14. NOVEMBER 2018, CHRISTIAN BIERMANN

Innovation in dry strength additives

45th INTERNATIONAL ANNUAL SYMPOSIUM DITP

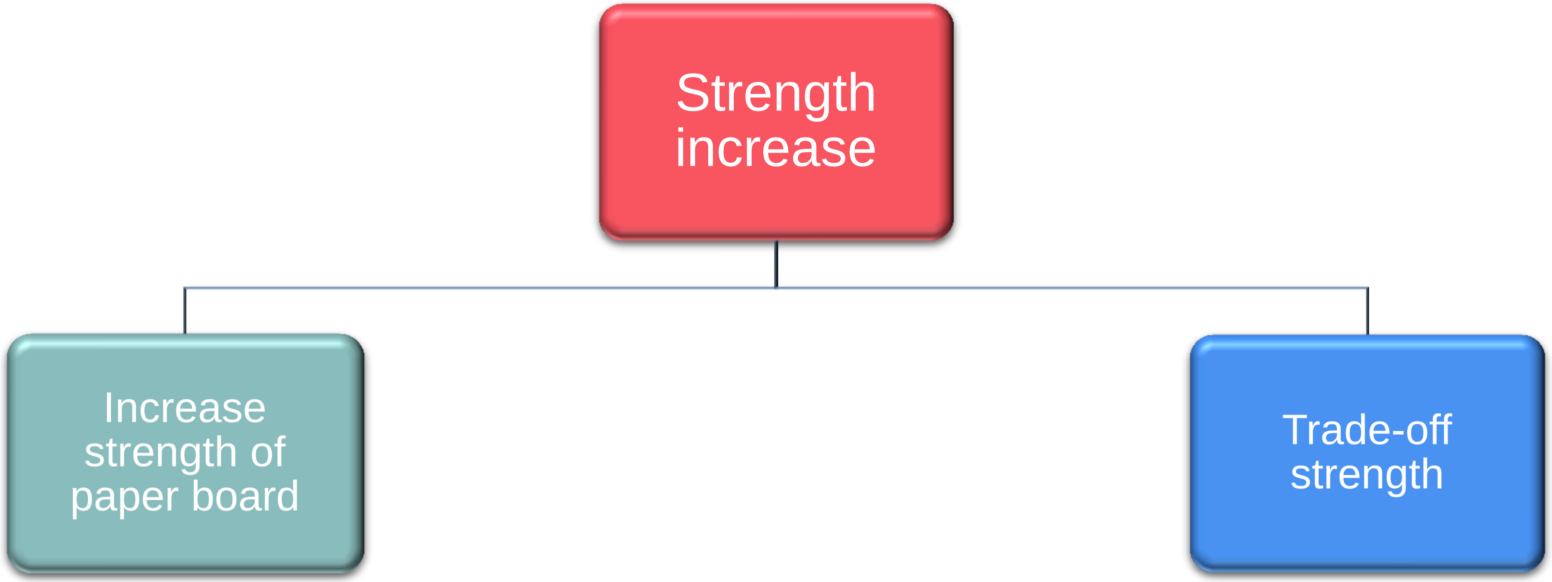
kemira

Content

- Reasons for using dry strength additives
- Basics of dry strength
- Dry strength agents by Kemira
- Case studies
- Summary

What are your drivers?

Value from investment in strength additives



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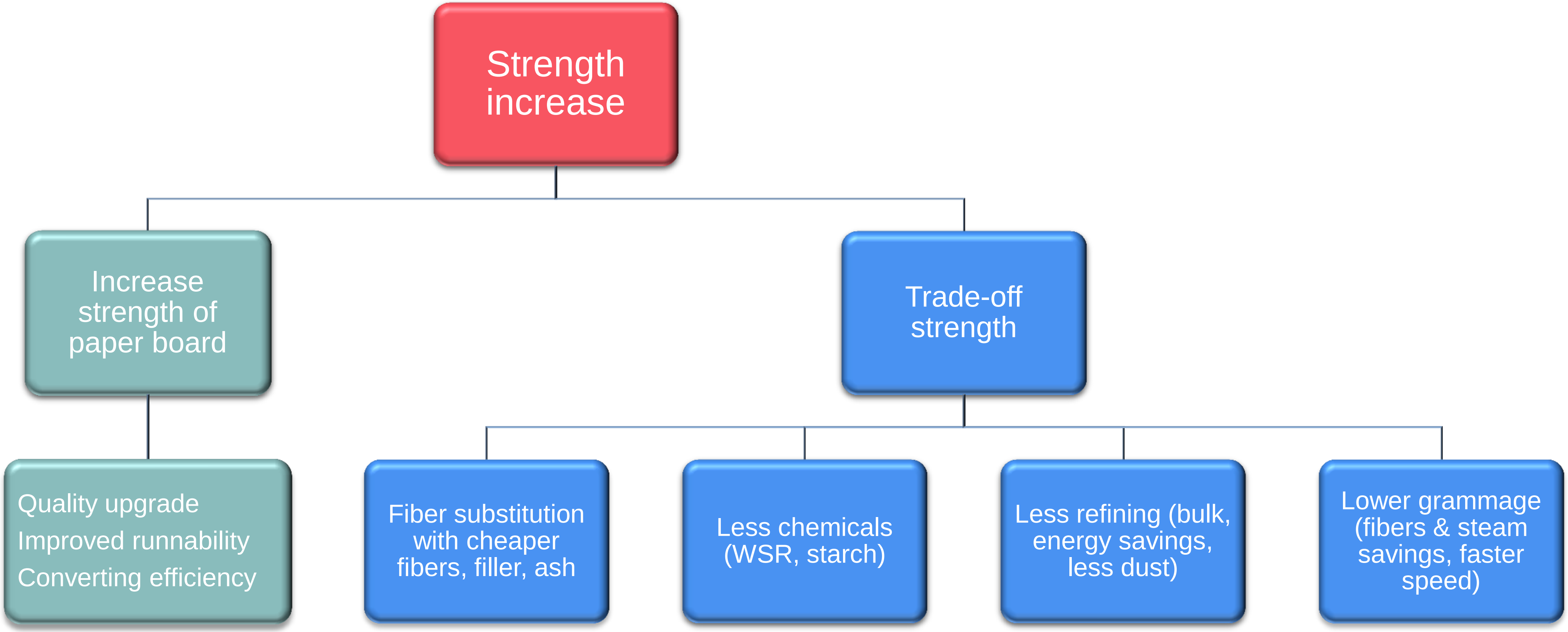
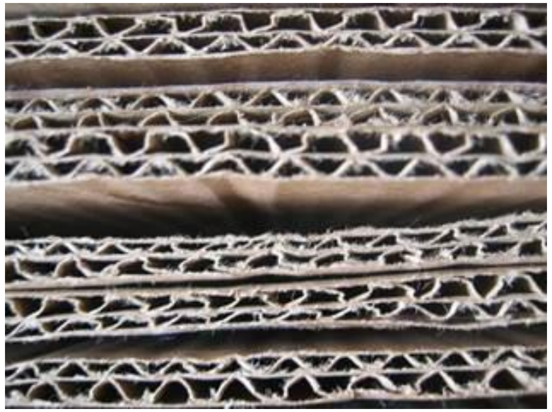
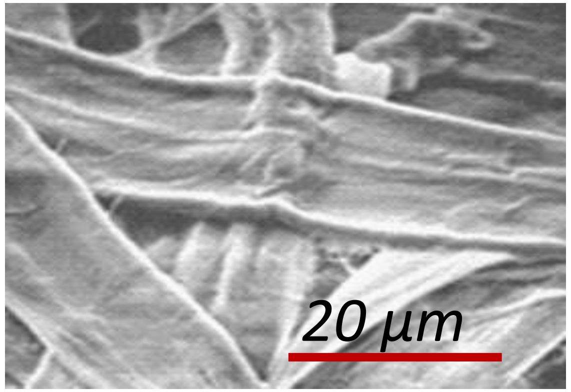


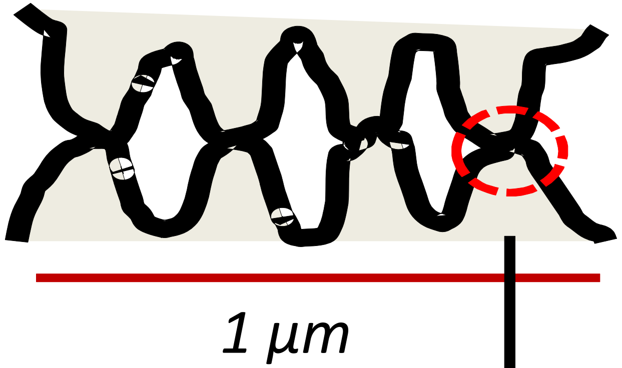
Origin of strength: fiber – fiber bonds



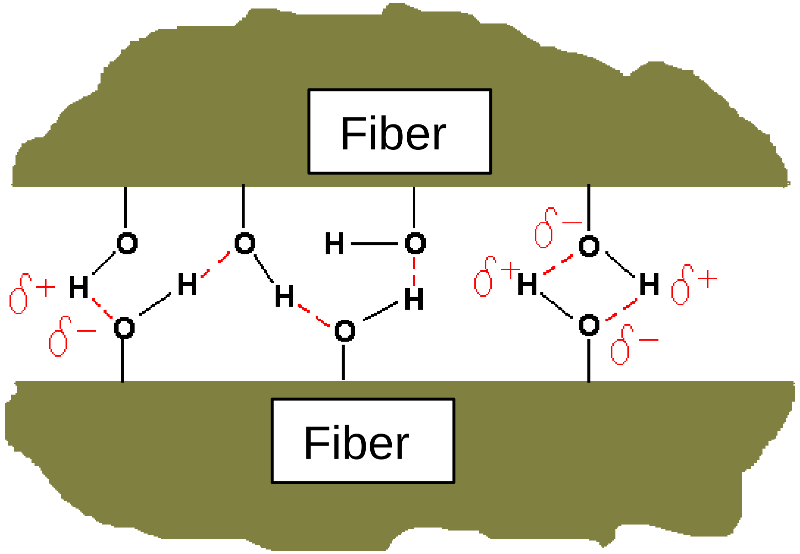
Bonded joint



Bonding area at micro scale



Bonded area: < 0,3 nm



$$F = \sum_{k=1}^{n} F_n \, Nn$$

F : Strength
F_n : Strength of bond
N_n : Number of bonds

Strength

Wet- and Dry-strength Additives – Application, Retention and Performance, Gavin G. Spence (Editor), Tappi Press, 1999.

Strength of bond

- Chemical nature of bond:
  - Hydrogen – hydrogen bonds
  - Ionic bonds
  - covalent bonds

Number of bonds

- Number and size of contact area
- Distribution of contact areas (formation)
- Flexibility of fibres
- Length of fibers

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- **Mechanical means**
  - Refining
  - Press
  - Dewatering
  - Volume

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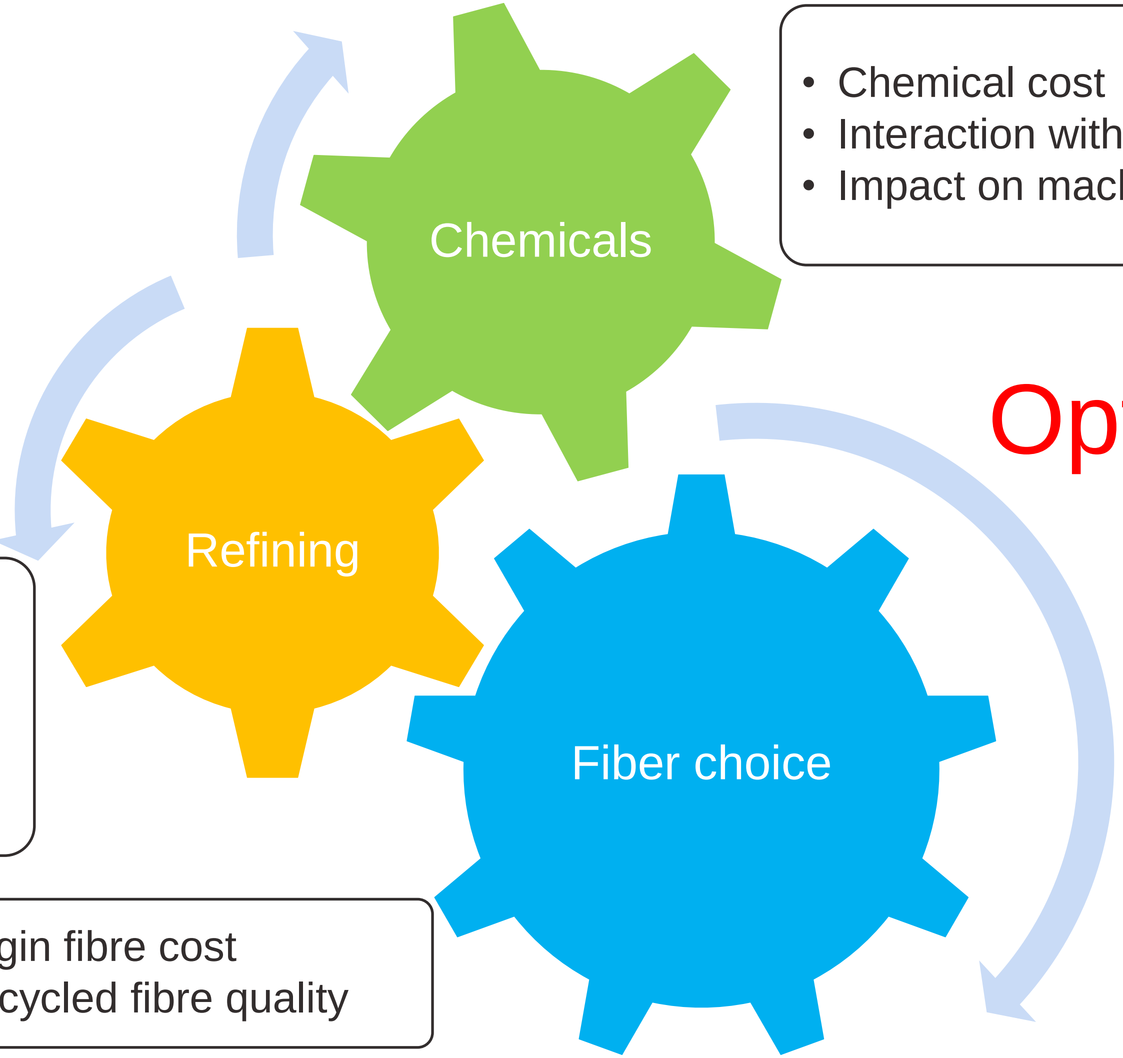
> ➢ **Chemical additives and cat. starch**
>   - ➢ Bridging the gaps in the fibre web
>   - ➢ Increasing robustness of bonds (Molgewicht, flexibles Polymer)
>   - ➢ Covalent bonds

Strength enhancement elements



- Chemical cost
- Interaction with other additives
- Impact on machine runnability

Optimization is critical!

- Energy cost
- Over-refining
- Loss of bulk
- Dust

- Virgin fibre cost
- Recycled fibre quality

Chemical dry strength additives

Achievable strength increase →

← Ease of application

Solution

- „pump & go“
- Addition to wet-end or size/film press

+10% strength

e.g.:

- FennoBond 3300E
- FennoBond 46
- FennoBond 80S

Powder

+20% strength

e.g.:

- FennoBond ECA 720 + cat. wet end starch

Powder + second component

+20% strength

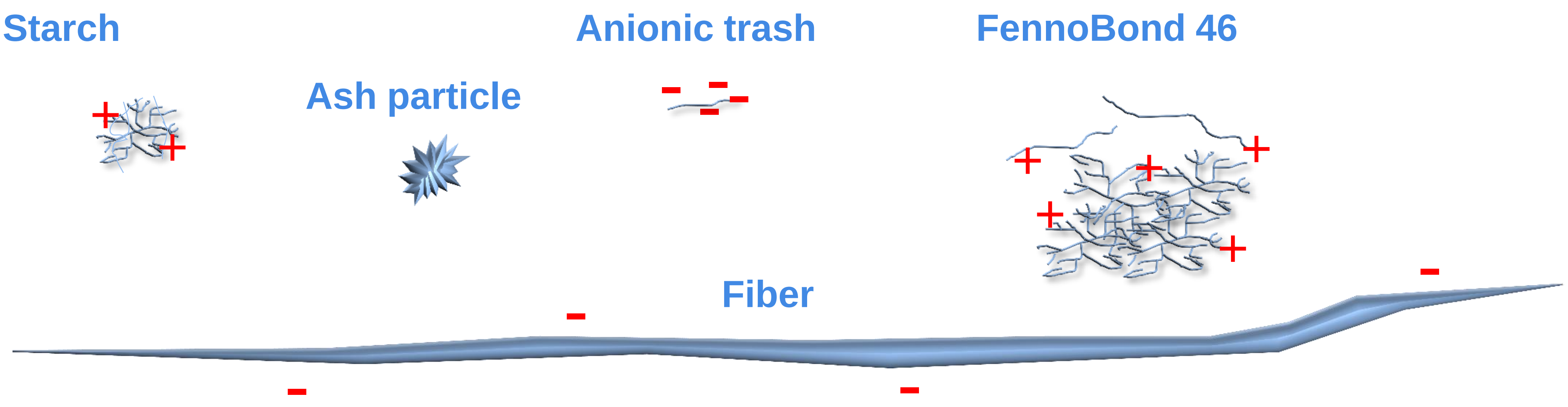
e.g.:

- FennoBond ECA 360 for filler treatment

Case studies

FennoBond 46

FennoBond 46



Optimal Mw and charge of FennoBond 46 (composit polymer):

- Mechanism: ionic bonds, hydrogen bonds, increased bonding area and number
- Improved effect on interfiber bonding
- Less sensitive to anionic trash
- Improved filler retention without a strength loss
- Pump & Go

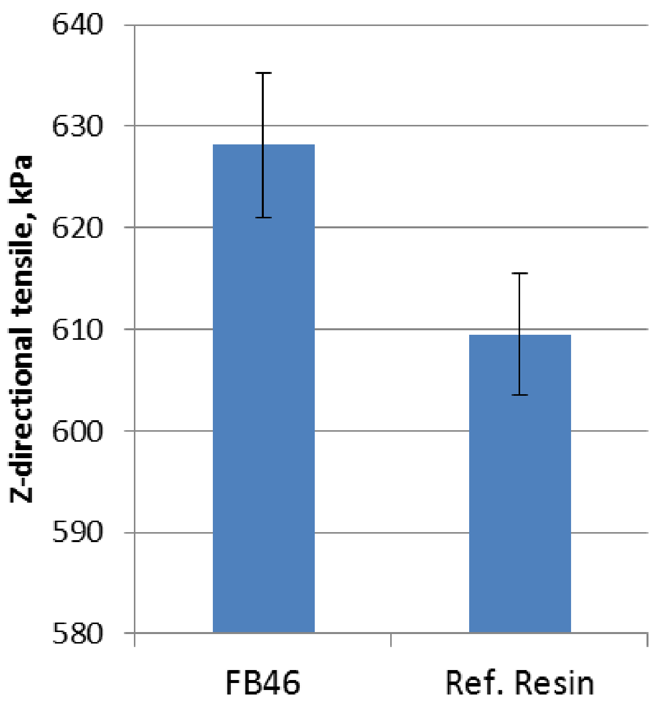
FennoBond 46 for lint control in SC paper

Machine overview	• Grade: SC-A++, 50-80 g/m^2 • Machine type: gap former 750 m/min, off-line super calanders • Furnish: Groundwood + bleached kraft • Chemicals: − 33% filler, GCC+Clay − Hercobond 5250 @ 4 kg/t anti-linting agent for high quality heatset grade
Needs	• Improve surface strength and reduce linting • Reduce cost of anti-linting additive
Solution and Benefits	• FennoBond 46 dosed @ 4 kg/t to thick stock instead of 4 kg/t HB 5250 • Runnability improved and speed increased by 15 m/min • Z-directional strength, IGT dry pick and tensile stiffness improved • Opacity improved and optical brightener reduced by 0,5 kg/t • Lint reduced by 30%, picking and piling reduced in printing trial

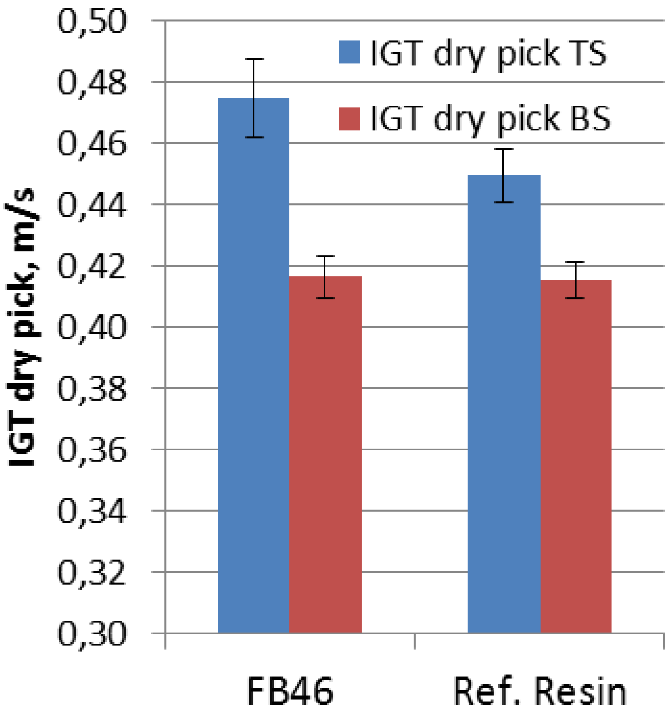
FennoBond 46 vs. PAE

Machine trial on SCA-paper

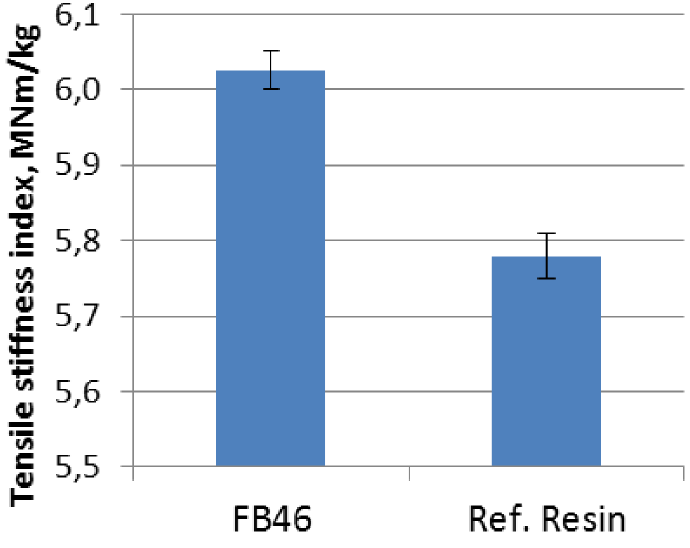
Z-tensile strength



IGT dry pick



Tensile stiffness index MD



FennoBond 46 vs. PAE

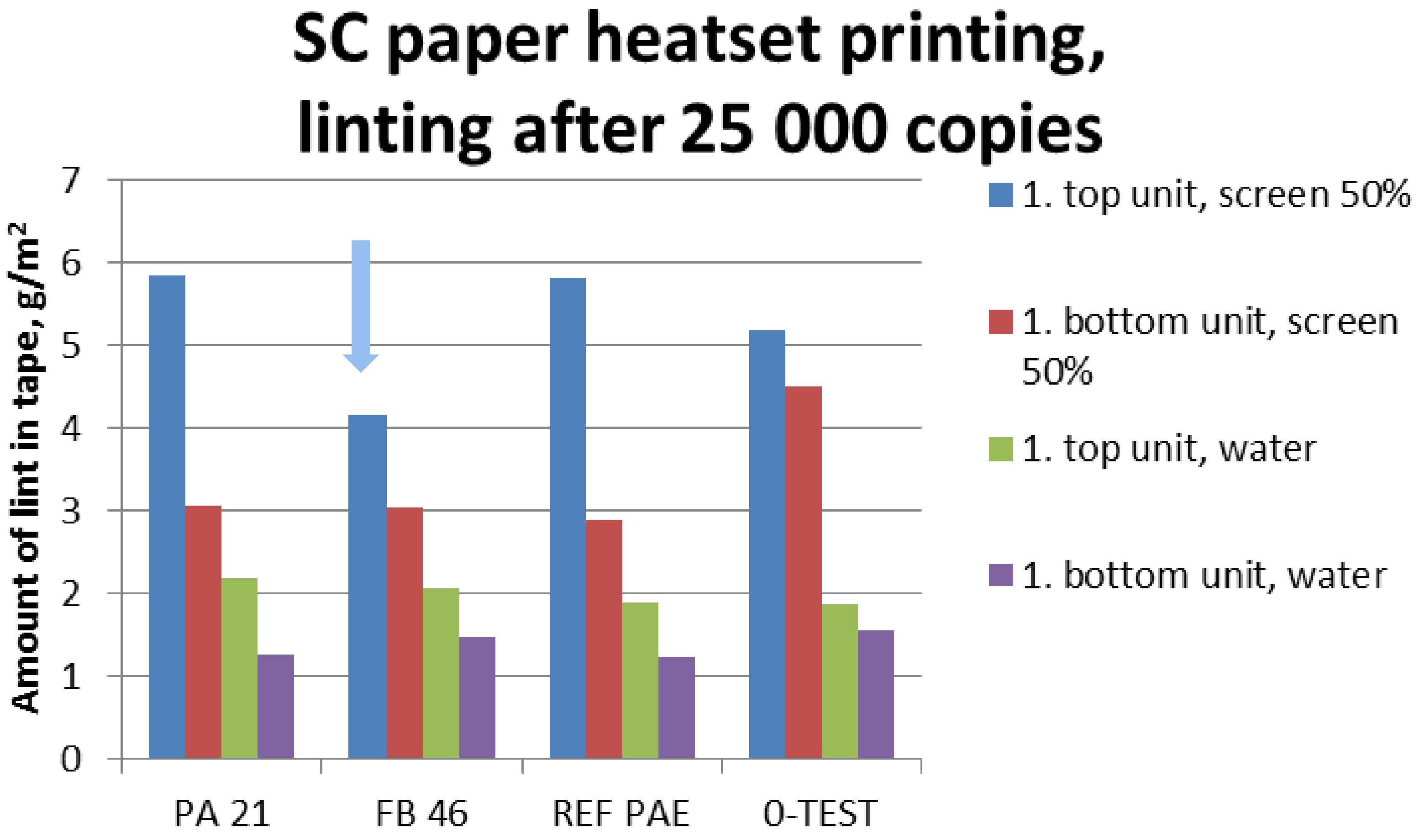
KCL PRINTING TRIAL

This trial paper had more issues with linting than dusting.

Linting was most critical in 1. top unit, screen 50% surface.

FennoBond 46 reduced lint by 29% in 1st top unit screen compared to reference PAE.

FennoBond 46 allows about 10 000 copies more.



EcoFill

Challenges for P&B grades

Poor and variable quality of recycled fibers, difficult to achieve high strength

Increasing cost of high quality recycled fibers

High ash level in the sheet: 10-20%

Closed water loops: conductivity 2-7 mS/cm, cationic demand 500-1500 µeq/l

Starch prices fluctuate, expecting shortage of starch in the market in the future

EcoFill

- Powder product, storage stable, high active content
- Anionic polymer, cationic component is needed for fixation
- Trade name: FennoBond ECA 360 or FennoBond ECA 720
- Mechanism: ionic bonds, hydrogen bonds, increased bonding area and number

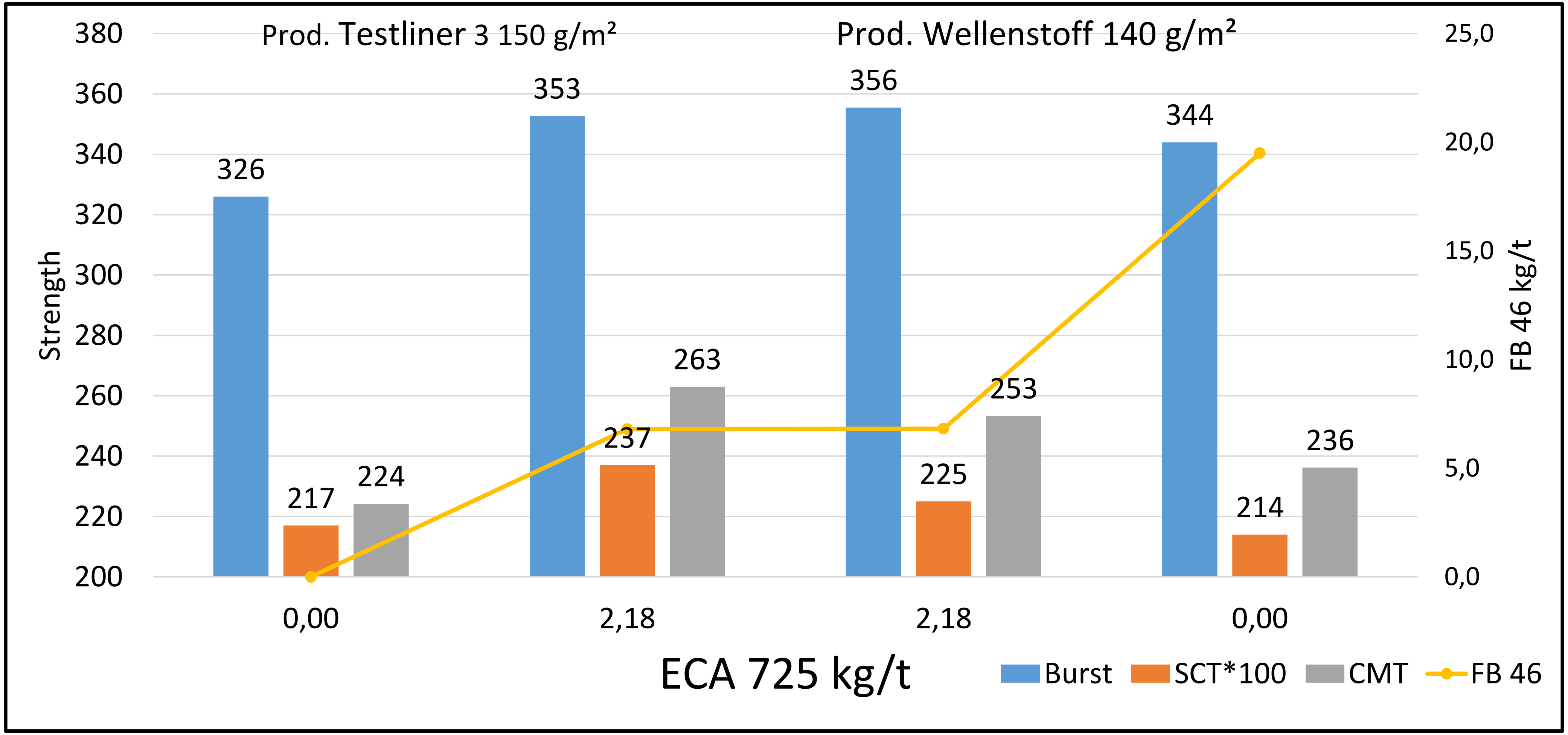
- Further details:
  - E.g. Jan-L. Hemmes, Jinho Lee, Ron Lai, Innovative Strength Technologies for Paper and Board on the Basis of Modified Renewable Raw Materials, J. of Korea TAPPI, 30. June 2017.

EcoFill for testliner

Machine overview	• 120.000 t/y Testliner, 100-200 g/m² • 100% RCF, unbleached • 2 Plies, Fourdrinier, shoe press • Size press • Conductivity: 4200 µS/cm, colloidal charge 350 µeq/ml
Needs	• Run size press only one sided • increase speed and/or safe steam • Stay safely within quality specification

Solution and Benefits	• EcoFill added to the back ply:
	    • FennoBond ECA 725 after mixing chest
	    • FennoBond 46 after machine chest
	
	• Strength increase: +10%, even when basis weight was reduced by 10 g/m²
	• Reduction of basis weight = fibers + steam + basis weight reduction may be feasible

Trial results, FennoBond ECA 720, avarage values



Summary

- Surface starch and/or wet end starch are not able to provide sufficient strength in all cases
- Synthetic dry strength agents are able to improve strength further and can positively influence dewatering, formation and retention
- Selection of a suited system depends on:
    - Required strength increase
    - The efforts/benefits for the customer
- Alternative or additiv to starch there are synthetic products, which can increase the achievable dry strength and productivity