava načela uporabe encimov pri mletju in razpuščanju izmeta ter povzema kazalnike učinkovitosti, pomembne za industrijsko uporabo.

Encimska obdelava pri mletju se običajno izvaja kot nadzorovana predobdelava kemične celuloze pred mehanskim mletjem. Z delnim in selektivnim spreminjanjem površinskih plasti vlaken ter hemiceluloznih struktur lahko pripravki, ki vsebujejo celulaze in hemicelulaze, izboljšajo sposobnost vlaknin za mletje in pospešijo razvoj njihovega vezivnega potenciala pri določeni ciljni stopnji mletja. V praksi to omogoča doseganje zahtevanih nateznih lastnosti pri manj intenzivnem mletju, kar se odraža v zmanjšanju specifične porabe energije za mletje. Dodatni učinki lahko vključujejo povečanje deleža kratkih vlaken in nastajanje finih delcev, spremembe v odvodnjavanju ter izboljšanje mehkobe, kadar se temu ustrezno prilagodi končna stopnja mletja. Objavljene laboratorijske raziskave in študije v industrijskem merilu kažejo, da sta obseg prihrankov energije ter ravnovesje med trdnostjo in mehkobo odvisna od sestave encimskega pripravka, odmerka, reakcijskega časa, temperature in vrste uporabljenih vlaknin. Zato sta ključnega pomena optimizacija posameznega procesa in jasno opredeljena strategija nadzora. Encimsko podprto razpuščanje izmeta je namenjeno učinkoviti ponovni uporabi izmeta, kar je še posebej pomembno pri vrstah higienskega papirja, ki vsebujejo smole za zagotavljanje trajne mokre trdnosti. Snovi za zagotavljanje mokre trdnosti lahko upočasnijo razpadanje vlakninske strukture in zahtevajo uporabo agresivnih oksidativnih ali alkalnih pogojev, ki lahko povzročajo izzive z vidika varnosti, korozije in obremenitve odpadnih voda.

Encimski pristopi k razpuščanju izmeta so usmerjeni v pospeševanje ločevanja vlaken ter skrajševanje časa razpuščanja pri milejših obratovalnih pogojih. S tem omogočajo večji delež ponovne uporabe izmeta ob hkratnem omejevanju negativnih vplivov na kakovost vlaken. V industrijski praksi se učinek dodajanja encimov običajno vrednoti na podlagi ključnih kazalnikov, kot so čas razpuščanja, količina preostalega nerazpuščenega materiala, potrebe po temperaturi in alkalijah ter vplivi na nemoten potek nadaljnjih proizvodnih procesov.

Celovita uporaba encimov pri mletju in razpuščanju izmeta tako predstavlja možnost za zmanjševanje stroškov v proizvodnji higienskega papirja, ki jo je mogoče razširiti na industrijsko raven in ki je povezana z razmeroma majhnim tveganjem, če njeno uvedbo podpirajo laboratorijsko preverjanje za posamezno sestavo vlaknin, nadzorovani industrijski preizkusi in

redno spremljanje ključnih kakovostnih lastnosti, kot so natezna trdnost, mehkoča in prostornina, skupaj s kazalniki porabe energije in ponovne uporabe izmeta.

Ključne besede: encimi, mletje, razpuščanje izmeta, higienski papir, zmanjševanje stroškov.

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TISSUE OPTIMIZATION AND COST REDUCTION THROUGH ENZYME USAGE

Thomas Brandenburger

Petrofer GmbH, Hildesheim, Germany

Modern tissue manufacturing is increasingly constrained by the need to improve product performance while simultaneously reducing specific energy consumption and fiber-related costs. Enzyme-based process aids represent a technically mature option to address these objectives, particularly when applied at two high-impact unit operations: stock preparation refining and broke repulping. This contribution reviews the application logic of refining and repulping enzymes and summarizes industrially relevant performance indicators.

Enzymatic refining is typically implemented as a controlled pre-treatment of chemical pulp prior to mechanical refining. By partially and selectively modifying fiber surface layers and hemicellulosic domains, cellulase- and hemicellulase-containing formulations can increase pulp beatability and accelerate the development of bonding potential at a given refining target. In practice, this enables achievement of required tensile properties at lower refining intensity, translating into reductions in specific refining energy. Secondary effects may include an increased short-fiber fraction and fines generation, changes in drainage behavior, and improvements in softness when the refining endpoint is re-optimized accordingly. Published laboratory and mill-scale studies report that the magnitude of energy reduction and the strength/softness balance depend on enzyme composition, dose, reaction time, temperature, and the underlying pulp type; therefore, process-specific optimization and a clearly defined control strategy are essential.

Enzyme-assisted repulping targets the efficient reuse of broke, with particular relevance for tissue grades containing permanent wet-strength resins. Wet-strength chemistries can reduce fiber disintegration kinetics and require harsh oxidative or alkaline conditions, which may pose safety, corrosion and effluent challenges. Enzymatic repulping approaches aim to accelerate fiber-fiber separation and reduce pulping time under milder operating conditions, thereby supporting higher broke utilization while limiting adverse impacts on fiber quality. In industrial practice, enzyme addition is typically evaluated against key metrics such as disintegration time, residual rejects, temperature/alkali demand and downstream runnability impacts.

Overall, the combined deployment of refining and repulping enzymes constitutes a scalable and comparatively low-risk route to cost reduction in tissue mills, provided that implementation is supported by furnish-specific laboratory screening, controlled mill trials and routine monitoring of critical quality attributes (tensile, softness, bulk) alongside energy and broke utilization KPIs.

Key words: enzymes; refining; repulping; tissue; cost reduction

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TEKSTILNI ODPADKI – KONKURENČEN VIR VLAKEN ZA LEPENKO IN LINER

Dr. Thomas Harter, Alexander Weissensteiner, prof. dr. Ulrich Hirn

Inštitut za bioproizvode in papirno tehnologijo, TU Gradec, Gradec, Avstrija

Naraščajoče količine odpadnega tekstila po uporabi zahtevajo razvoj načinov recikliranja, ki dopolnjujejo obstoječe postopke recikliranja vlaken v nova vlakna. V tej raziskavi je bila ovrednotena predelava odpadnega bombažnega tekstila v vlakna za proizvodnjo papirja z mehanskim razvlaknjevanjem in mletjem. Preučeni so bili vplivi velikosti razrezanih kosov, časa razvlaknjevanja in specifične energije mletja (SBE) na lastnosti vlaken in suspenzije, hkrati pa je bila izmerjena tudi poraba energije pri predelavi. Vlakna, pridobljena iz tekstila, so bila primešana industrijski papirni masi za proizvodnjo kartona in embalažnega kartona, laboratorijsko izdelani listi pa so bili ocenjeni glede na njihove mehanske lastnosti.

Učinkovito ločevanje vlaken je bilo doseženo z uporabo razmeroma grobega razreza in zmernimi časi razvlaknjevanja, kar kaže na široko območje ustreznih procesnih pogojev. Zmesi, ki so vsebovale 30 % vlaken iz tekstila, so dosegle enake ali boljše mehanske lastnosti v primerjavi z industrijsko papirno maso brez dodatka tekstilnih vlaken. Povečevanje specifične energije mletja (SBE) je izboljšalo natezno trdnost, kratkoročno tlačno trdnost, gostoto in modul elastičnosti, vendar je zaradi zgostitve strukture in zmanjšanja debeline lista zmanjšalo upogibno togost. Omejena zgostitev med začetno fazo mletja je pripomogla k ohranjanju upogibne togosti.

Poraba energije, potrebna za doseganje lastnosti vlaken, pomembnih za industrijsko uporabo, je bila primerljiva s porabo pri proizvodnji primarne mehanske celuloze. Ugotovitve kažejo, da recikliranje manj kakovostnega bombažnega tekstila predstavlja dopolnilno možnost predelave, ki bi lahko omogočila preusmeritev znatnih količin odpadnega tekstila v proizvodnjo embalaže.

Ključne besede: odpadni bombažni tekstil, recikliranje tekstila, vlakna za proizvodnjo papirja, mehansko razvlaknjevanje, energija mletja, mehanske lastnosti, embalažni material, krožno gospodarstvo

TEXTILE WASTE - A COMPETITIVE FIBER SOURCE FOR PAPERBOARD AND LINER

Dr. Thomas Harter, Alexander Weissensteiner, Prof. Dr. Ulrich Hirn
Institute of Bioproducts and Paper Technology, Graz University of Technology, Graz, Austria

Increasing volumes of post-consumer textile waste require recycling pathways complementary to fibre-to-fibre applications. This study evaluates the conversion of cotton textile waste into papermaking fibres through mechanical disintegration and refining. The effects of scrap size, defibration time, and specific beating energy (SBE) on fibre and suspension properties were investigated, and processing energy was quantified. Textile-derived fibres were blended with industrial cartonboard and containerboard stock, and laboratory handsheets were assessed for mechanical properties.

Effective fibre separation was achieved using relatively coarse cutting and moderate defibration times, indicating a broad processing window. Blends containing 30% textile-derived fibres exhibited equal or improved mechanical performance compared with industrial stock alone. Increasing SBE enhanced tensile strength, short-span compression strength, density, and elastic modulus, but reduced bending stiffness through densification and decreased sheet thickness. Limited densification during initial refining helped preserve bending stiffness. Energy requirements for achieving industrially relevant fibre properties were comparable to those of virgin mechanical pulp production. These findings demonstrate a complementary recycling route for lower-grade cotton textiles, with potential to divert substantial waste volumes into packaging.

Key words): Cotton Textile Waste, Textile Recycling, Papermaking Fibres, Mechanical Disintegration, Refining Energy, Mechanical Properties, Packaging Materials, Circular Economy



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PODALJŠANA ŽIVLJENJSKA DOBA KOMONENT ZA PRESEJANJE IN PREČIŠČEVANJE

Mr. Kimmo Nurminen¹, dr. Jens Heymer²

¹Aikawa Fiber Technologies, Helsinki, Finland

²Aikawa Fiber Technologies, Montreal, Canada

Predavatelja: Mr. Francois Labbe, Aikawa Fiber Technologies; Michael Kremsner, Flowtec Industrietechnik GmbH

Sortiranje in mletje papirne mase imata ključno vlogo pri doseganju želenih lastnosti papirja in kartona. Močno onesnažena papirna masa lahko pri različnih načinih uporabe predstavlja velik izziv zaradi abrazivne obrabe in zahtev po dolgi življenjski dobi ključnih strojnih komponent.

Novi materiali: površinska obdelava brez kroma za manjši vpliv na okolje

Ustrezna simulacija procesov, optimizacija procesnih parametrov ter uporaba novih naprednih materialov lahko podaljšajo življenjsko dobo komponent, odpravijo različne obratovalne težave ter prinesejo znatne prihranke pri energiji, surovinah in obratovalnih stroških.

- Tradicionalni materiali za stroje, ki se uporabljajo v papirni in celulozni industriji, so se v zadnjih letih le malo spreminjali.

- Novi napredni materiali odpirajo nove možnosti tako pri izbiri osnovnih materialov kot pri površinski obdelavi za večjo odpornost proti obrabi.

AFT DiamondWire® je edinstvena tehnologija, ki zagotavlja vrhunsko zaščito sitnih valjev pred obrabo.

Njene prednosti so odlična odpornost proti obrabi v primerjavi s tradicionalnim kromiranjem, manjši vpliv na okolje zaradi nove tehnologije površinske obdelave, nemoteno in stabilno delovanje sita z manj nenačrtovanimi zastoji ter boljše obratovalne lastnosti skozi celotno življenjsko dobo valja.

Mletje

AFT Finebar® so mlevne plošče za rafinerje, ki vključujejo lastne konstrukcijske rešitve.

Glavne značilnosti tehnologije AFT Finebar® so manjša obraba plošč, duktilno obnašanje materiala prečk ter obdelava vlaken z nizko intenzivnostjo.

Tehnologija AFT Finebar® uporablja difuzijsko spajanje, pri katerem je konstrukcija izdelana s spajanjem materialov namesto z litjem.

Oblika utorov je optimizirana za zmanjšanje mašenja, posebni konstrukcijski materiali pa omogočajo izdelavo ozkih prečk z visoko trdnostjo in dolgo življenjsko dobo.

Ključne besede: sortiranje papirne mase, mletje, odpornost proti obrabi, napredni materiali, površinska obdelava brez kroma, AFT DiamondWire®, AFT Finebar®, optimizacija procesov, energetska učinkovitost

EXTENDED LIFETIME FOR SCREENING AND REFINING PERFORMANCE COMPONENTS

Mr. Kimmo Nurminen¹, Dr. Jens Heymer²

¹Aikawa Fiber Technologies, Helsinki, Finland

²Aikawa Fiber Technologies, Montreal, Canada

Presenters: Mr. Francois Labbe AFT / Michael Kremsner - Flowtec Industrietechnik GmbH

Pulp screening and refining plays an essential role in achieving the desired properties of paper and board products. Highly contaminated furnish can be very challenging for different applications in terms of abrasive wearing and in achieving long lifetime of the performance parts.

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Correct process simulation, optimization of process parameters and novel advanced materials can bring extended lifetime, solve various operational problems and bring significant savings in energy, raw materials and operation costs.

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Key words: Pulp Screening, Refining, Wear Resistance, Advanced Materials, Chrome-Free Surface Treatment, AFT DiamondWire®, AFT Finebar®, Process Optimization, Energy Efficiency



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STRAN 4: MOŽNOSTI ZA VARČEVANJE Z ENERGIJO

PAGE 4: POTENTIALS IN ENERGY SAVINGS

KAKO Z OPTIMIZIRANIMI ČRPALNIMI SISTEMI DOSEGATI ZNATNE PRIHRANKE ENERGIJE

Axel Döring, Stefan Leder
Andritz AG, Graz, Austria

Ozadje in pomen

Zmanjševanje okoljskega odtisa je eden ključnih izzivov za celuložno in papirno industrijo, ki je odgovorna za skoraj 2 % svetovnih industrijskih emisij. Ker se pričakuje, da se bo proizvodnja papirja do leta 2030 povečala, se stopnjujejo tako okoljski kot gospodarski pritiski, zlasti zaradi visokih stroškov energije v energetske intenzivnih panogah, kot je papirna industrija.

Vloga črpalnih sistemov

Centrifugalne črpalke pomembno prispevajo k porabi energije v celuloznih obratih. Sodoben obrat lahko uporablja približno 350 črpalk s skupno instalirano močjo od 30.000 do 40.000 kW. Učinkovitost teh sistemov ni odvisna zgolj od zasnove črpalk, temveč tudi od njihove vgradnje in povezave z drugimi deli obrata, vključno z geometrijo sistema, cevovodi, ventili in obratovalnimi parametri.

Ključni dejavniki, ki vplivajo na porabo energije

1. Izbira črpalk in njihova učinkovitost

- Izbira črpalk z visokim izkoristkom, pri katerih obratovalna točka (pretok in tlačna višina) ustreza točki največjega izkoristka.
- Izogibanje nepotrebnim varnostnim rezervam pri izračunu obratovalne točke.
- Sodobne črpalke ANDRITZ za napajanje dovodnih sistemov pršilnih omar oziroma za čiščenje papirne mase (seriji ASP/FP) dosegajo izkoristek do 93 %, serija procesnih črpalk ACP pa do 91 %.
- Pri aplikacijah z intenzivno obrabo je ključna ustrezna izbira materialov, ki preprečuje prezgodnjo obrabo in zmanjšanje izkoristka.

2. Učinkovitost motorjev in pogonov

- Uporaba motorjev z najvišjim energijskim izkoristkom, kot sta IE4 (Super Premium Efficiency) in IE5 (Ultra Premium Efficiency), ki omogočajo znatno izboljšanje učinkovitosti v primerjavi s standardnimi motorji.

3. Cevovodi in ventili

- Skupna tlačna višina je sestavljena iz statične komponente (višinske razlike in vstopni tlaki) ter dinamične komponente (izgube zaradi trenja v cevovodih).
- Izgube zaradi trenja v cevovodih se povečujejo s pretokom, zlasti pri črpanju papirne mase z višjo koncentracijo vlaknin.
- Optimalen premer cevovodov in skrbna izbira ventilov sta ključna za zmanjšanje izgub in porabe energije črpalk.

4. Strategije krmiljenja črpalk

- Pri črpalkah, ki morajo delovati pri različnih obratovalnih točkah, je z vidika energetske učinkovitosti prednostna regulacija hitrosti pred dušenjem pretoka z ventili ali regulacijo z obodom.
- Regulaciji z obodom se je priporočljivo izogibati zaradi visoke specifične porabe energije.
- Regulacija hitrosti prilagaja pretok s spreminjanjem hitrosti črpalke in tako omogoča optimalno prilagajanje porabe energije trenutnim potrebam.

5. Optimizacija obstoječih sistemov

- Primerjava dejanskih obratovalnih parametrov z izvirnimi izračuni. Večja odstopanja lahko razkrijejo možnosti za prihranek energije.
- Izkoristek črpalk se lahko v življenjski dobi zmanjša za 10–25 %. Zamenjava dotrajanih črpalk lahko zato prinese znatne prihranke.
- Sistematična analiza, ki jo izvedejo strokovnjaki, na primer podjetja ANDRITZ, lahko pomaga prepoznati in uvesti optimizacijske ukrepe, pri čemer se naložbe običajno hitro povrnejo.

Zaključek

Znatne prihranke energije pri proizvodnji celuloze in papirja je mogoče doseči z naslednjimi ukrepi:

- izbiro in vzdrževanjem črpalk ter motorjev z visokim izkoristkom;
- optimizacijo cevovodov in ventilskih sistemov;
- uporabo regulacije hitrosti pri spremenljivih obratovalnih pogojih;
 - rednim pregledovanjem in posodabljanjem obstoječih sistemov.

Ti ukrepi ne zmanjšujejo le emisij in stroškov, temveč tudi povečujejo konkurenčnost podjetij. Strokovna analiza in ciljno usmerjene naložbe v optimizacijo črpalnih sistemov lahko zagotovijo hitro povračilo investicije ter znatne dolgoročne koristi.

Ključne besede: energetska učinkovitost, črpalni sistemi, celulozna in papirna industrija, centrifugalne črpalke, optimizacija procesov, regulacija hitrosti, prihranki energije, trajnost

HOW TO ACHIEVE SIGNIFICANT ENERGY SAVINGS WITH OPTIMIZED PUMPING SYSTEMS

Axel Döring, Stefan Leder
Andritz AG, Graz, Austria

Context & Importance

Reducing the ecological footprint is a critical challenge for the pulp and paper industry, which accounted for nearly 2% of global industrial emissions. With paper production expected to rise by 2030, both environmental and economic pressures are intensifying, especially due to high energy costs in energy-intensive sectors like pulp and paper.

Role of Pump Systems

Centrifugal pumps are central to energy consumption in pulp mills, with a modern facility using around 350 pumps requiring 30,000–40,000 kW of installed power. The efficiency of these systems is influenced not only by pump design but also by integration into the plant, including geometry, piping, valves, and operating parameters.

Key Factors Affecting Energy Consumption

1. Pump Selection and Efficiency

- Use pumps with high efficiency, ensuring the operating point (flow rate and delivery head) is at the best efficiency point.
- Avoid unnecessary reserves in operating point calculations.
- Modern ANDRITZ headbox feed or cleaner pumps (ASP/FP series) achieve up to 93% efficiency; ACP process pumps series reach up to 91%.
- Material selection is crucial for wear-intensive applications to prevent premature wear and efficiency loss.

2. Motor/Drive Efficiency

- Employ motors with the highest energy efficiency (IE 4 => Super Premium Efficiency or even the soon-to-be-released IE 5 => Ultra Premium Efficiency) for significant efficiency gains over standard motors.

3. Piping and Valves

- Delivery head comprises static (height differences, inlet pressures) and dynamic (piping friction losses) components.
- Piping friction losses increase with flow rate, especially when pumping higher-consistency pulp.
- Optimal pipeline diameter and careful valve selection are essential to minimize losses and reduce pump power consumption.

4. Pump Control Strategies

- For pumps serving multiple operating points, speed control is preferred over throttle or bypass control for energy efficiency.
- Bypass control should be avoided due to high specific energy consumption.
- Speed control adjusts flow rate by changing pump speed, offering optimal energy adaptation.

5. Optimization of Existing Systems

- Evaluate real operating parameters against original calculations; significant deviations can reveal energy-saving opportunities.
- Pump efficiency can degrade by 10–25% over its lifetime; replacing aging pumps can yield substantial savings.
- Systematic analysis by specialists (e.g., ANDRITZ) can identify and implement optimization measures, with investments typically paying off quickly.

Conclusion

Significant energy savings in pulp and paper production are achievable by:

- Selecting and maintaining high-efficiency pumps and motors,
- Optimizing piping and valve systems,
- Using speed control for variable operating conditions,
- Regularly reviewing and upgrading existing systems.

These measures not only reduce emissions and costs but also enhance competitiveness. Expert analysis and targeted investments in pump system optimization can deliver rapid returns and substantial long-term benefits.

Key words: Energy Efficiency, Pump Systems, Pulp and Paper Industry, Centrifugal Pumps, Process Optimization, Variable Speed Control, Energy Savings, Sustainability.



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VPLIV ONESNAŽENOSTI SUŠILNEGA SITA NA UČINKOVITOST SUŠENJA: EKSPERIMENTALNA ANALIZA IN PRAKTIČNE REŠITVE ZA ČIŠČENJE

Claus Roberts¹, Nenad Milosavljević²

¹ProJet

²Abo Akademi University

Sušilna sita v papirnih strojih so ključnega pomena za podpiranje papirnega traku in zagotavljanje učinkovitega prenosa toplote med sušenjem. Njihova učinkovitost je v veliki meri odvisna od zračne prepustnosti, ki se med obratovanjem zmanjšuje zaradi kopičenja nečistoč. V tej študiji so s kontroliranimi dinamičnimi preizkusi sušenja primerjali nova in rabljena sušilna sita treh različnih tipov. Rezultati kažejo, da onesnaženje bistveno zmanjša prepustnost sit, kar povzroči nižjo specifično hitrost izparevanja in podaljša čas sušenja.

Za povezavo eksperimentalnih ugotovitev z industrijsko prakso je predstavljena študija primera uporabe sistema za čiščenje sit ProJet. Neprekinjeno čiščenje s sistemom ProJet pomaga ohranjati visoko prepustnost sit in preprečuje kopičenje nečistoč, pri čemer se porabijo le majhne količine vode, stisnjenega zraka in energije. Čista sušilna sita omogočajo boljši izkoristek razpoložljive sušilne zmogljivosti in izboljšujejo celotno delovanje papirnega stroja pri širokem naboru vrst papirja.

Ključne besede: sušilno sito; sušenje na papirnem stroju; prepustnost sita; onesnaženje sita; prenos toplote; učinkovitost sušenja; poraba energije; profil vlage; sistem za čiščenje ProJet; delovanje papirnega stroja; študija primera v industriji.

INFLUENCE OF DRYER FABRIC CONTAMINATION ON DRYING PERFORMANCE: EXPERIMENTAL ANALYSIS

Claus Roberts¹, Nenad Milosavljević²

¹ProJet

²Abo Akademi University

Dryer fabrics in paper machines are essential for supporting the paper web and enabling efficient heat transfer during drying. Their performance strongly depends on air permeability, which decreases as contaminants accumulate during operation. This study compares new and used dryer fabrics of three types using controlled dynamic drying tests rig. Results show that contamination significantly reduces permeability, leading to lower specific evaporation and increasing drying time.

To connect the experimental findings with industrial practice, a case study using the ProJet fabric cleaning solution is presented. Continuous cleaning with the ProJet system helps maintain high fabric permeability, preventing contamination build-up while using minimal water, compressed air, and energy. Maintaining clean dryer fabrics improves available dryer capacity and overall machine performance across a wide range of paper grades.

Keywords: Dryer fabric; Paper machine drying; Fabric permeability; Fabric contamination; Heat transfer; Drying efficiency; Energy consumption; Moisture profile; ProJet cleaning system; Paper machine performance; Industrial case study.



ROBASMART EZ EKOLOŠKI ČISTILEC

Roland Eckerstorfer
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Trajnostna tehnologija čiščenja za največjo učinkovitost in znatne prihranke v proizvodnji papirja

Učinkovitost in trajnost sta v današnji papirni industriji pomembnejši kot kdaj koli prej. Papirnice iščejo možnosti za zmanjšanje stroškov na tono, da bi ohranile svojo konkurenčnost.

Čistilni sistem RobaSmart EZ Eco je inovativna rešitev za neprekinjeno čiščenje sit in sušilnih klobučevin na tissue in papirnih strojih. Z več kot 440 nameščenimi sistemi po vsem svetu, na strojih s širino sita do 11.300 mm in obratovalnimi hitrostmi nad 1.800 m/min, predstavlja preverjeno tehnološko rešitev.

Ključne prednosti čistilnega sistema RobaSmart EZ Eco:

- Zmanjšanje porabe vode do 98 %

V primerjavi s klasičnimi visokotlačnimi pršnimi cevmi in robnimi prhami je mogoče prihraniti do 98 % sveže vode. To lahko pomeni zmanjšanje porabe sveže vode za do 410.000 m³ na leto.

- Znatno zmanjšanje porabe energije

Zaradi visoke učinkovitosti sistema je mogoče odstraniti vse vrste sistemov za odsesavanje meglice, čistilnih komor za sita in podobne opreme. To skupaj z uporabo bistveno manjših visokotlačnih črpalk omogoča zmanjšanje porabe energije do 70 %. Letni prihranki lahko dosežejo 2.200.000 kWh.

- Zmanjšanje porabe kemikalij

Učinkovitost čiščenja omogoča opustitev uporabe kemikalij za pasivacijo.

- Odstranjevanje lepljivih nečistoč

Zaradi bistveno večje učinkovitosti čiščenja glave sistema EZ Eco v primerjavi s klasičnimi visokotlačnimi pršnimi šobami je mogoče odstraniti lepljive nečistoče (stickies). To prispeva k zmanjšanju števila pretrgov papirnega traku.

Sistem uporablja inovativne visokotlačne čistilne glave, ki učinkovito odstranjujejo obloge ter izboljšujejo prepustnost sit in sušilnih klobučevin, pri tem pa ne povzročajo nastajanja meglice. Zasnovan je tako, da v celoti nadomesti vse obstoječe visokotlačne prhe, robne prhe, komore za odstranjevanje meglice in druge sisteme za kondicioniranje strojnih oblog.

Celovita rešitev na ključ

Rešitev vključuje naslednje komponente:

- Edinstvena vrtljiva čistilna glava, ki zagotavlja največjo učinkovitost čiščenja in se uporablja zlasti pri zgornjih formerjih in zgornjih sitih. Vgrajeni vakuumski priključek zagotavlja delovanje brez nastajanja meglice.
- Prečni nosilec iz nerjavnega jekla, zasnovan za dolgo življenjsko dobo.
- Zelo zanesljive visokotlačne črpalke v redundantni konfiguraciji, ki zagotavljajo največjo razpoložljivost sistema ob čim manjši porabi energije.
- Dvojna filtrirna postaja z izjemno kakovostno zasnovo. Posebna funkcija povratnega izpiranja omogoča neprekinjeno delovanje brez potrebe po stalnem nadzoru.
- Avtomatizacija po meri, ki je na voljo kot samostojen sistem ali kot integrirana rešitev v sistemu DCS.

Primer uspešne uporabe

Podjetje International Paper je eden največjih svetovnih proizvajalcev embalaže in upravlja 28 obratov za proizvodnjo celuloze, papirja in embalaže. Na papirnem stroju PM2 v obratu v kraju Mansfield v zvezni državi Louisiana v ZDA uporabljajo tehnologijo čiščenja RobaSmart EZ Eco. Papirni stroj s širino sita 9.600 mm letno proizvede približno 480.000 ton papirja za valoviti srednji sloj (corrugating medium). Obratovalna hitrost dosega do 760 m/min.

Z namestitvijo inovativne tehnologije čiščenja so dosegli naslednje letne izboljšave:

- Prihranek 583.000 m³ sveže vode.
- Prihranek 1.500.000 kWh energije.
- Zmanjšanje števila pretrgov papirnega traku z 2,2 na 1,2.

Povračilna doba naložbe (ROI) je bila krajša od petih mesecev.

Povzetek

S čistilnim sistemom RobaSmart EZ Eco je mogoče doseči znatne prihranke vode in energije, kar zmanjšuje stroške na tono proizvedenega papirja in povečuje konkurenčnost proizvodnje.

ROBASMART EZ ECO CLEANER

Roland Eckerstorfer
Röchling SE & Co. KG

Sustainable cleaning technology for maximum efficiency and significant savings potential in paper production

Efficiency and sustainability are more critical than ever in today's paper industry. Paper mills are looking for possibilities to reduce the costs per ton to remain competitive.

The RobaSmart EZ eco cleaner is an innovative cleaning system for the continuous cleaning of fabrics and felts in tissue and paper machines. With over 440 installations worldwide, on machines up to 11.300 mm wire width and speeds over 1.800 m/min, it is a well-proven technological solution.

Key advantages of the RobaSmart EZ Eco cleaner are:

- **Reduction of water consumption of up to 98%**
Compared to conventional high-pressure shower pipes and edge showers, up to 98% freshwater can be saved. This leads to possible freshwater reductions of up to 410.000m³ per year.
- **Significant energy reduction**
Thanks to its efficiency, all kind of mist-extraction systems, wire cleaning boxes and similar equipment can be removed. This, and the considerably smaller high-pressure pumps can reduce the energy consumption up to 70%. Annual savings of 2.200.000 kWh are possible.
- **Reduction of chemical usage**
The cleaning efficiency allows to eliminate passivation chemicals.
- **Elimination of stickies**
Because of the much higher cleaning efficiency of the EZ Eco cleaner head compared to a conventional HP shower nozzle, stickies can be eliminated. This leads to a reduction of paper breaks.

Using innovative high-pressure cleaning heads, it efficiently removes deposits and improves the permeability of fabrics and felts – without any mist formation. The system is designed to fully replace all existing HP showers, edge showers, mist removal boxes and any other clothing conditioning solutions.

The turn-key solution includes the following components:

- Unique **rotating head** for maximum cleaning efficiency, especially used for top former and top wire installations. Included vacuum connection ensures an absolute mist-free operation.
- Stainless steel **traversing beam** is designed entirely for durability.
- Extremely reliable **High-pressure pumps** in redundant configuration to ensure maximal availability with smallest energy consumption
- Double **Filter station** with unparalleled quality and design. Special back-washing function allows an uninterrupted operation without attention.
- Customized **Automation** – available as stand-alone system as well as integrated into the DCS System

**Success story:**

International Paper is one of the world's largest packaging manufacturer and operates 28 pulp, paper and packaging mills. On its PM2 machine in Mansfield, Luisiana, USA they trust on the RobaSmart EZ Eco cleaner technology.

With a wire width of 9.600 mm, this paper machine produces around 480.000 t of corrugated medium per year. The operating speed is up to 760 m/min.

With the installation of the innovative cleaning technology, following annual improvements were achieved:

- 583.000m³ freshwater savings
- 1.500.000 kWh of energy savings
- Reduction of sheet breaks from 2,2 to 1,2

The ROI of this system was less than 5 months.

Summary:

With the RobaSmart EZ eco cleaner, significant water and energy savings can be realized which is reducing the costs per ton and make the production more competitive.

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TURBO-VAKUUMSKI SISTEM Z MAGNETNO LEVITACIJO ZA STROJE ZA PROIZVODNJO PAPIRJA: PLATFORMA LEVIO IN PRVA EVROPSKA NAMESTITEV V PODJETJU UMKA

Andrea Rodolfi

IBS, Teufenbach-Katsch, Avstrija

Proizvodnja vakuuma predstavlja enega največjih porabnikov električne energije na papirnem stroju. Kljub temu večina papirnic še vedno uporablja sisteme z vodnoobročnimi črpalkami ali zobniško gnanimi turbinami, ki le 40–68 % vhodne energije pretvorijo v uporaben vakuum. Ob tem porabljajo tesnilno vodo in olje ter dosegajo ravni hrupa od 110 do 120 dB.

Predstavitve predstavlja alternativno tehnologijo, ki že deluje v Evropi: turbinski vakuumski sistem z magnetnim lebdenjem, ki se trži pod imenom LEVIO. Rotor s trajnimi magneti se pri visokih hitrostih vrti v sistemu aktivnih magnetnih ležajev, pri čemer neposredni pogon odpravlja potrebo po menjalniku, mazalnem olju in tesnilni vodi. Sistem dosega skupni izkoristek nad 83 %. Magnetni ležaj hkrati deluje kot merilni instrument, saj neprekinjeno meri položaj rotorja z mikrometrsko natančnostjo. Tako se podatki za spremljanje stanja naprave pridobivajo že med njenim običajnim delovanjem.

Osrednji del predstavitve je primer papirnice Umka, kjer je bila avgusta 2026 na kartonskem papirnem stroju za proizvodnjo večslojnega kartona prvič v Evropi zagnana tovrstna naprava. Devet vodnoobročnih črpalk so nadomestili trije sklopi vakuumskih turbin z magnetnim lebdenjem, devet odsesovalnih mest pa so prerazporedili v tri vakuumske nivoje z regulacijo hitrosti.

Rezultati temeljijo na podatkih iz lastnega sistema za vodenje in nadzor procesa (DCS) v papirnici, ne pa na ocenah dobavitelja. Priključna moč sistema se je zmanjšala z 1.233 na 716 kW, kar pomeni 41,9-odstotni prihranek električne energije. Specifična poraba energije se je znižala z 39,2 na 22,7 kWh na tono proizvedenega kartona. Sistem je deloval celo 29 kW pod lastno projektirano vrednostjo.

Ob upoštevanju obratovalnih ur papirnice to pomeni približno 4,1 GWh prihranjene električne energije in 1.240 ton manj emisij CO₂ na leto.

Ključne besede: Energetska učinkovitost, vakuumaska tehnologija z magnetnim lebdenjem, aktivni magnetni ležaji, optimizacija vakuumskega sistema, specifična poraba energije, zmanjšanje emisij CO₂.

MAGNETIC-LEVITATION TURBO VACUUM FOR PAPER MACHINES: THE LEVIO PLATFORM AND THE FIRST EUROPEAN INSTALLATION AT UMKA

Andrea Rodolfi

IBS, Teufenbach-Katsch, Avstrija

Vacuum generation is one of the largest electrical loads on a paper machine, yet most mills still run water-ring or geared-turbine sets that turn only 40–68% of their input into useful vacuum while consuming sealing water and oil and running at 110–120 dB. This presentation introduces an alternative now operating in Europe: a magnetic-levitation turbo vacuum platform, marketed as LEVIO. A direct-drive, high-speed permanent-magnet rotor runs on active magnetic bearings, with no gearbox, no lubricating oil and no sealing water, and reaches above 83% overall efficiency. The bearing is also an instrument: it measures rotor position continuously in micrometers, so condition data arrives as a by-product of running the machine.

The center of the talk is Umka, the first European installation of this technology, commissioned in August 2026 on a three-layer board machine. Nine water-ring pumps gave way to three maglev trains, and nine suction points were regrouped into three speed-controlled vacuum levels. The results come from the mill's own DCS rather than a supplier projection: installed demand fell from 1,233 to 716 kW, a 41.9% saving, and specific energy dropped from 39.2 to 22.7 kWh per ton. The plant ran 29 kW below its own design point. At the mill's operating hours that is about 4.1 GWh and 1,240 tons of CO₂ a year.

Keywords: Energy efficiency, Maglev turbo vacuum technology, Active magnetic bearings, Vacuum system optimization, Specific energy consumption, CO₂ emissions reduction.



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TIP 95 d.o.o.
Cesta na Lenivec 43
6210 Sežana, Slovenia

www.tip95.si

P: +386 5 7302 090
F: +386 5 7302 091
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