

Nordic Pilot Center

Pilot Machine Presentation

ABOUT US

Oy Keskuslaboratorio Ab (KCL) in Espoo, Finland, together with **Fiber-X Finland** in Lappeenranta, Finland, have combined their service offerings and expertise.

At the heart of the collaboration is a vision to promote sustainable development and provide a competitive advantage in the paper, board and biofiber markets.



ABOUT THIS PRESENTATION

This presentation provides an overview of the Nordic Pilot Center's piloting equipment (a combination of KCL and Fiber-X facilities) and the related services available.

For information on Design Engineering & Process Optimization or Training Services, please refer to our other presentations or contact joonas.soikkeli@fiber-x.fi

**Nordic
Pilot
Center**



KCL PILOT FACILITY

Founded in 1916

Approx. 40 employees

Unique set-up of pilot plant, fiber and processing platform, laboratory, and novel bio-materials

Espoo, Finland --> 2025 at Lohja, Finland

**Nordic
Pilot
Center**



FIBER-X PILOT FACILITY

Founded in 2020

Approx. 15 persons

Unique set-up of pilot plant, from stock preparation, paper machine to stock washing.

2000m² “professional playground”

Lemi, Finland

**Nordic
Pilot
Center**



Nordic Pilot Center Machines

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**Nordic
Pilot
Center**

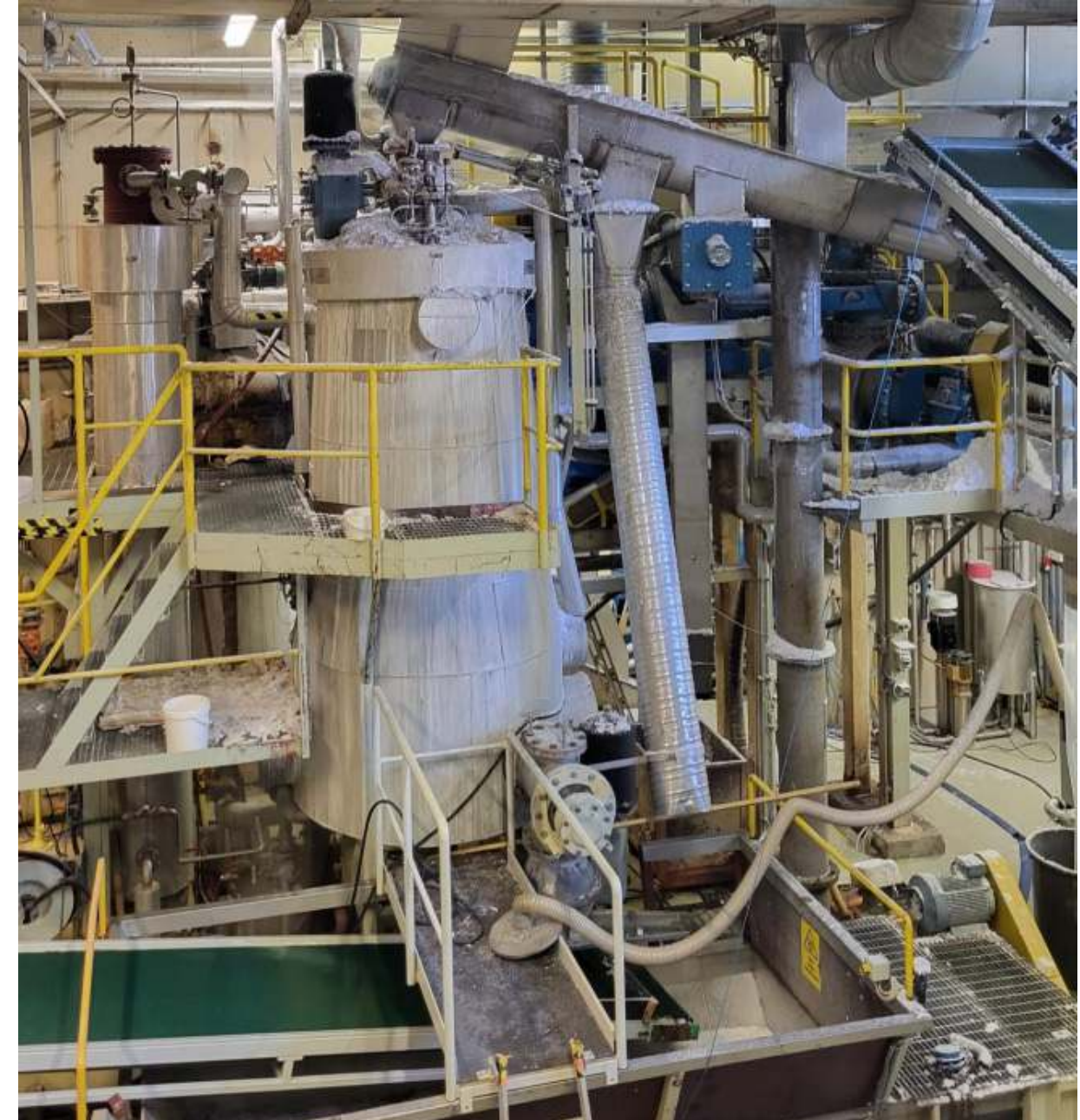
Fiber Processing Services

PRESSURIZED REACTOR SYSTEMS

- Purification and fractionation in high capacity
- Removal of hemicellulose from pulp
- Bleaching of biomass
- Activation of biomass
- Sand/solids removal
- Liquid-solid removal

- 4 m³ pressurized reactor, up to 10 bar (~180°C)
- 300 L pressurized reactor, up to 20 bar (~200°C)
 - Purified water
 - Pressurized reactors and high temperature
 - Basic/acidic activation and removal of impurities
- Drying with or without heat
- Mechanical processing
- Packing and logistics

- Side-stream processing
 - Filtration and control of the waste streams
 - Re-use and recycling of side streams
 - Nano and ultrafiltration
- Disposal of waste



Fiber Processing Services

HIGH-CONSISTENCY REACTOR SYSTEM(S)

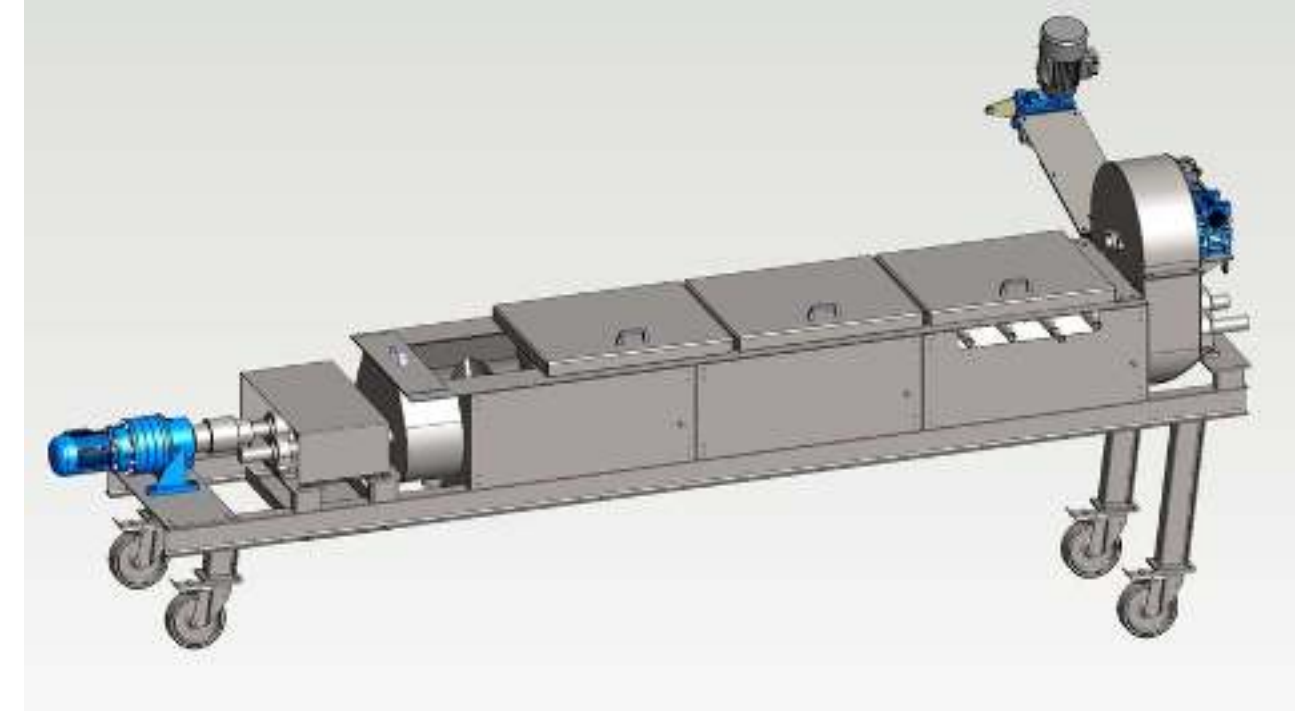
- High-consistency extraction of biomass
- High-consistency continuous drying with gentle conditions

Processing conditions

- Atmospheric
- High consistency
- Continuous or batch possibility
- Heated jacket with steam
- Closed-loop air circulation or atmospheric operation
- Possibility to input chemicals in sectors

Equipment specifications

- Twin-screw reactor type
- 450 L capacity in reactor
- Higher capacity options available (up to 2200 L)



Fiber Processing Services

ATMOSPHERIC PULP TREATING ENVIRONMENT

Processing conditions

- Low consistency (up to 6%)
- Heating with direct steam or liquid-liquid
- heat exchanger
- Alkaline conditions / mild acidic conditions
 - Purified water availability
 - Liquor collection

Equipment

- Pulper (8 m³)
- High storage tank capacity (up to 200 m³)
- Several atmospheric tanks with mixing & heating
- Pressure-screening, solids removal, water removal
- Water removal via pressing
 - Wire-press
 - Screw-press
- Drying with heat
 - Ovens
 - Jacketed continuous heating reactor



Filtration Services

BHS SONTHOFEN BELT FILTER

- **Model:** BHS 10/6.5, suction width 1 m
- **Washing process:** Three-stage suction/dilution, fourth sequence with a steam box
- **Mechanical press:** Adjustable according to the pulp, capable of achieving a drymater of 30 - 42%
- **Production capacity:** 300 - 600 kg/h
- **Washing efficiency:** For instance, achieved pH 6.7 from a pulp at pH 1.2 in a single wash
- **Peroxide/hypochlorite bleaching:** Possible in existing tanks
- **Solvents:** Can withstand natural solvents
- **Daily output:** 1 - 2 tons of pulp, larger quantities may be limited by tank capacity and dilution
- **Maximum process temperature:** 60°C

- **Ability to process and wash a variety of materials, including:**
 - Nanocellulose
 - MFC/MCC (microfibrillated / chrystalline cellulose)
 - Long/short fibers
 - Recycled materials
 - Lignin
- **Separating:**
 - Hemicellulose C5/C6 sugars,
 - Acids
 - Dyes
 - Lignin,
 - Extractives.



Filtration Services

OTHER AVAILABLE EQUIPMENT

- Process liquid separation
- Purification of liquids
- Closing the waste stream loops
- Inhouse analytics and operational analysis
- Data collection
- Processing conditions

Wide variety of conditions

- E.g. temperature, pressure, flow speeds
- Heating possibilities
- Continuous setup or batch
- Diafiltration possibility
- High-pressure filtration
- Ultra and nano filtration, reverse osmosis

Equipment

- Automated filtration system
- Complete setup
- Manual-controlled filtration system
- Customizable setup
- Two pipe modules for different cylindrical membranes



Drying Services

SLOW METHODS | TWIN-SCREW DRYING WITH INDIRECT HEATING | FLUIDIZED BED DRYER

- Drying of material in mild or aggressive conditions
 - With pressure
 - With heat
- Tailored drying to certain DMC
- Possibility to dry without promoting hornification
- Inhouse laboratory analytics

Equipment

- Slow methods
 - Oven(s) in pilot and laboratory scale
 - Circulating air oven
 - Batch
- Fluidized bed drier (small-scale)
 - Batch
- Twin-screw drying with indirect heating
 - Continuous
- Fast methods
 - Paper machine
 - Up to 1000 kg/water removed per hour
 - Equals to tons of dried material per day
 - Continuous



Mechanical Processing Services

JYLHÄ CONFLO 75KW REFINER AND 3 m3 PULPER

Industrial Scale Refiner

- Standard and special blades for different refining segments (short/long fibers and special fibers MFC, MCC, CNF)
- Batch/series type refining options (50-100kg capacity)
- Refining simulations to e.g. desired SR degree + bagging/shipping/
- Enzyme testing in refining

Pulper

- Pulper capacity approx. 500kg/day
- Fractionating pilots
- Different material pulping and bagging/shipping
 - min 50 kg of bone dry material



Mechanical Processing Services

LOW-CONSISTENCY REFINING METSO OPTIFINER RF-01

- Promoting reusability of the fiber material
 - Reject refining, Recirculation testing, Fiber length adjusting
 - Inhouse laboratory analytics (e.g. energy curve)
- Testing new raw materials
 - Demo production
 - Fibrillation with specified certain energy
 - Homogenization of pulp
 - Mixing chemicals to the pulp
- Process optimization
 - Finding suitable parameters for your process or material

Refiner technical specs:

- Conical refiner with SW, HW, Eucalyptus filling options
- Feed consistency 3-5 %
- Max load 400 kW
- Voith laboratory refiner as counterpart in laboratory-scale with similar fillings. More info available per request



Mechanical Processing Services

HIGH-CONSISTENCY REFINING SUNDS RGP 42 REFINER

- Evaluating biomass potential for different applications with industrially applicable technologies
- HC- and LC-refining in conjunction screening
- Inhouse laboratory services for biomass, pulp, sheets and process liquids
- Material chemical impregnation during refining between the blades
- New raw materials for biomaterial applications
 - Agrofibers, Pulp, Bark, textiles..

Equipment

- Pre-steaming reactor 4m³ & TMP/CTMP/BCTMP possibility
- SD/DD options
 - Several filling options

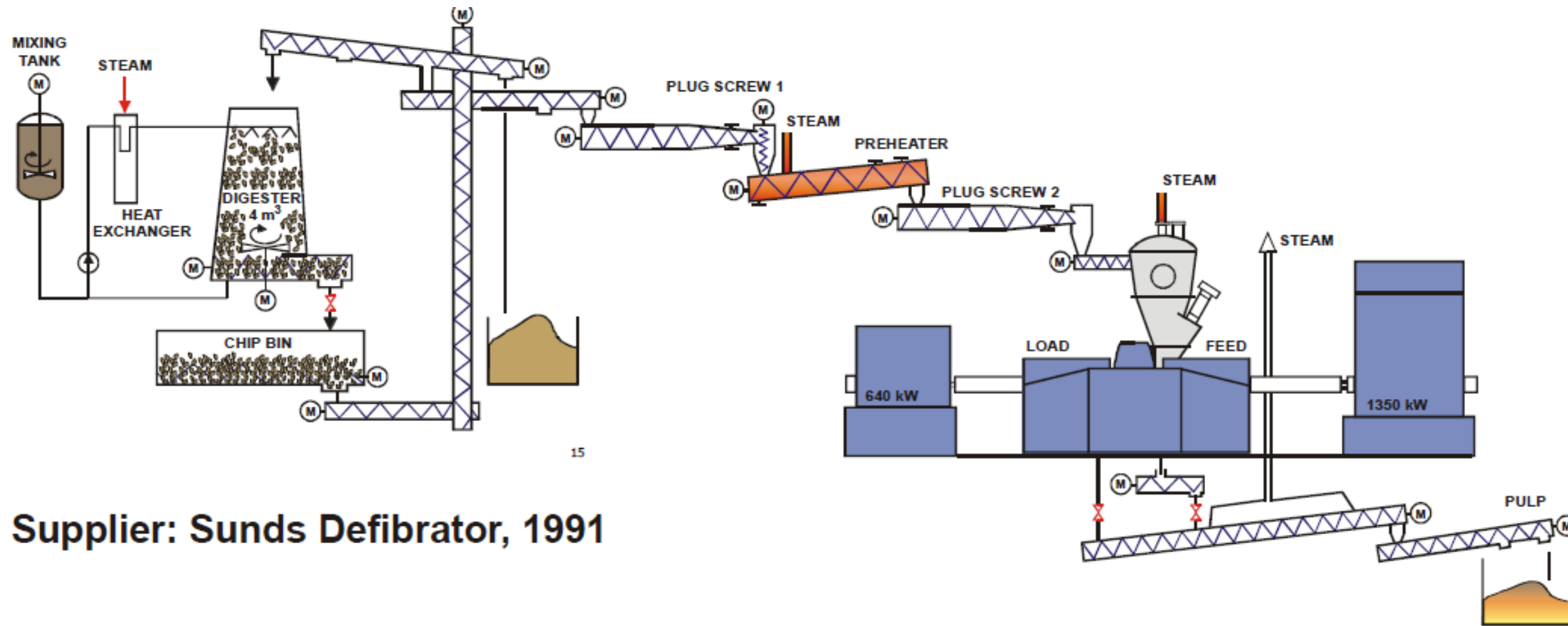
Typical analyses from our laboratory:

- Fiber analytics (e.g. Fiber length distribution, fines) with FS5
- Freeness (CSF) /Schopper-Riegler (SR)
- Water-retention value (WRV)
- Sticks/Stickies
- Bauer-McNett fiber classification
- Laboratory sheet testing



Mechanical Processing Services

HIGH-CONSISTENCY REFINING SUNDS RGP 42 REFINER



CONTROL SYSTEM

- Damatic XD

Supplier: Sunds Defibrator, 1991

RESEARCH AREAS:

- TMP, RMP and CTMP refining
- Reject refining
- Refining deinked pulp and semi-chemical pulp
- Raw material evaluation
- Process research
- Refiner plate development

TECHNICAL INFORMATION:

- Single disc, double disc or conical disc
- Rotating speed 1000 - 2400 rpm
- Preheater and refiner pressurized separately
- One-stage refining: 400 kg of chips
- Two-stage refining: 500-600 kg of chips
- 3-4 one-stage trials / day and 3 two-stage trials / 2 days
- Drives: feeding 1350 kW and loading 640 kW (ABB)

CHEMICAL TREATMENT:

- Batch digester 4 m3
- Liquid or steam phase digesting
- Max. temperature 180 C
- Peroxide bleaching in preheater or in refiner plate gap.

MODIFICATION OF EQUIPMENT:

- Change of plate: 1 day
- Changing to conical disc refining: 1 week

TDC DISC CLEARANCE MEASUREMENT

- Plate gap measurement
- Plate temperature measurement

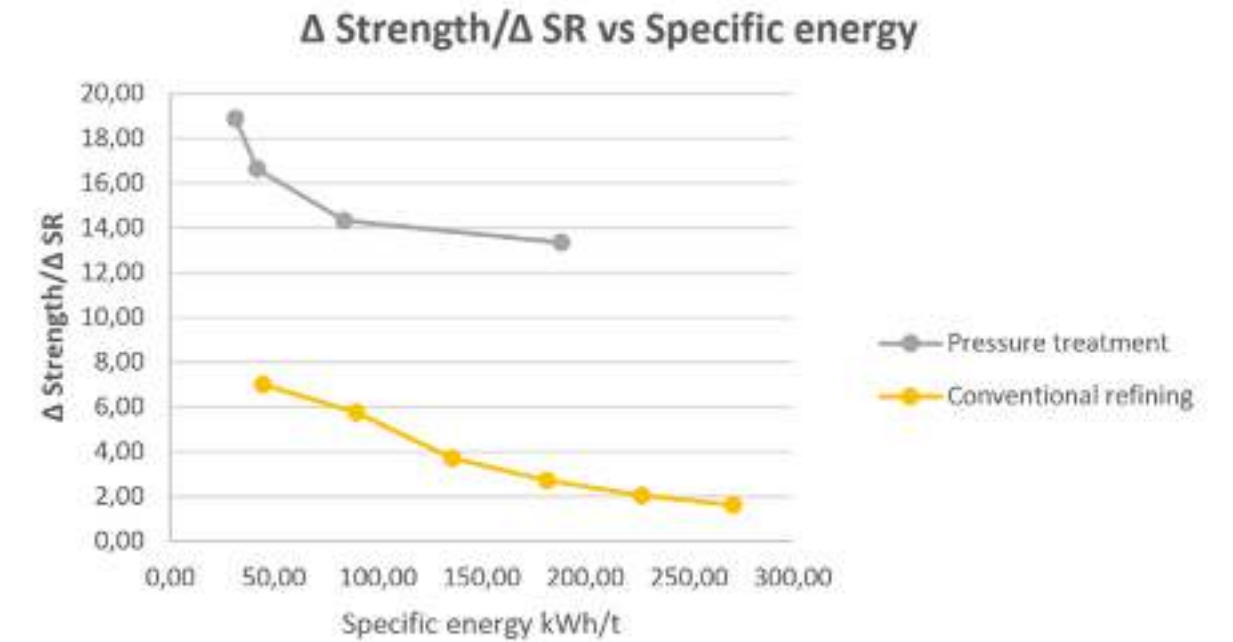
Mechanical Processing Services

PRESSURE REFINING

- Fiber-X own patent: ZACAPA refiner
- Pressure refiner for superior treatment of fibers, pretreatment before MFC production
- Saving energy
 - Fiber treatment
 - Drainage and pressing
 - Drying of more porous web
- New pulp properties
 - Reduced fines will affect linting and dusting
- Easier dewatering through chemical pulp layers in multi ply products
- Less shortening of fibers reduces need for long fiber
- When the ratio of strength increase and change in dewatering properties is high, the specific energy consumption is low
 - Conventional refining ratio is 2 - 8
 - Pressure treatment can ratio be more than 20
- Lab scale: 1kg/d, possible to send own pulp for demonstration of the patent
- Pilot scale : work in progress

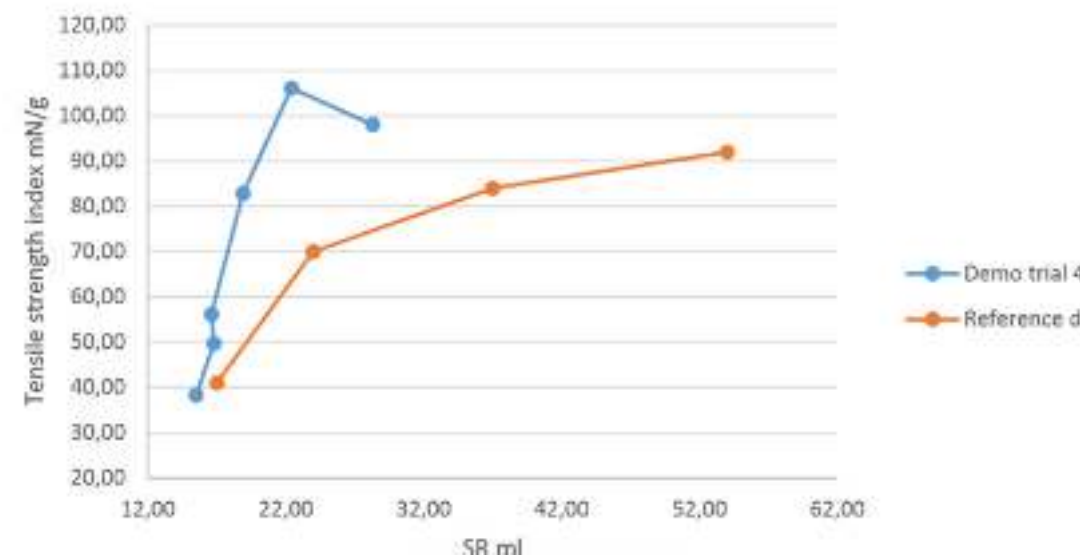


Fiber pressure treatment



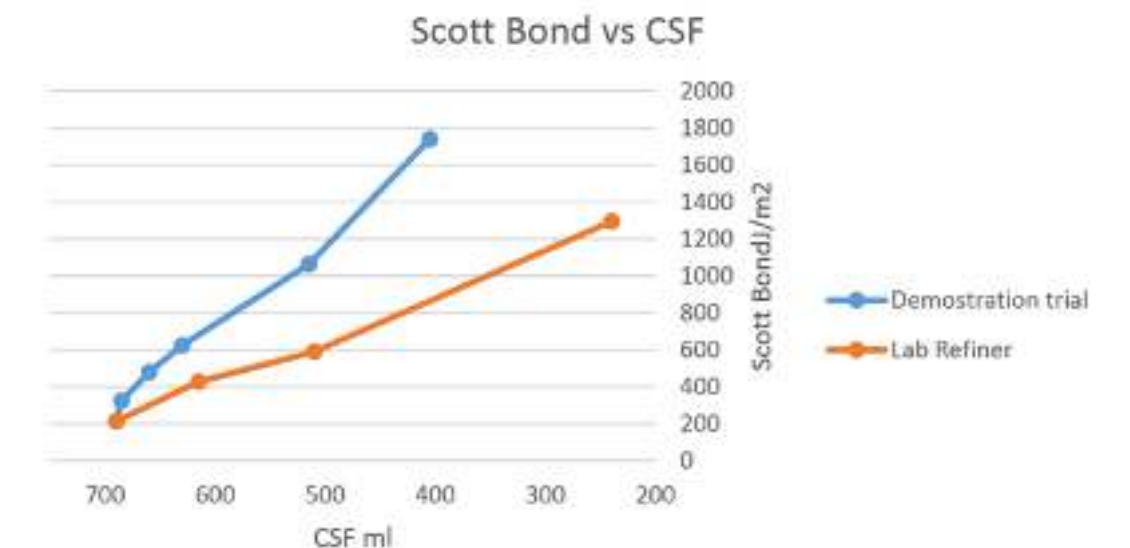
Fiber pressure treatment

Bale birch, Tensile strength index Nm/g vs. Shopper Riegler ml



Fiber pressure treatment

Integrated long fiber Scott bond J/m² Canadian Freeness ml



Mechanical Processing Services

CRUSHING, MILLING

- Fluff pulp production
- Pre-crushing of biomass to further processing
- Fractionation to determined sieve size
- Inhouse laboratory analytics

Equipment

- Hammermill (90 kW)
 - Powerful milling and crushing
 - Feeding screw for constant inlet
 - Several different sizes of sieves
 - In pilot-and laboratory-scale



Pelletizing Services

PELLETIZING

- Pelletizing fractionated materials with different sieve-sizes
- Crushing and drying combined with pelletizing
- Inhouse laboratory analytics

Equipment

- Sieve options of 6 and 8 mm (other sizes available per request)
- Several different pelletizing machines in different sizes and capacities with different pressure profiles

Collaboration possibilities

- We also have larger pelletizing equipment in our network for larger quantities



Finishing & Converting Services

PILOT PAPER MACHINE

- Suitable for all fibers;
 - NFC/MFC, different wood fibers, agrofibers, OCC etc and non-woven capabilities
- Standard wetlaid and foam forming capabilities
- Paper machine specs:
 - Paper machine length
 - 30 meters
 - Fourdrinier wire
 - Headbox width
 - 750mm (alternative foam forming headbox 250mm)
 - Reels:
 - 600-650mm width, 1m dia reels, default core 76 (alternatives to be confirmed separately)
 - Press section:
 - 2 nip pressing
 - Drying section:
 - 12 drying cylinders & IR dryer
 - Grammage
 - 30-150gsm (200 gsm theoretical)
 - Speed
 - 30-150 m/min (200 m/min theoretical)
 - Production capacity
 - 200-500kg per day (depending on material, gsm etc.)
 - TrumpJet chemical feeding system: 1-4 chemicals can be fed directly to the headbox
 - 40% free space on paper machine for new equipment
 - Example on-line coating



Finishing & Converting Services

SHEETING

- Sheet cutting from pilot and mill reel to sheets
- Sheet-fed offset sheets, A4 and A3 sheets, special sheet sizes
- Guillotine & Wohlenberg sheet cutters
- Outsourced, flexible and fast sheeting / slitting service
- Max. reel diameter 1.600 mm
- Max. reel width 1.000 mm
- Max. reel weight: 1.500 kg

Equipment

- Wohlenberg sheet cutter



Finishing & Converting Services

WINDING

- Rewinding pilot or mill reels for further converting
- Moistening of reels for calendering
- Special sizes and smaller amounts from mill reels
- Possibility to install special on-line measuring devices to analyse moving paper web
- Max. speed 1.000 m/min
- Reel width 350-1.000 mm
- Max. reel diameter 1.600 mm
- Cores 3" and 6"

Equipment

- Quatrollwinder
- Jagenberg winder
- V.I.B moistening unit
- Guillotine



Coating & Printing Services



Dispersion coating

Develop new barrier products, replace plastic components in the recipes with bio-based alternatives and test new raw materials and technologies.



Extrusion coating

Create novel sustainable packaging material innovations using the unique pilot line.



Printing

Test your newly developed materials' performance on sheet-fed offset or flexo-printing press including possible lab scale measurement services.



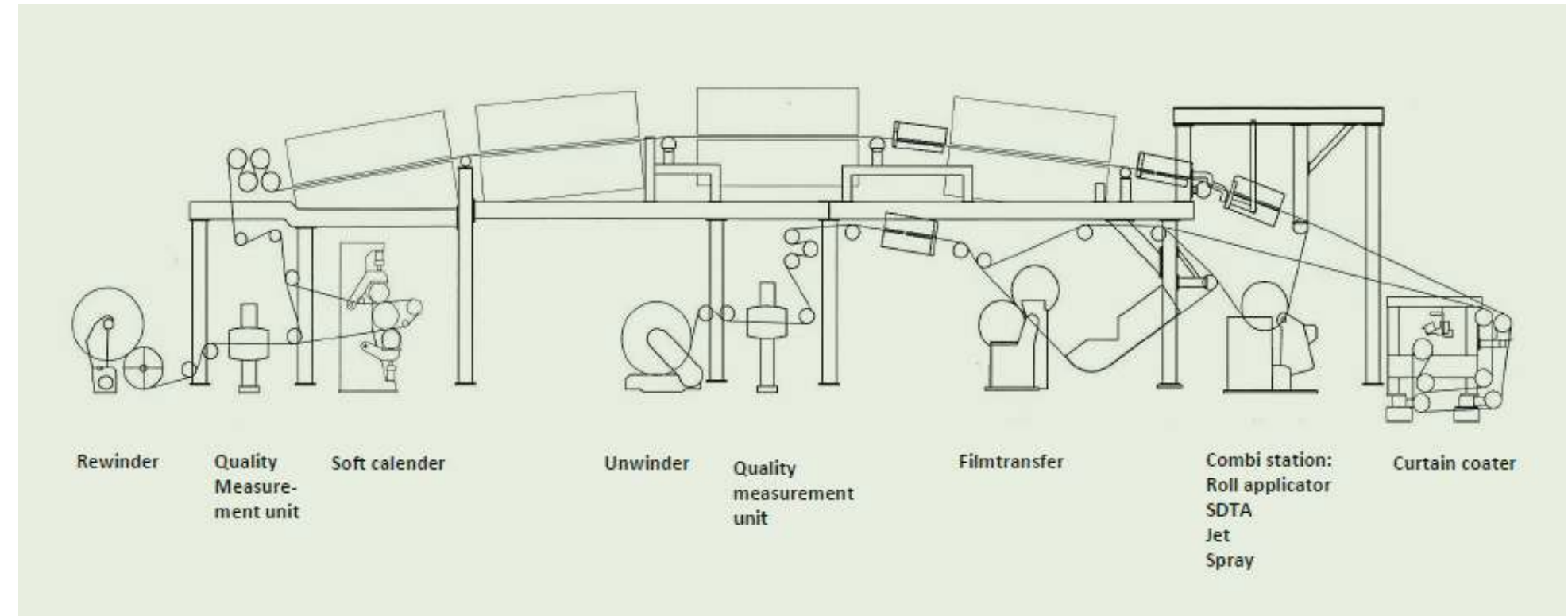
Finishing and converting

Rewinding reels for converting and sheet cutting services.

Coating & Printing Services

DISPERSION COATER

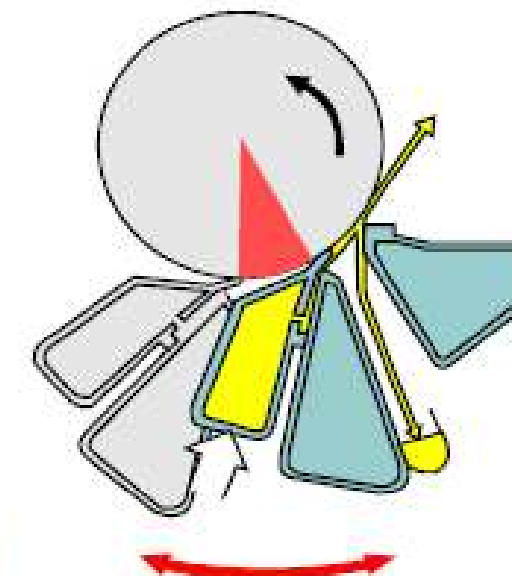
- Max speed 3050 m/min
 - Web width 550-600 mm
 - Reel max diameter 1580 mm
 - Core 3", 4" or 6"
 - Typical coating colour volume 200-400 l
 - Pre-infrared drying + 3 infrared driers + 4 air-floats
 - On-line / off-line 2-nips soft calender
 - Coat weight, grammage, moisture and web temperature measurements
-
- Coating recipe development basing on end-use target setting
 - Recipe optimisation prior mill implementation
 - New bio-based raw materials replacing non-biodegradable components
 - Coating technology comparison
 - Trouble shooting
 - Novel barrier concepts



Coating & Printing Services

DISPERSION COATING METHODS

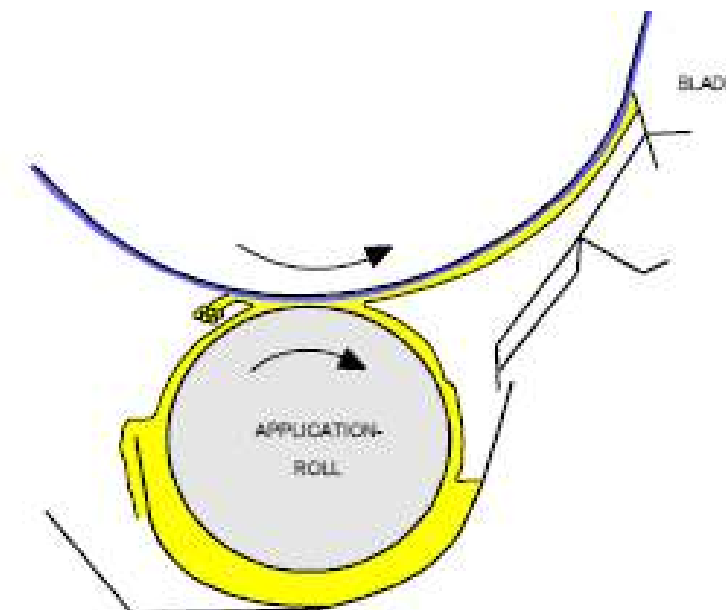
- **Jet application**
 - Distance between application and blade is adjustable (30-50 cm)
 - Long dwell time
 - Valmet OptiAir deaerator
 - Adjustable jet angle
 - Speed range 400 - 2000 m/min



Coating & Printing Services

DISPERSION COATING METHODS

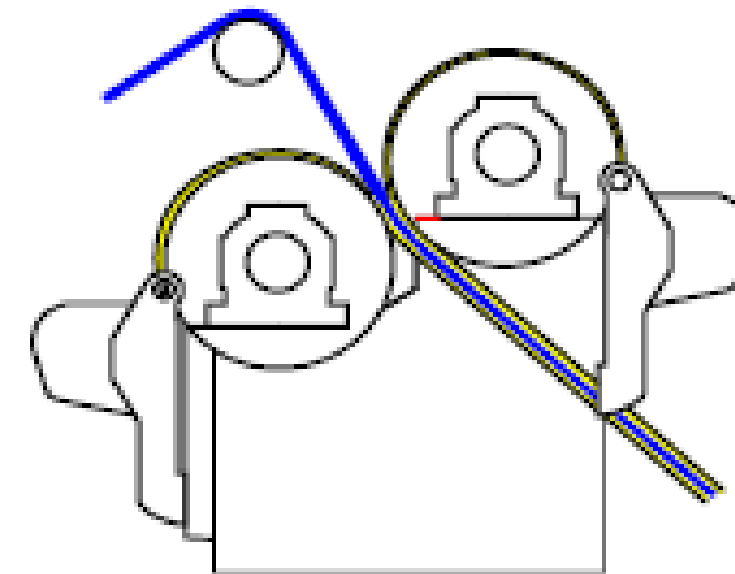
- Roll application
 - Metering with blade or rod
 - Typically for board coating
 - Long dwell time
 - Stiff or bent blade mode
 - Speed range 300-1300 m/min
 - Enables high coat weights >15 gsm



Coating & Printing Services

DISPERSION COATING METHODS

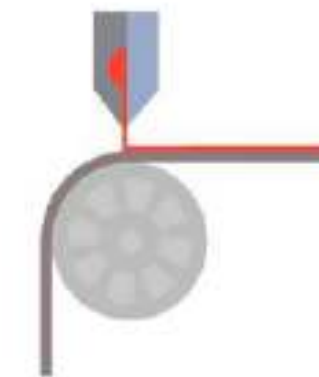
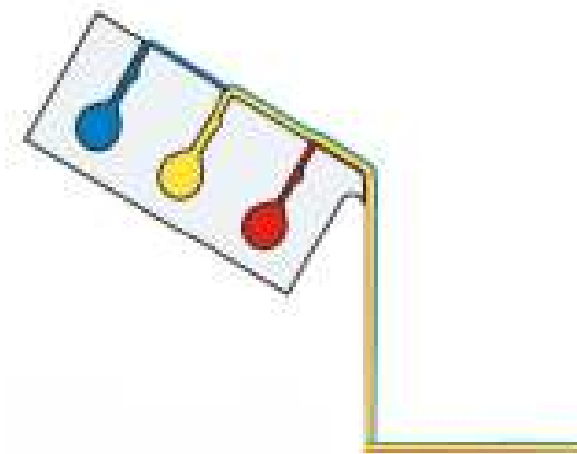
- **Film coating**
 - **Metso OptiSizer**
 - **Double sided coating**
 - **2 coating colour circulations (top/bottom)**
 - **Surface sizing and pigmenting**
 - **Diameter of rolls Ø 1000 mm**
 - **Material of rolls: PU and steel**
 - **Valmet TurnDry unit after size press**
 - **Grooved or smooth rods**



Coating & Printing Services

DISPERSION COATING METHODS

- **Curtain coating, slide die and slot die**
 - **Andritz Prime Coat Curtain Coating Unit**
 - **TSE Troller temperature controlled 3-layer-slide-die or 1-layer-slot die**
 - **Coating width 562 mm**
 - **NetzschType 602 deaerator**
 - **4 temperature-controlled feeding tanks equipped with mixing**
 - **Speed range 100 -2000 m/min**



Coating & Printing Services

DISPERSION COATING METHODS

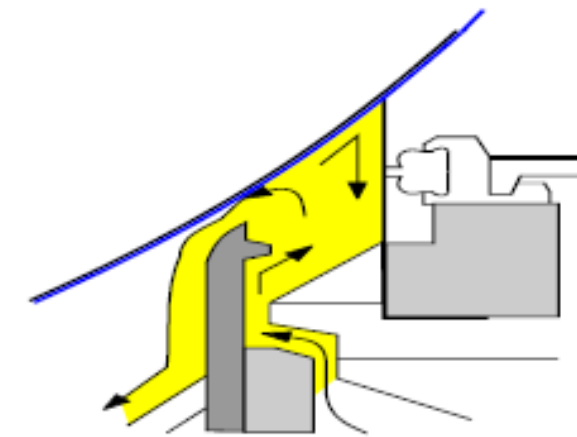
- **Spray coating**

- **One or two layers at the same time**
- **Metering with blade or rod**
- **Good coverage, improved gloss and smoothness**
- **High viscosity range**
- **Speed range 400 - 1600 m/min**



- **Short dwell time application**

- **SDTA or OptiBlade Plus**
- **From application to blade 30-50 mm**
- **Valmet OptiAir air removal**
- **Max. speed 1200 m/min**



Coating & Printing Services

DISPERSION COATING METHODS

- **Gravure and reverse gravure**
 - **Anilox / smooth roll application, blade metering**
 - **Gravure and reverse gravure options**
 - **Speed max. 100 m/min**
 - **Web width 400 mm**
 - **Max. diameter 400 mm**
 - **Air float drying**
 - **Glue lamination**



Coating & Printing Services

DISPERSION COATING METHODS

- Flexoapplication technology
 - Anilox→rubber sleeve→paper application
 - Two alternative formats:
 - Web format on Fischer & Krecke8-unit flexoprinting machine
 - Sheet format on the varnishing unit of Heidelberg SpeedmasterCD 74 (banded anilox roll allows 4 coat weights on the same sheet)



Coating & Printing Services

COATING KITCHEN

- **Dispersing**
 - Jylhä 1100 l
 - Jamix 800 l
 - Salomix 600 l
 - Jaro 80 l
- **Color making**
 - 2 mixers 600 l, 400 -2000 rpm
- **Batch size**
 - 150-500 kg (dry)
- **Starch cooking**
 - Batch cooking
 - Jet-cooker 10-20 l/min
- **Screens**
 - 60, 80 and 100 mesh
- **Pressure screen**
 - 100 mesh



Coating & Printing Services

COATING COLOUR ANALYSES

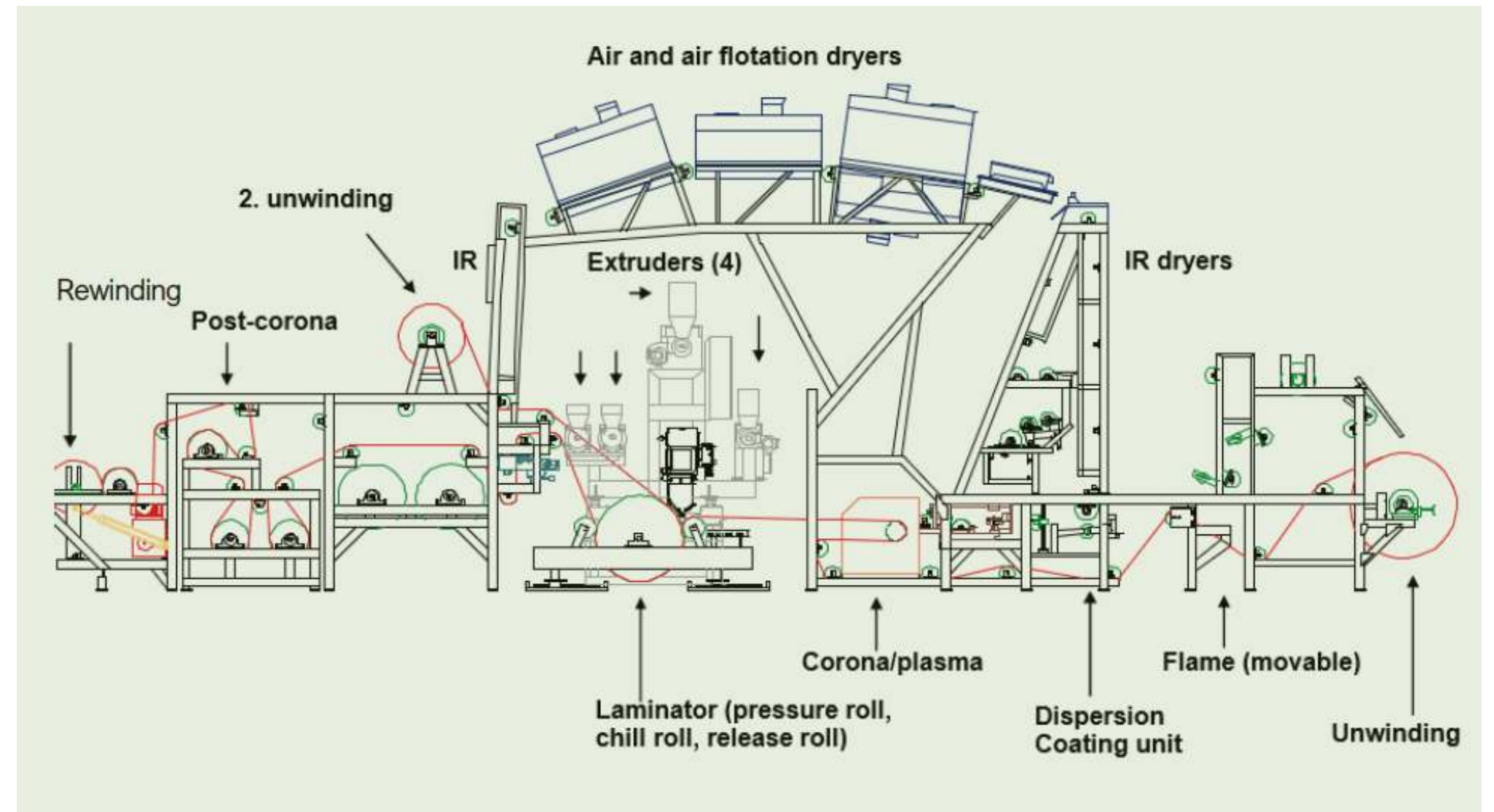
- Solid content
- pH
- Ash
- Viscosity (Brookfield)
- ACA AX-100 high shear viscosity
- Surface tension energy
- Gradekwater retention



Coating & Printing Services

EXTRUSION COATING AND LAMINATION REWINDING

- Pilot line specifications
 - Co-extrusion coating and lamination
 - 4 extruders and 5-layer technology with encapsulation possibility to produce multilayer structures - multiple selector plugs
 - Coatings, treatments and functionalization of surfaces, e.g. corona, flame, plasma
 - Matt and gloss chill rolls
 - Max. line speed ~400 m/min, max. web width 500 mm
- Replacement of oil-based polymers in barrier materials with biodegradable alternatives
- Reduction of oil-based polymer layer thicknesses
- Productivity improvement



Coating & Printing Services

EXTRUSION COATING LABORATORY SERVICES

- Adhesion
- Coat weight
- Cross-section pictures
- Pinholes
- Heat sealability
- Barrier properties
- Rub resistance



Coating & Printing Services

EXTRUSION BLENDING OF POLYMERS

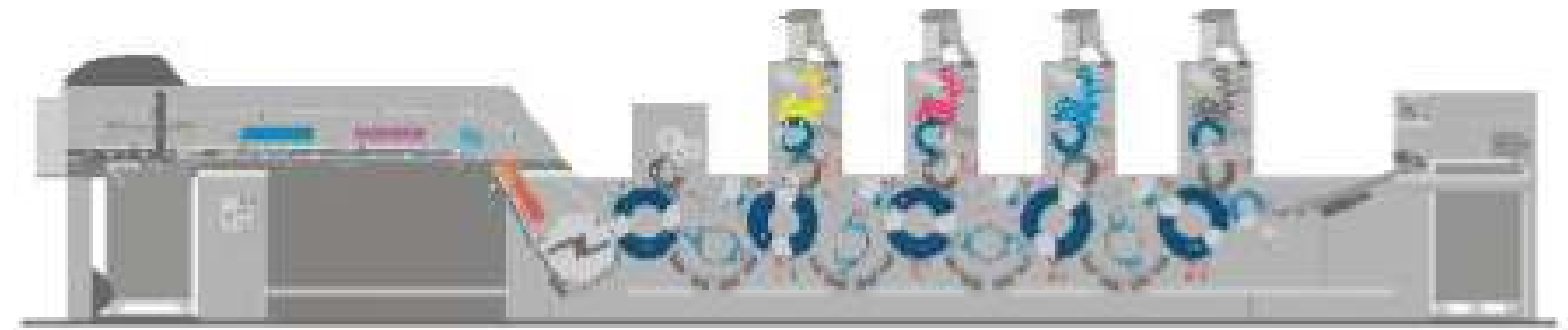
- Weber NE 45 extruder
- Diameter 45 mm
- Length 1 meter
- 4 zones
- 5-200 rpm
- Temperature up to $\sim 250^{\circ}\text{C}$
- Granulation option



Coating & Printing Services

SFO PRINTING

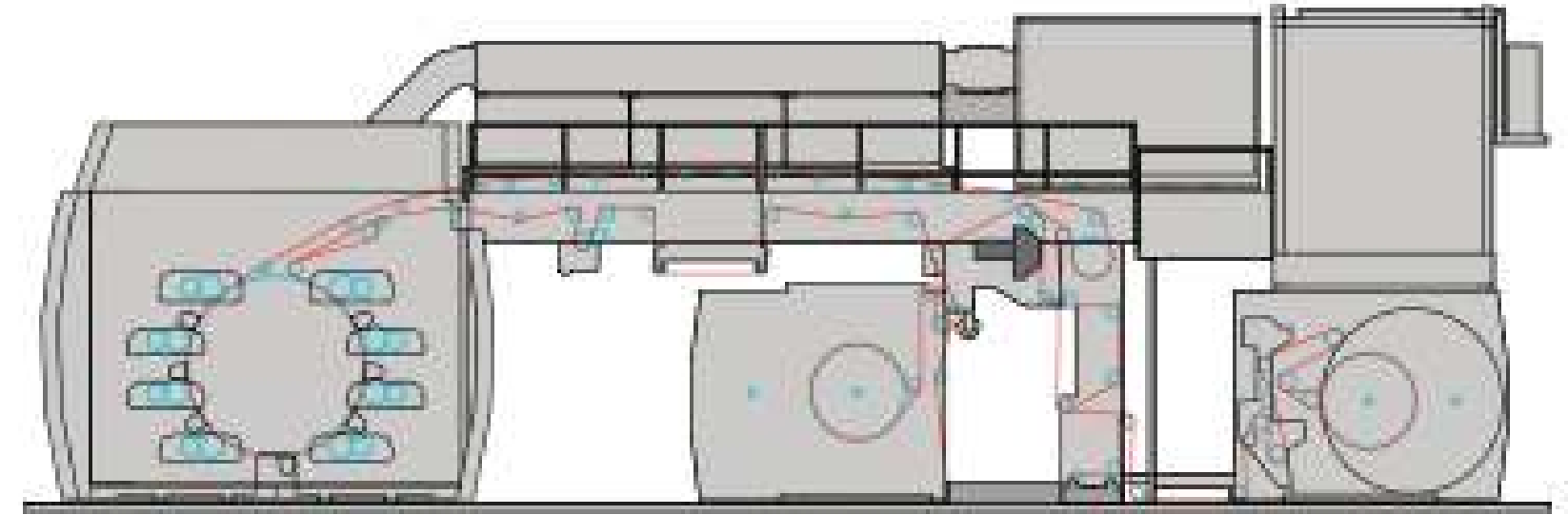
- **Verification of coated or mill samples printability parameters, e.g.**
 - Overall print quality; mottling, defects
 - Delamination, dusting, piling
 - Setoff, blocking
 - Varnish amount requirement
- **Equipment**
 - Heidelberg Speedmaster CD 74
 - Four printing units
 - Varnishing unit, IR & UV curing
 - Max. speed 15 000 sheets/hr



Coating & Printing Services

FLEXO PRINTING

- **Verification of coated or mill samples printability parameters, e.g.**
 - **Visual print quality, ink coverage**
 - **Print density**
 - **Dot gain**
- **Equipment**
 - **Fischer & KreckeFlexopress6S**
 - **8 printing units**
 - **Water and solvent based inks**
 - **Max. speed 400 m/min**
 - **Printing material basis weight:30-350 g/m²**



Laboratory Services

Chemical analysis

Analysis of biomaterials (wood, pulp, non-woods, food industry residue, recovery samples, process streams and waters).

Extractives, lignin content, TOC, COD, Cl, anions, carbohydrates and organic acids.

Refining and testing of pulp

Benchmarking of pulp, refining of different pulps, testing of trial pulp samples and quality control.

Production of low-consistency refined MFC and platform for testing of different refining aids and enzymes.

Board and paper making

Testing fillers, fibers, new raw-materials.

Manufacturing sheets from different fiber fractions.

Dynamic sheet former suitable for making paper or multilayer board.

Tests for board and packaging

Testing key strength and structural properties, barrier properties and recyclability of packaging material.

Tapio Analysis of paper and board.

T295 - accredited according to EN ISO/IEC 17025.

Laboratory Services

Biomaterials:

Carbohydrate content
Anions
Organic acids
Oxalate
Lignin content
Extractives content
Elements
Alkali solubility
Alkali resistance

Black, green, white liquor:

Sulphur compounds
Lignin
Oxalate
Organic acids
Carbohydrates
Alkaline content
Chloride
Fiber content

Tall oil:

Fiber and lignin content
Density
Soap content
Acid number
Elements

Microbiology

Processes
Products
- shelf life
- storage time

Dev. paper and board :

Refining of pulp
Testing of pulp, furnishes,
chemicals, fillers
Single or multilayer forming
Coating and calendaring



Process waters

TOC, TIC, TC
Anions
Elements
Oxalate

Troubleshooting:

Paper, board and pulp
- Processes
- Products

Paper, board and packaging

testing:

Strength
Structure (e.g. Tapio-analyzing)
Surface
Barrier (e.g. O₂-transmission)
Print
Heat sealability

Recyclability:

Repulpability testing
Reusability of fibers
Compostability testing

Calibration services for
paper testing devices

User experience:

Sensory testing
Impressions, preference

Microscopy:

Fibers
Paper and board
Cross sections
Precipitates

Laboratory Services

LABORATORY REFINING –VOITH LAB REFINER

- Simulation of mill scale refining
- Benchmarking refining and quality control
- Refining for sheet forming lab trials
- Production of MFC through LC refining
- 7 different filling available
- Specific Edge Loads 0.2-4 J/m, depending on filling
- 6 samples taken automatically at different refining levels



Laboratory Services

ENZYMES AND BIO-CHEMICALS IN REFINING AND PAPERMAKING

- **Examples**
 - **Enzymes to promote refining**
 - **Decreased energy demand**
 - **Development of fiber properties**
 - **Enzymes in paper making**
 - **Improved paper machine drainability**
 - **Reduction of extractives and stickies**
 - **Bio-chemicals in papermaking**
 - **Decreased energy demand in refining**
 - **Improved formation and strength**
 - **Hydrophobation**
 - **Special characteristics of paper**



Laboratory Services

PAPER AND BOARD MAKING IN LAB SCALE

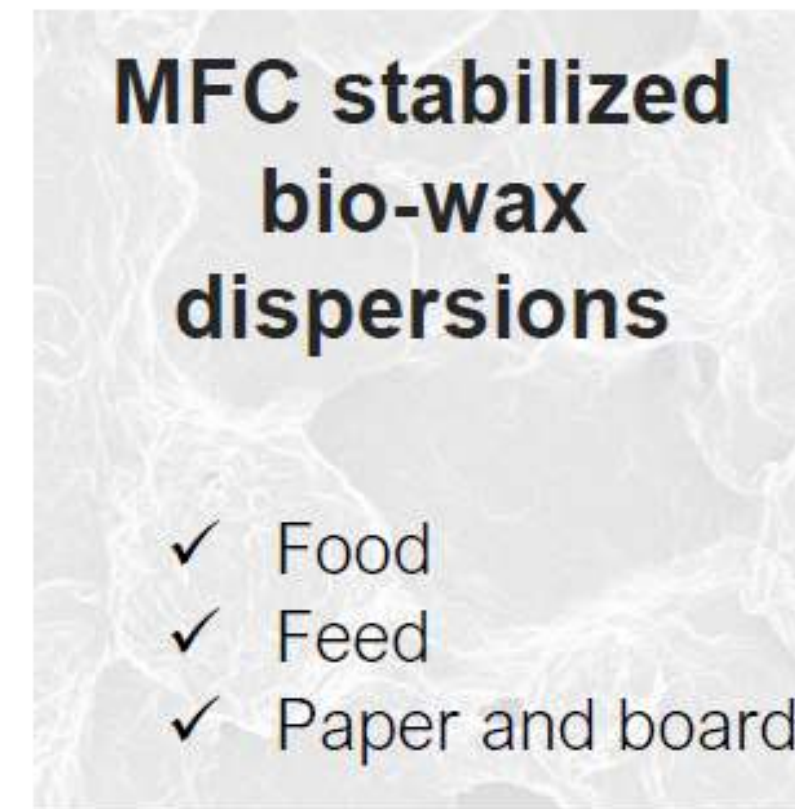
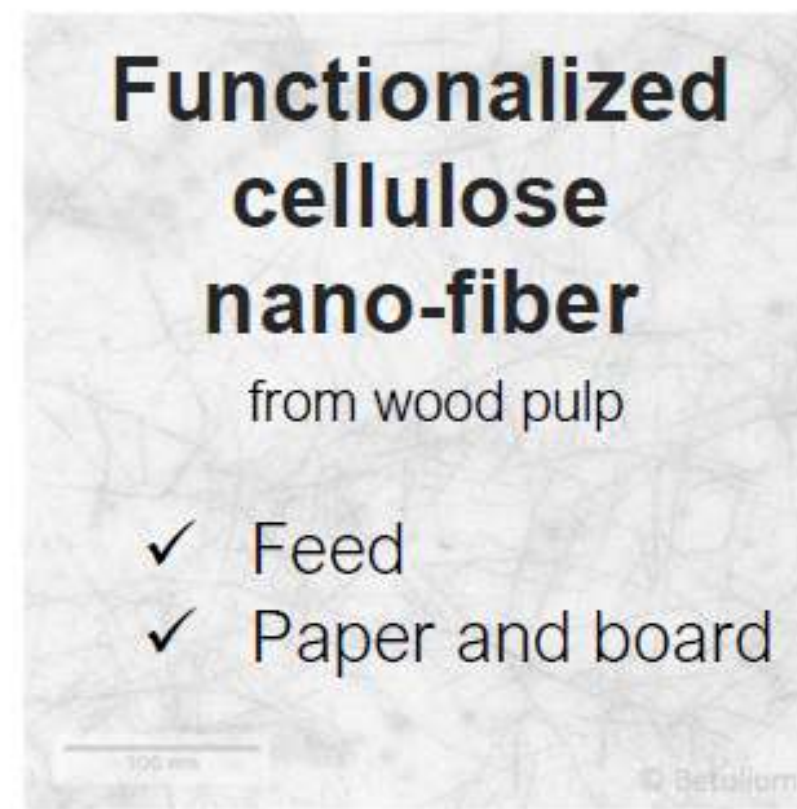
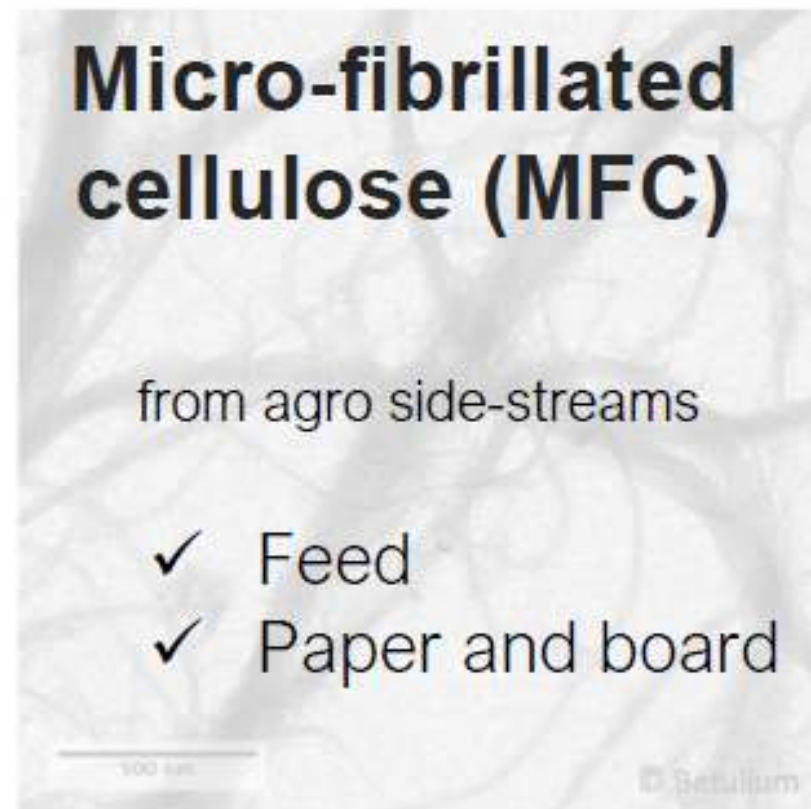
- Standard sheets, fiber fraction sheets, filler and furnish sheets, paper chemicals
- Conventional sheet former
- Dynamic sheet former
 - Paper with an orientation
 - Multilayer sheets –board making
 - 0.2 m²
- Lab calendering



Novel Biomaterials

BETULIUM

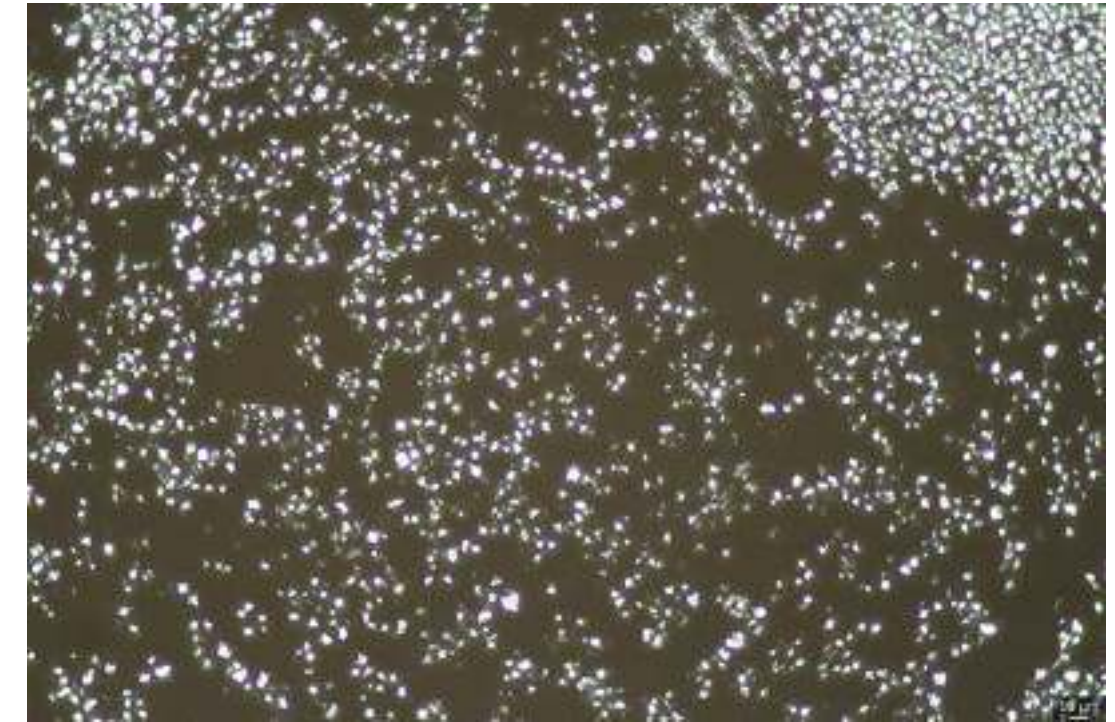
- **Betulium is a 100% affiliate of KCL and commercializes new biomaterials to replace oil-based raw materials in food and feed and paper and board applications**



Novel Biomaterials

BIO WAX – PLASTIC FREE WATER RESISTANCE

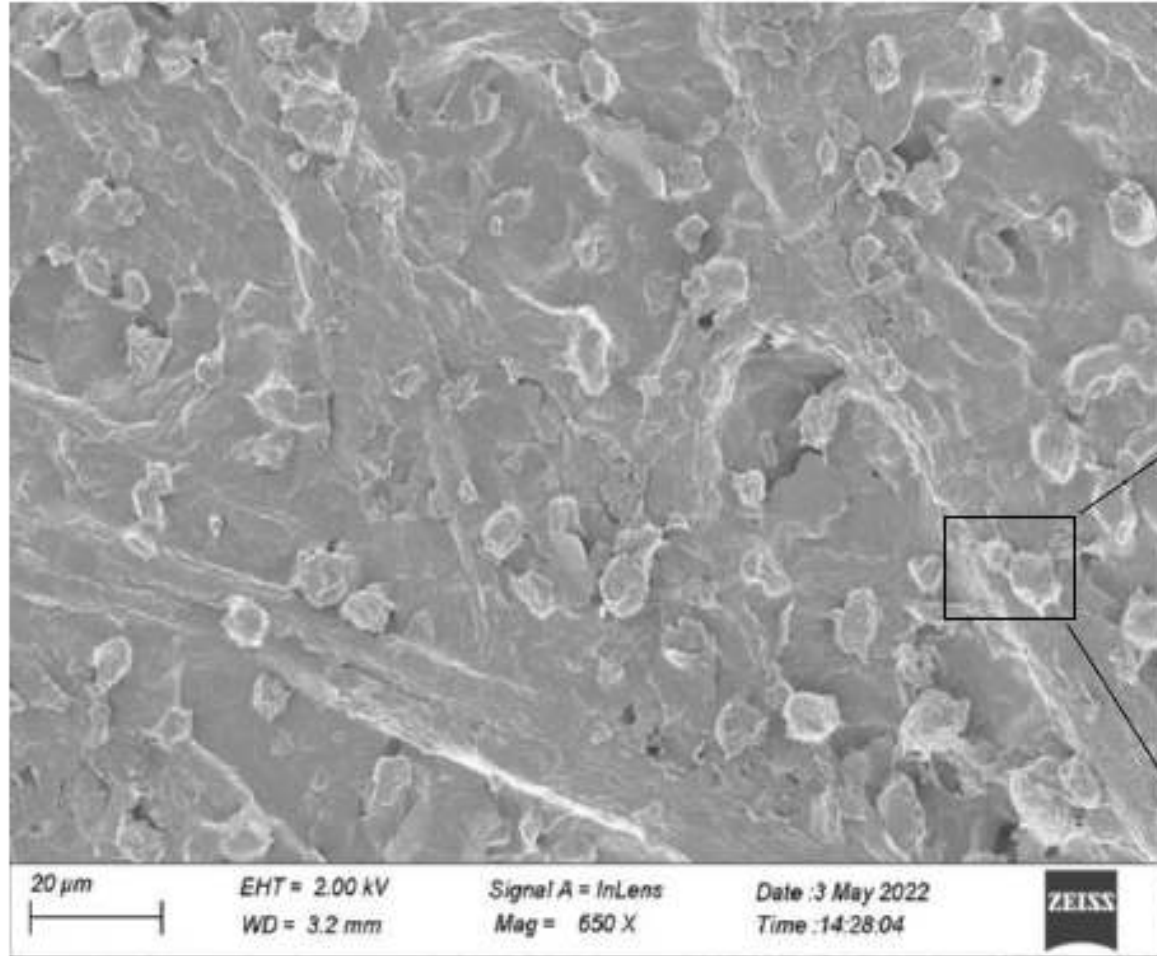
- 30% aqueous wax dispersion – solid bio wax particles in water
- Wax is hydrogenated plant oil, the formulation comprising only biobased natural ingredients, including MFC
- The wax particles are stabilized with MFC, which act also as an adhesion promoter
- Melting point 60-70 deg, depending on the used wax
- Usage level of 5-10 g/m²
- Applicable to different coating methods, easily sprayable
- Compatible to numerous coating formulations
- Production capacity of bio wax currently to 5 tons per day and from Q3-2024, 20 tons per day



Microscopy image of bio wax dispersion, particles 3-8 microns

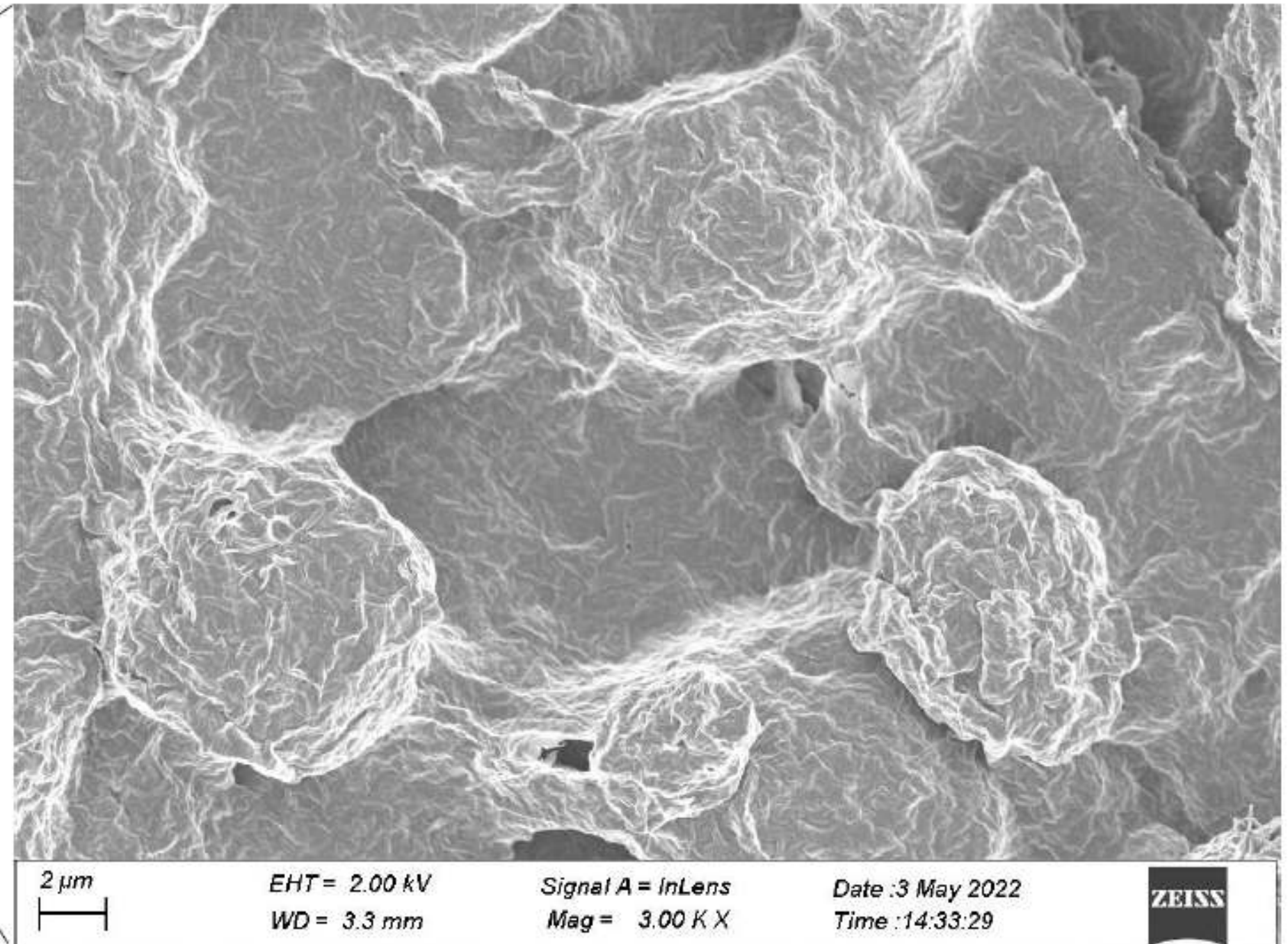
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MFC STABILIZED BIO WAX DISPERSIONS



Paper coated with FIBRY-BIOWAX dispersion, 6 g/m²

Wax microparticles cover the coated paper surface and bond on the pulp fibers through MFC-pulp interactions



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BIO WAX COATING RESULTS

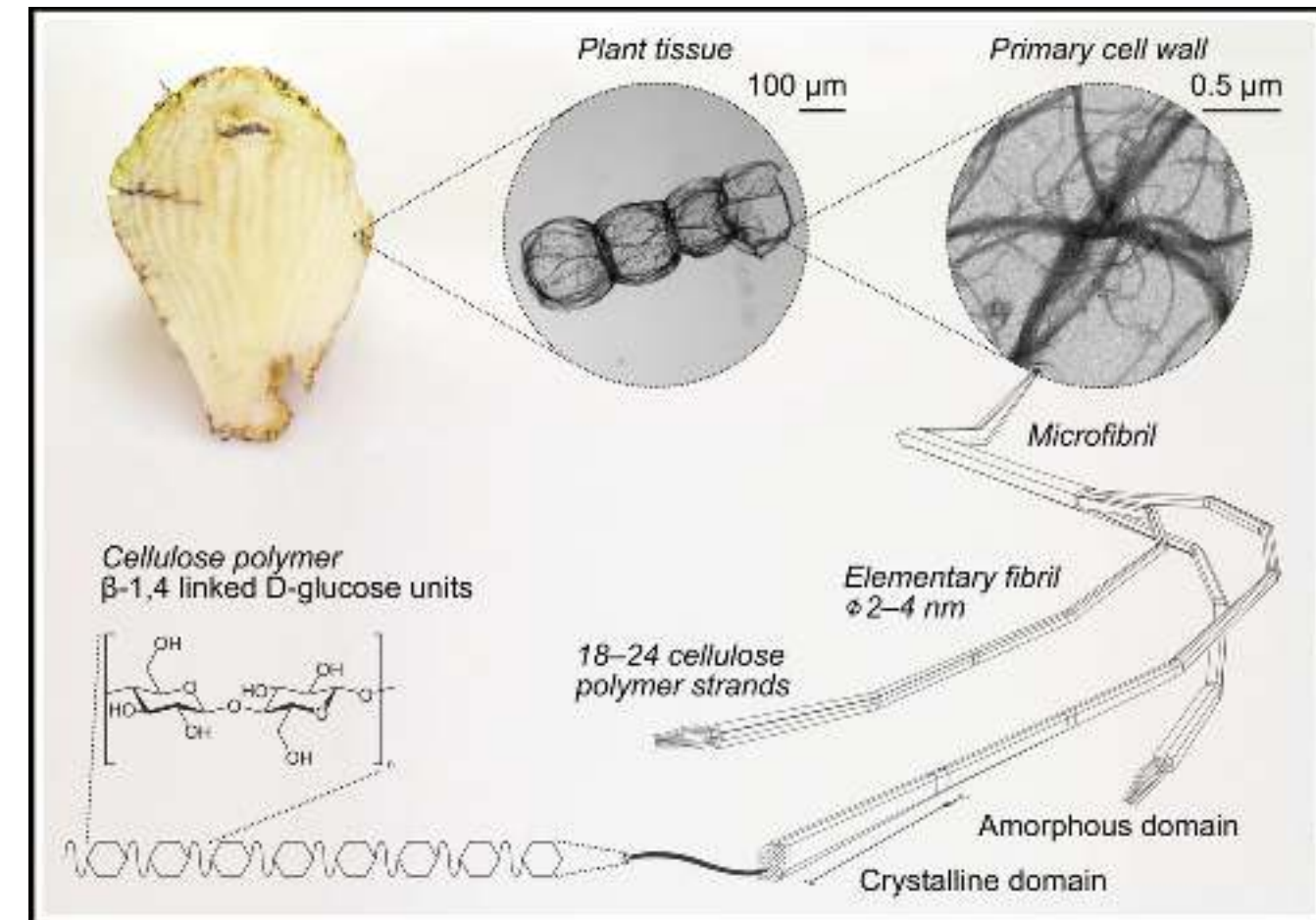
- **Good stability under various storage conditions**
- **Easy handling and mixing properties with other coating chemicals**
- **Increased Cobb values and thereby effective water and water vapor barriers**
- **High water contact angle indicating a high degree of hydrophobicity and thereby dirt resistance**
- **Low surface energy values and formulation needed for converting applications**



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COST SAVINGS WITH MICROFIBRILLATED CELLULOSES (MFC) AND CELLULOSE NANOFIBERS (CNF)

- Strength improvement of board and paper or coat formulation
- Good barrier properties –for oxygen (carbon dioxide) and grease barriers
- Rheology modifiers, stabilizers and film forming agents
- Synergy with coating compositions, for example starch, CMC and minerals



MFC from agricultural side-streams

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SUGAR BEET BASED MFC

- First commercial production line, 2019
- Utilizes sugar beet pulp – Located beside Finland's only sugar factory
- Produces several MFC product types
- Liquid, wet granulate, or dry products
- Can be packed in IBC's, bulk, or big bags
- Current capacity is 1 ton (dry) per day



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REPLACEMENT OF KRAFT IN OCC BLENDS

- Adding 3% of MFC to the furnish increases key strength properties by 4-7%
- The same affect can be achieved with an addition of 15% virgin pulp with refining level of SEC 120

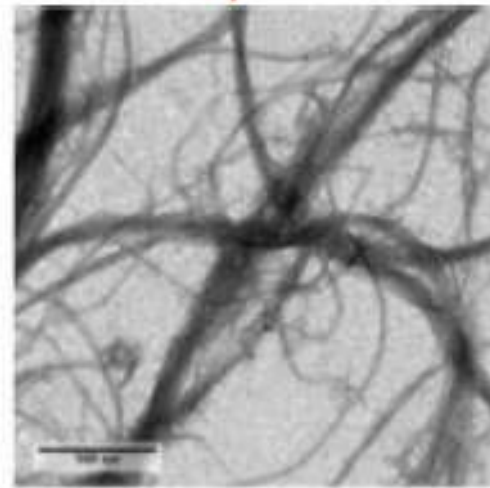
	100% OCC (SEC 30)	85% OCC (SEC 30) + 15% Pulp (SEC 120)	% Increase	97% OCC (SEC 30) + 3% MFC	% increase
Tensile index (Nm/g)	40,16	42,52	5,9%	42,87	6,7%
Tensile stiffness index (kNm/g)	5,29	5,49	3,8%	5,58	5,5%
Elastic modulus (kN/mm ²)	3,17	3,35	5,7%	3,39	6,9%
Compressive strength (SCT) (kN/m)	1,324	1,369	3,4%	1,378	4,1%

- Various possible ways to save money with MFC
- Use poorer quality OCC
 - Use more fillers
 - Make thinner and lighter materials

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CNFS PROVIDE HIGHER EFFICACY WITH VERSATILE PROPERTIES

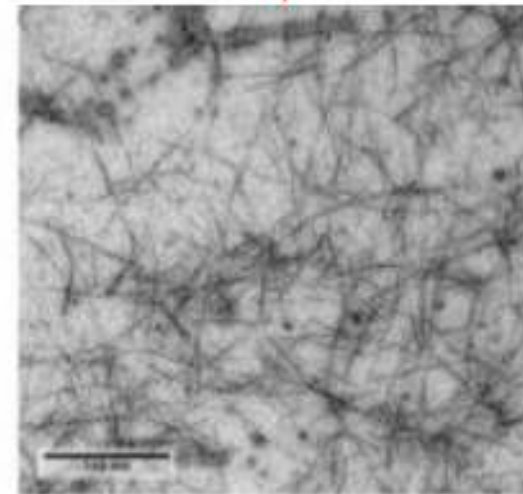
Microfibrillated cellulose - MFC



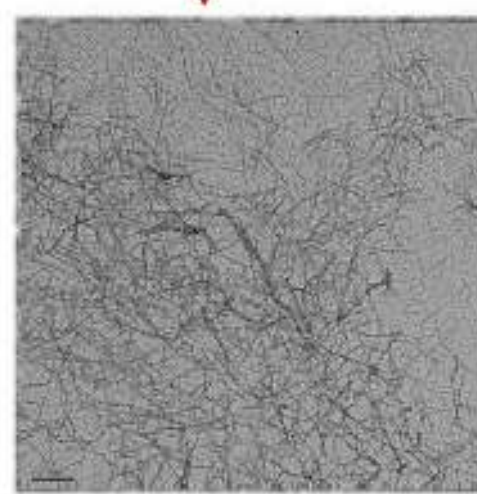
Natural microfibrils
MFC-NS65

Non-wood raw materials

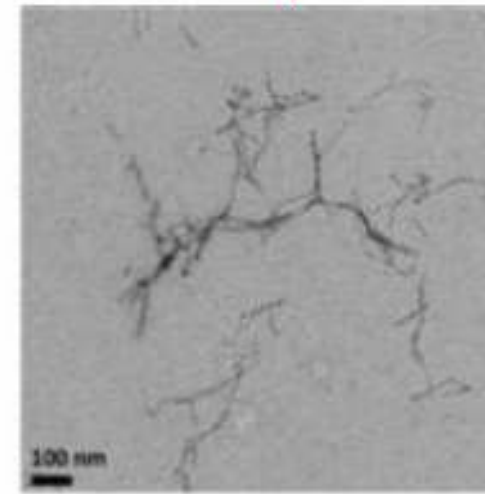
Cellulose Nanofibers - CNF



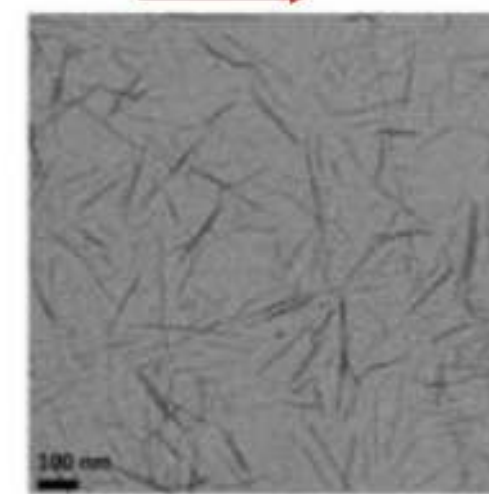
Carboxylated
CNF-AP16



Cationized
CNF-QP10



Phosphorylated
CNF-PP07



Sulphonized
CNF-SP10

Wood raw material

- Inexpensive and efficient cellulose derivatization process
- Derivatized cellulose can be shipped and stored in dry form and activated when used
- Dimensions are far smaller than MFC which means higher efficacy
- The chemical entity determines CNF properties and functionalities
- Current production capacity 10 kg/day scale

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CASE STUDY ON MFC/CNF BARRIERS: GAS BARRIER COATING FOR PP OR PE COATED CARTON

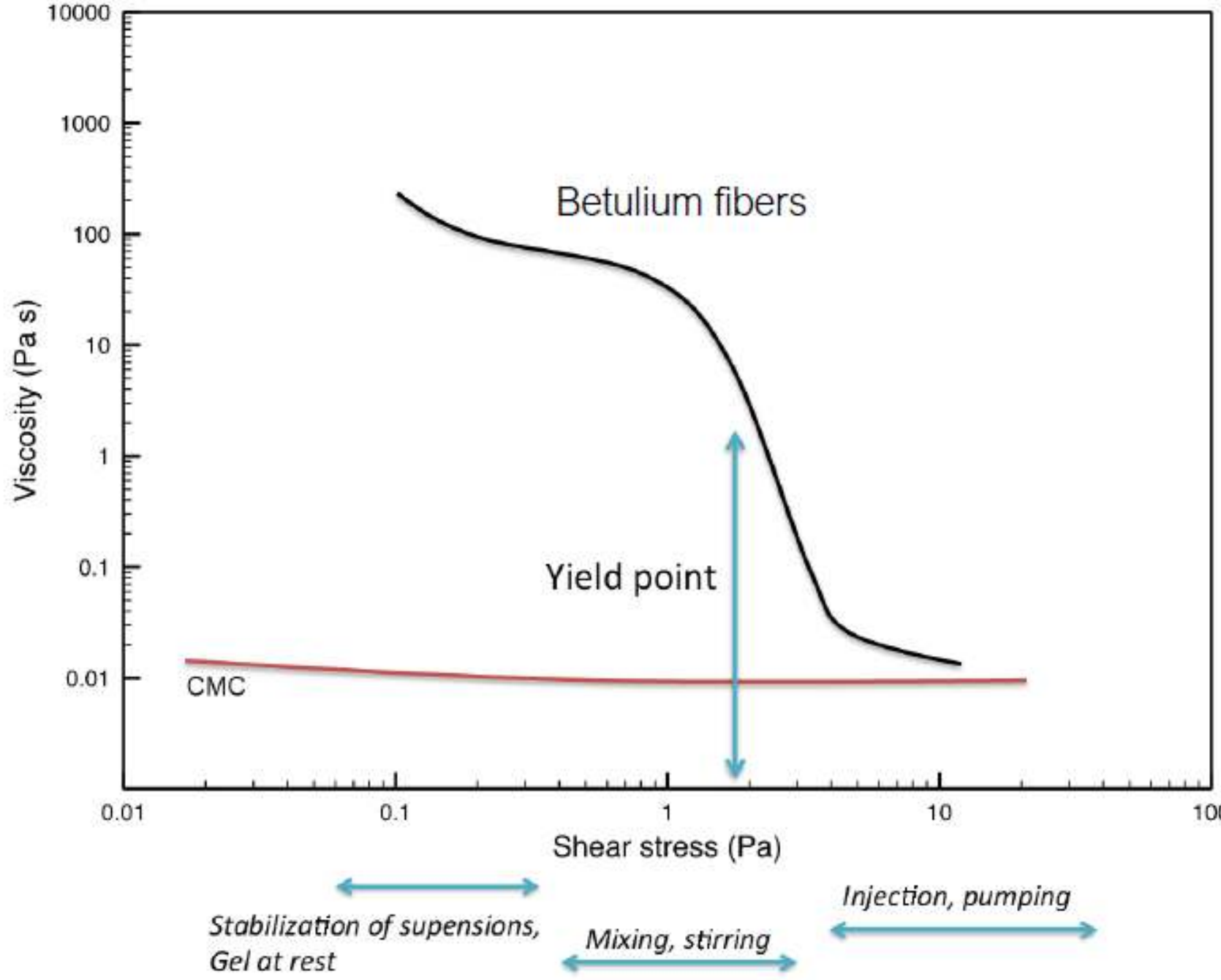
- Different FIBRY MFC and CNF products were applied on top of polypropylene film or PE coated carton
 - Spray or bar coated, 3-5 microns, two replicates

MFC/CNF type	Substrate	MFC (dry) g/m ²	MFC coat thickness (um)	1st OTR (cc/m ² *d)	2nd OTR (cc/m ² *d)
-	PP REF	-	-	>20000	2080
MFC	PP	4.54	3.0	86.7	98.1
CNF Cationic	PP	4.47	3.0	1.95	2.24
CNF Cationic	PE coated carton	7.00	4.7	1.37	1.32

- Oxygen transmission rate dramatically lower compared to un-coated substrate
- Cationically modified CNF is comparable to best commercial barrier films

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FLOW BEHAVIOR OF MFC/CNF



High yield stress is needed to stabilize suspensions...



... and allow spreading or injection

Coming Out Next

- **Microplastics analyses**
- **Industrial compostability**
- **Oxygen barrier –quick analysis**
- **New dispersion coating application techniques**
- **Higher productivity on the extrusion coating pilot**
- **Improvement of Pilot Paper Machine capabilities**
- **Wastewater treatment pilots**
 - **Removing heavy metals, hormones, dyes etc organic and inorganic substance which are dissolved into water**
 - **Industrial scale piloting**

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