Innovation in dry strength additives
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What are your drivers?
Value from investment in strength additives

Strength increase

Increase strength of paper board

Trade-off strength

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What are your drivers?

Value from investment in strength additives

Strength increase

Increase strength of paper board

- Quality upgrade
- Improved runnability
- Converting efficiency

Trade-off strength

- Fiber substitution with cheaper fibers, filler, ash
- Less chemicals (WSR, starch)
- Less refining (bulk, energy savings, less dust)
- Lower grammage (fibers & steam savings, faster speed)
Origin of strength: fiber – fiber bonds

Bonded joint

Bonding area at micro scale

\[ F = \sum_{k=1}^{n} F_n N_n \]

- \( F \): Strength
- \( F_n \): Strength of bond
- \( N_n \): Number of bonds

Bonded area: < 0.3 nm
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
Strength

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Mechanical means

- Refining
- Press
  - Dewatering
  - Volume
Strength

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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

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

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

- Fiber choice
  - Virgin fibre cost
  - Recycled fibre quality

Optimization is critical!
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
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/m²
- 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
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:
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, average values

**Graph:**
- **Prod. Testliner 3 150 g/m²**
  - Strength: 326, 353, 356
  - ECA 725 kg/t: 217, 237, 225
- **Prod. Wellenstoff 140 g/m²**
  - Strength: 344
  - ECA 725 kg/t: 214, 236

**Legend:**
- Burst
- SCT*100
- CMT
- FB 46 kg/t
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