Enhanced Capabilities in Wet-end Paper Machine Clothing

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Introduction

- Increased demand for higher paper machine production and efficiencies as well as lower total operating costs has led to the development of two new concepts in Forming Fabric design
- Ultra High Fiber Support – Sheet Quality
- Surface Enhancement – Machine Runnability
- Comparison of new concepts to current standard structures
- Case stories of both separately and in combination

Key Properties of Forming Fabrics

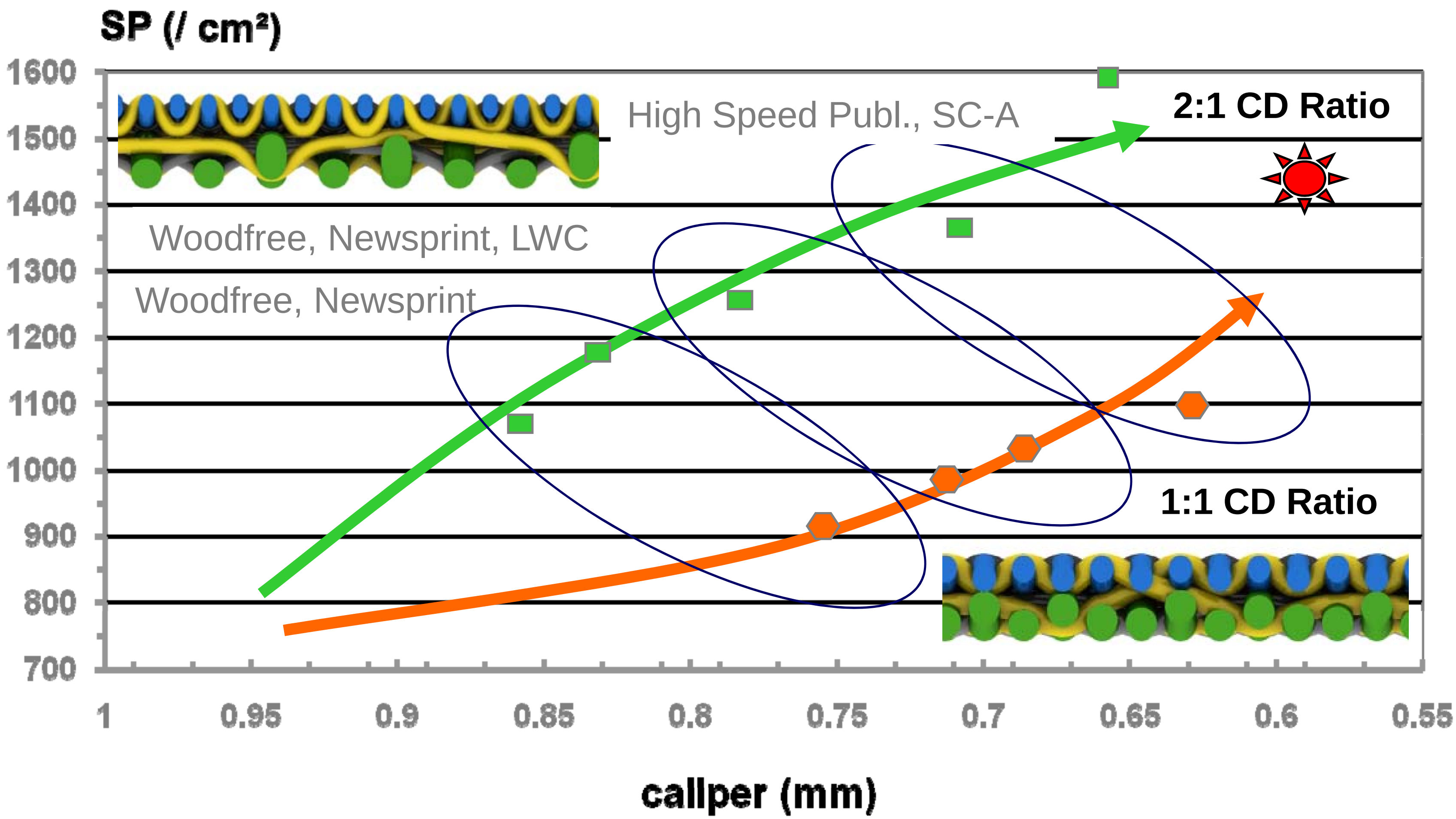
- Support fiber mat, Drainage of water, Transport formed sheet to press section
- Woven structure patterns developed to enhance one or more key properties
- Publication grade machines globally today primarily run MD or CD bound self supporting binder (SSB) triple layer structures.
  - Similar trend in tissue/towel and packaging/board grades more recently

Key Properties of Forming Fabrics

- Key measures of Fiber Support and Drainage
  - # support points / cm^2 or Fiber Support Index (FSI)
  - Shape of drainage channels
  - Air permeability
  - Caliper
  - Internal void volume
- Trend is almost always towards finer and thinner

SSB Evolution

Publication grades



Ultra High Support

- Developed for enhanced sheet quality
- New woven structure with increased paper side CD yarn support
- Alters CD yarn ratio from standard 2:1 to 3:1 for greater sheet support
- Benefits include sheet smoothness, print quality, porosity, fines/filler retention

Figure 1 Paper side and wear side comparison of 2:1 and 3:1 CD yarn ratio SSB structures

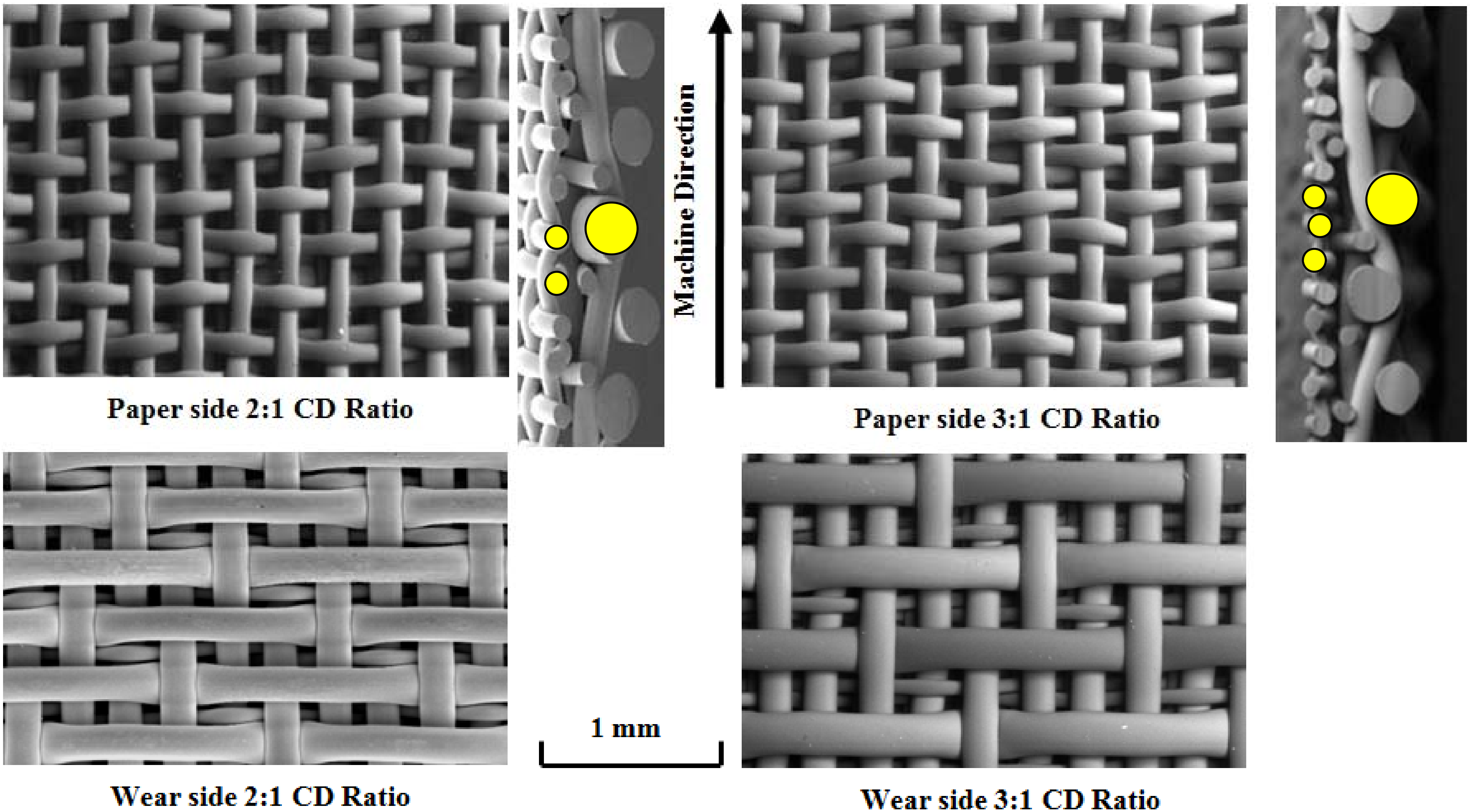


Table I Key Characteristics for the SSB structures used in the fabric/sheet contact studies

Fabric ID	Paper Side Mesh x Count MD x CD /cm	Yarn diameters MD : CD [mm]	Support points No per cm²	FSI	Caliper [mm]	Air Perm [m/s]	CD Ratio Top:Btm
A	28.5 x 39.0	0.13/0.21 : 0.13/0.30	1,130	180	0.89	1.50	2:1
B	34.5 x 42.0	0.11/0.18 : 0.11/0.25	1,450	200	0.72	1.50	2:1
C	38.0 x 43.0	0.10/0.17 : 0.10/0.24	1,635	210	0.68	1.50	2:1
D	28.5 x 47.0	0.13/0.21 : 0.13/0.30	1,340	207	0.85	1.50	3:1
E	34.5 x 58.0	0.11/0.18 : 0.11/0.25	2,000	255	0.71	1.46	3:1
F	38.0 x 58.0	0.10/0.17 : 0.10/0.25	2,200	261	0.71	1.51	3:1

SSB Evolution
Publication grades

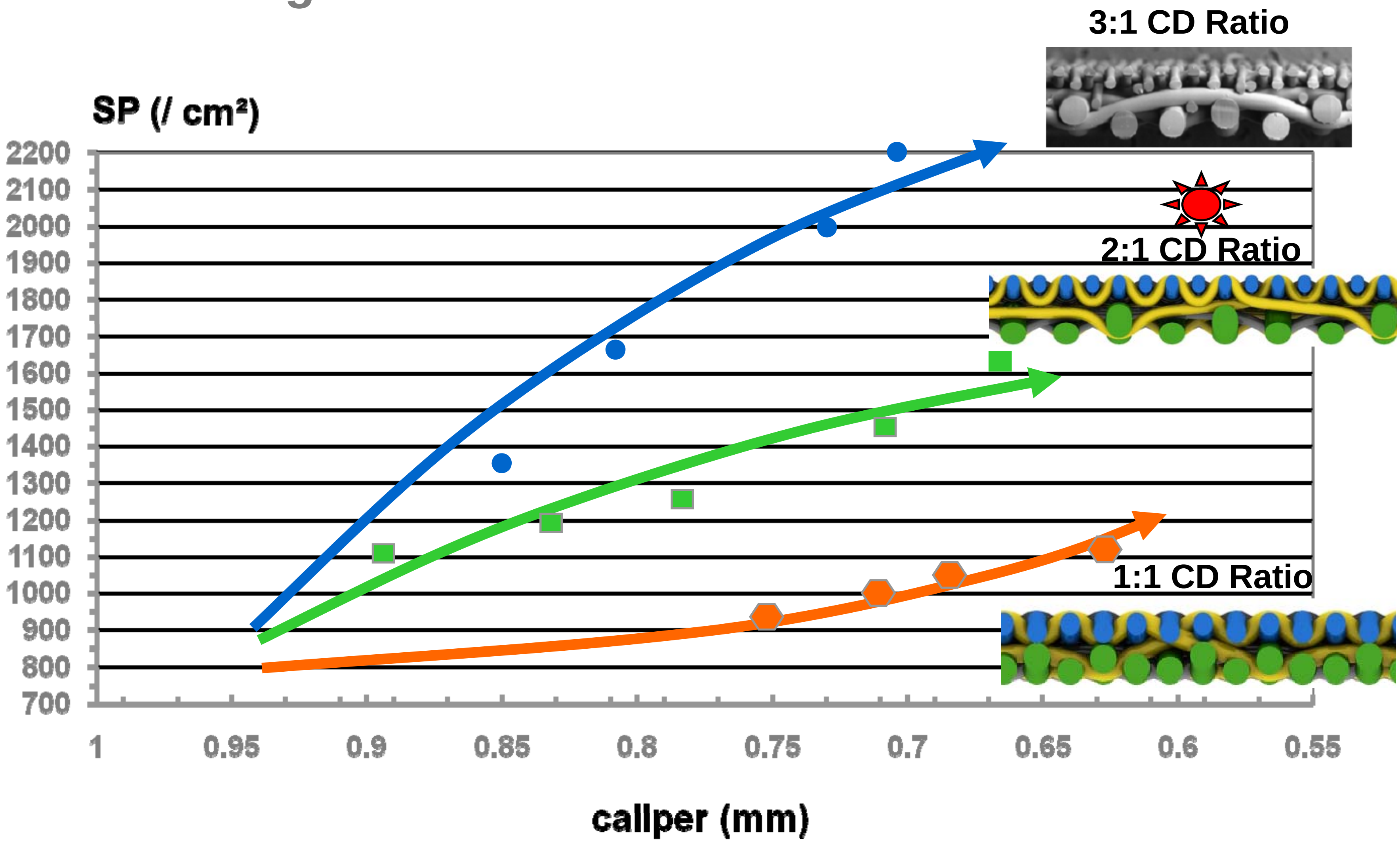


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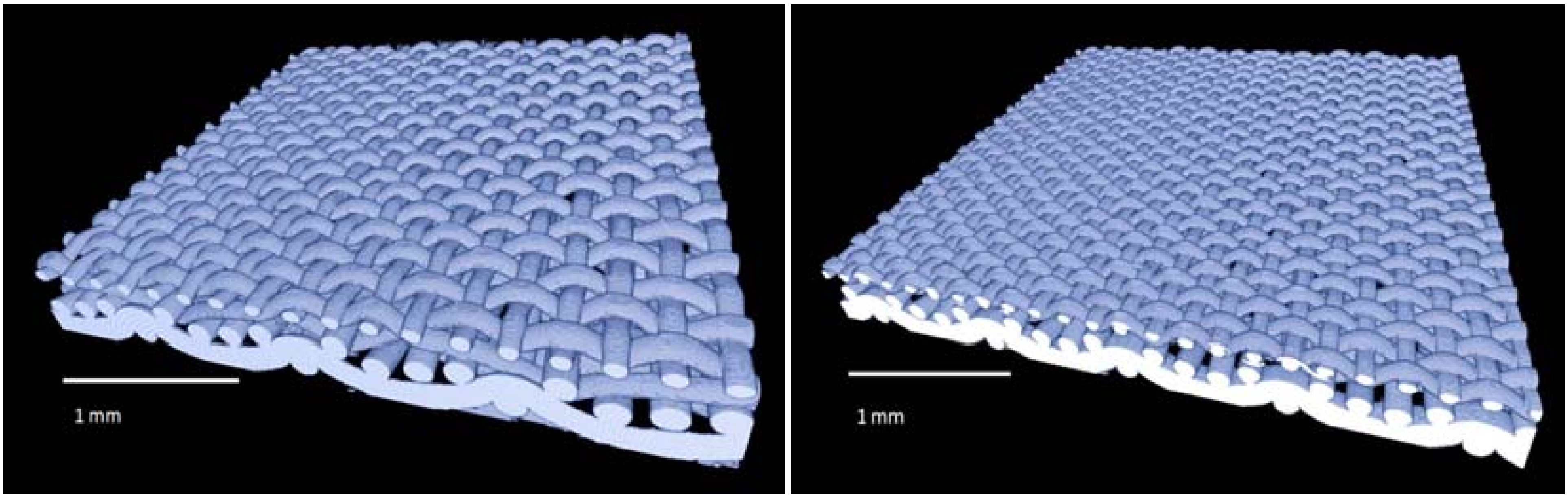
Figure 2 Micro x-ray computed tomography model images of two SSB structures



Structure A: 28.5/cm Mesh
2:1 CD yarn ratio

Structure F: 38.0/cm Mesh
3:1 CD yarn ratio

Figure 3 Cross section of Fabric B (2:1 CD ratio) from paper to wear side to demonstrate the changing open area of the structure

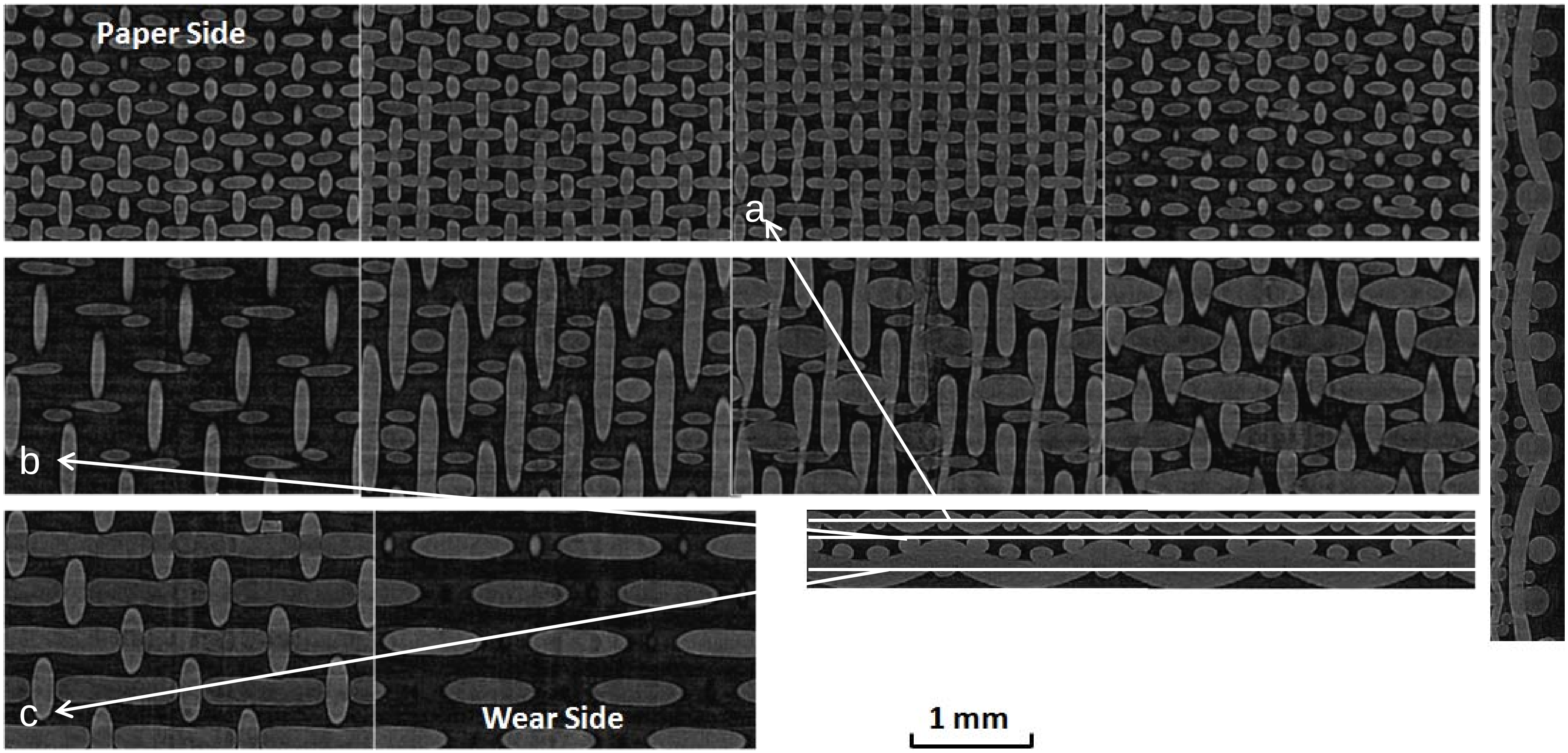
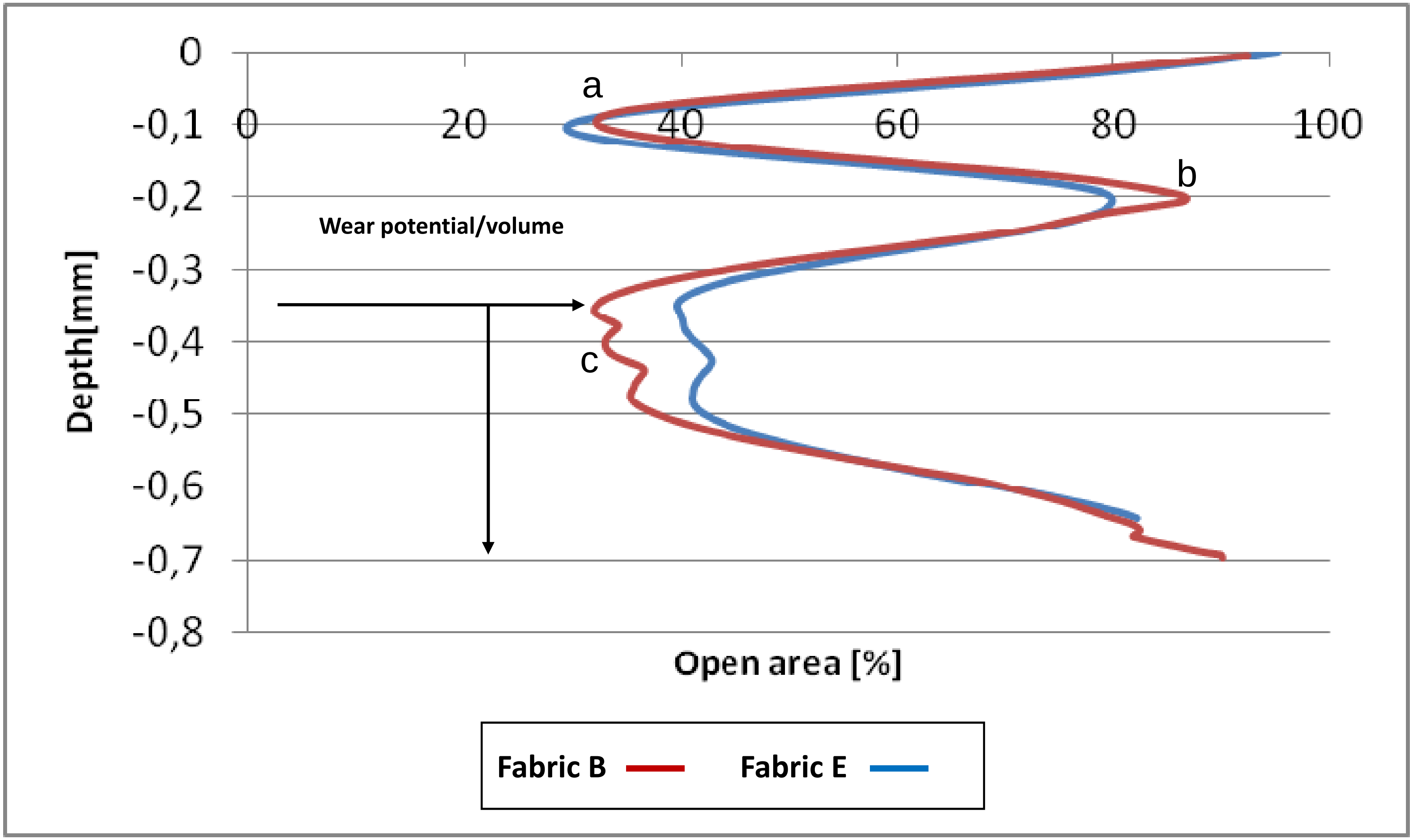
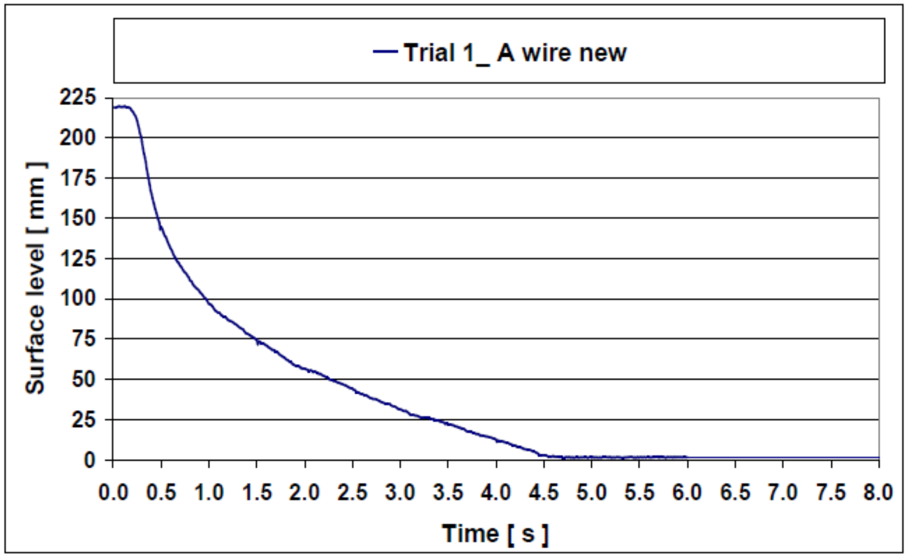


Figure 4 Open area as a function of position or depth through the fabric



Drainage / Retention Comparison between 2:1 and 3:1 CD ratio SSB Designs

- Measured with “Juupeli” vacuum assisted sheet former
  - Measured amount of stock containing filler poured onto fabric
  - Constant vacuum level below fabric
  - Surface level monitored with ultrasonic detector for slurry thickness
  - No additional shear forces applied during dewatering
  - Repeat test method to determine process variability
- Drainage time determined
- Former sheet samples measured for fiber and filler retention



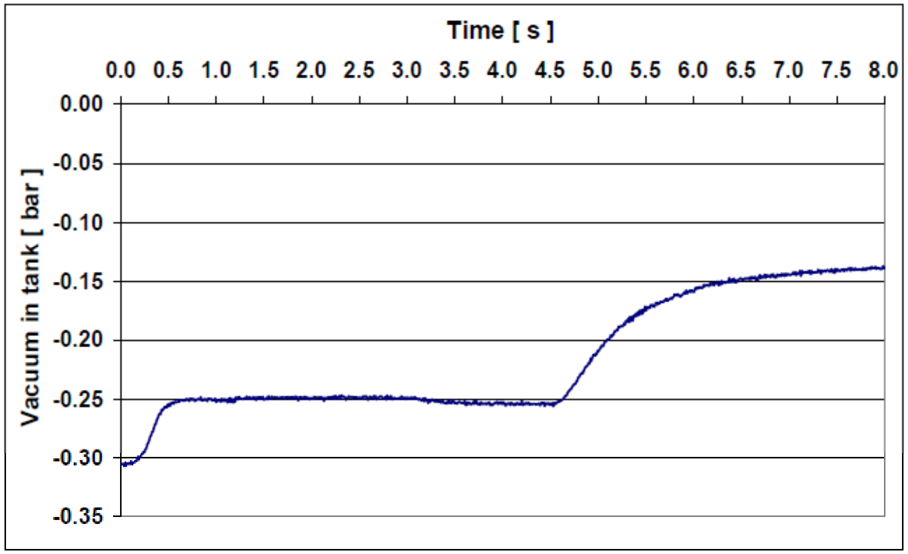


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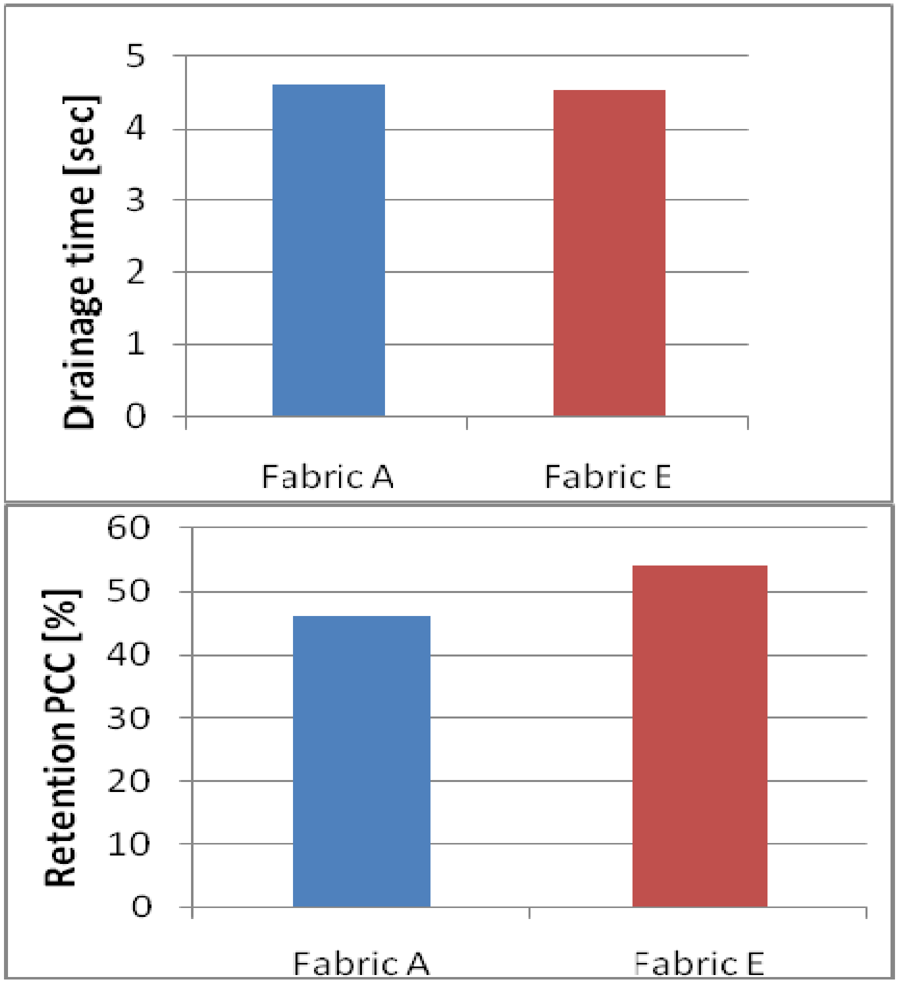
Figure 5 PCC retention and drainage time for Fabric A (2:1 CD ratio) and Fabric E (3:1 CD ratio)

- Greater sheet support (FSI) of 3:1 CD ratio design builds more uniform fiber mat without restricting drainage of smaller openings
- Drainage time slightly faster with high support design
- Retention of filler significantly higher



Tests performed on "Juupeli" vacuum assisted sheet former at VTT Technical Research Centre of Finland.
Grammage 80 g/m^2, Eucalyptus pulp, SR^{0}30 with PCC

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Surface Enhancement

- Developed for enhanced machine runnability
- Proprietary manufacturing process flattens paper side knuckles
- Densified internal void volume of structure
- Reduced overall fabric caliper
- Benefits include reduced wire knuckle mark, improved vacuum dewatering efficiency, higher couch solids, cleaner running former

Table II Properties before and after enhancement of Fabric B (34.5/cm Mesh, 2:1 CD ratio)

Surface Enhancement	Open Area at surface [%]	Caliper [mm]	Void Volume	Air Perm[1,2] (m/s)	Plane difference (µm)
Non-Enhanced	39	0.70	0.57	1.5	30
Enhanced	37	0.65	0.55	1.5	20

1. ASTM D737 – 96
2. The CD-yarn density was altered for the enhanced sample in order to reach the same air perm.

Figure 6 Micro x-ray tomography model images of fabric before and after surface enhancement

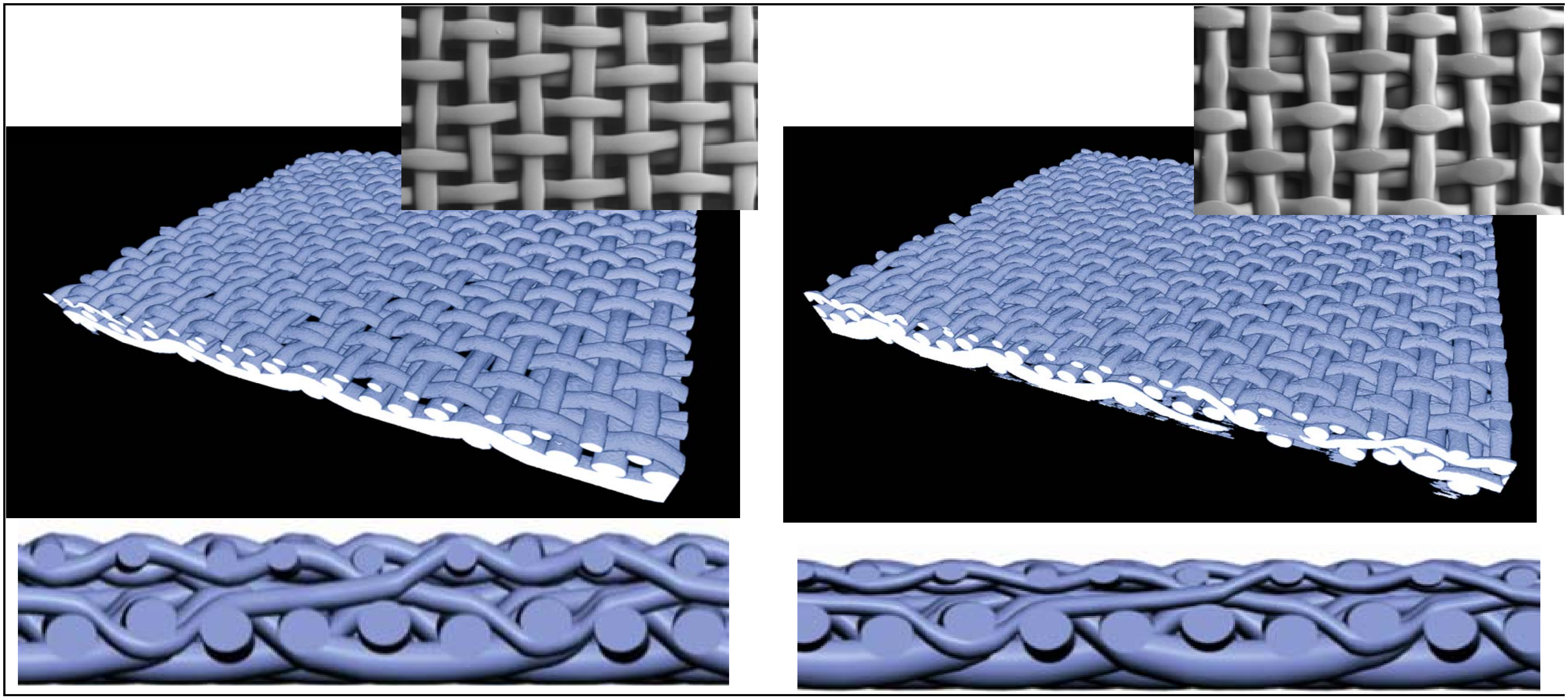
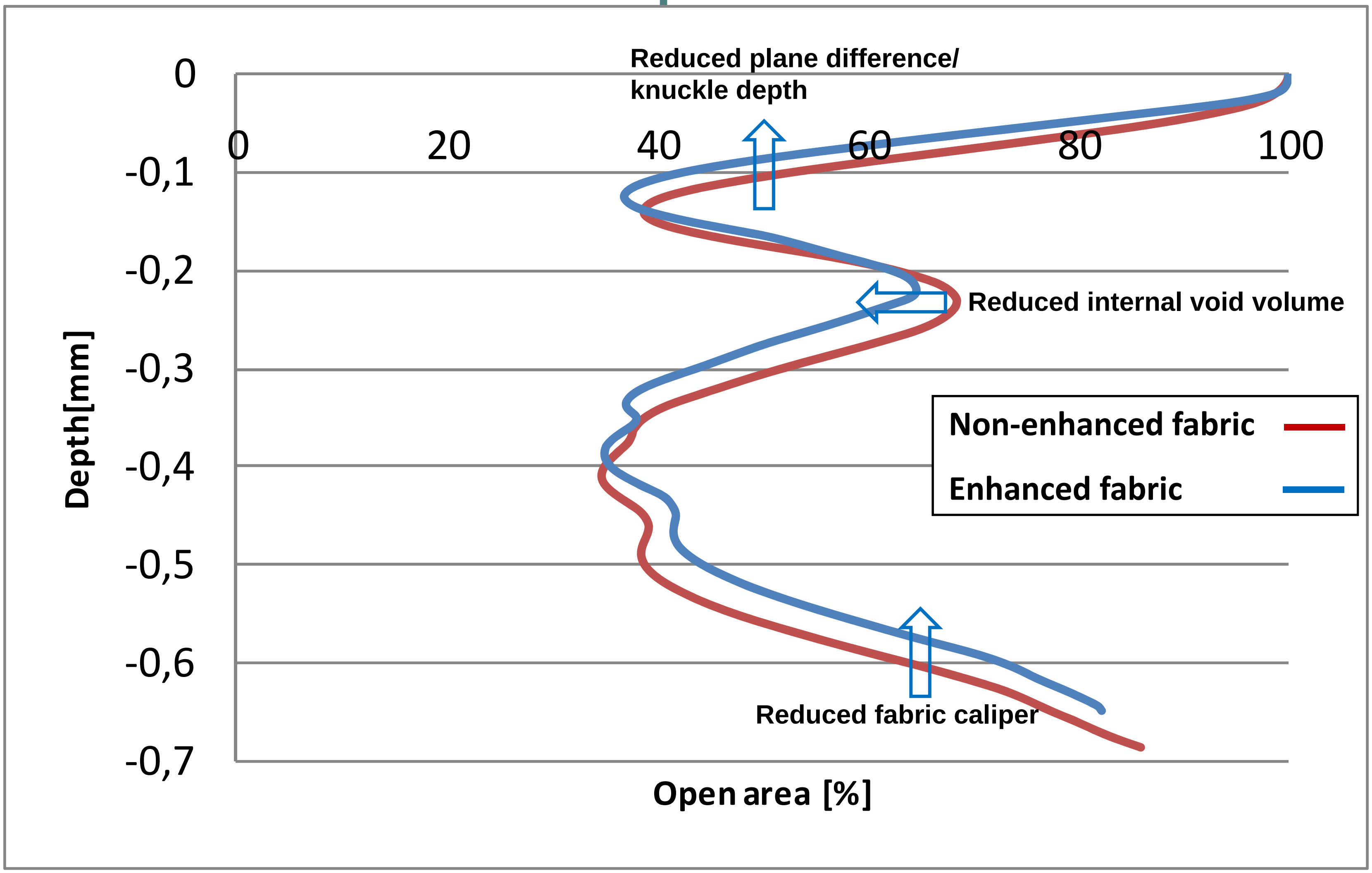


Figure 7 Open area as a function of position or depth comparison for before and after enhancement process



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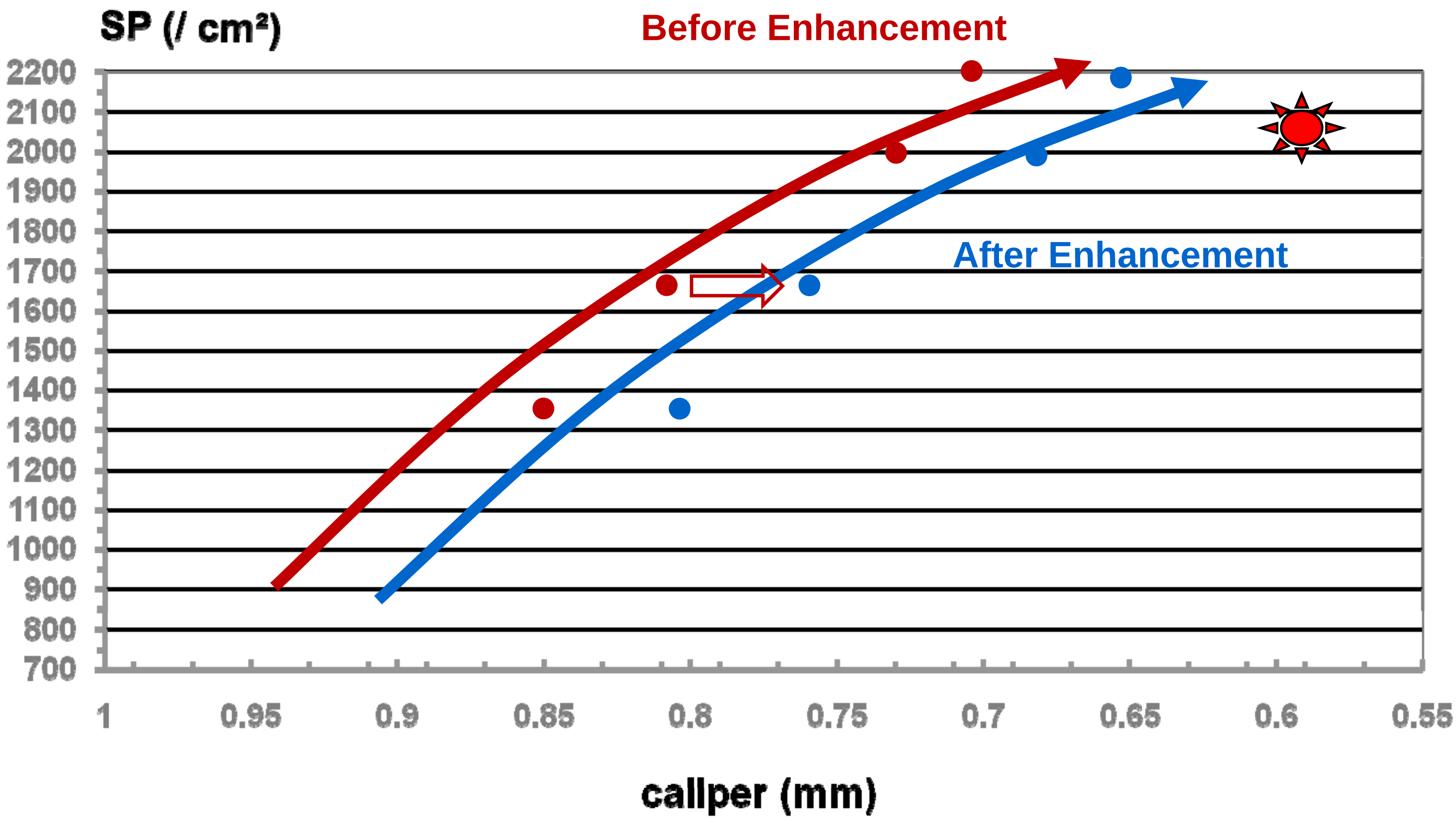

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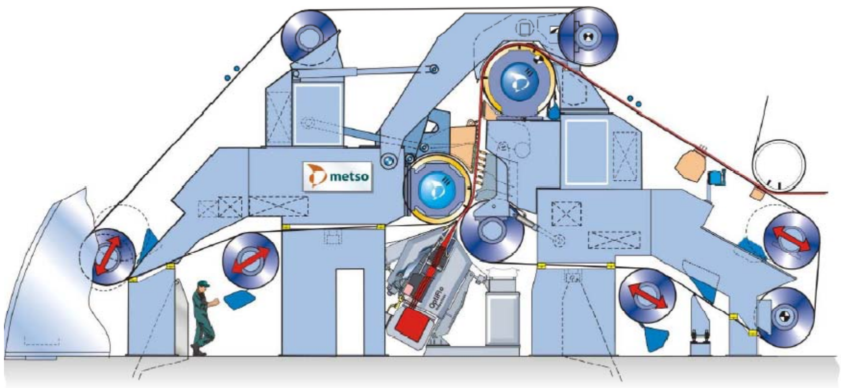
Case Stories

Case Story 1

Metso Optiformer with Loadable Blades producing SC-A Magazine grades at 1800 mpm

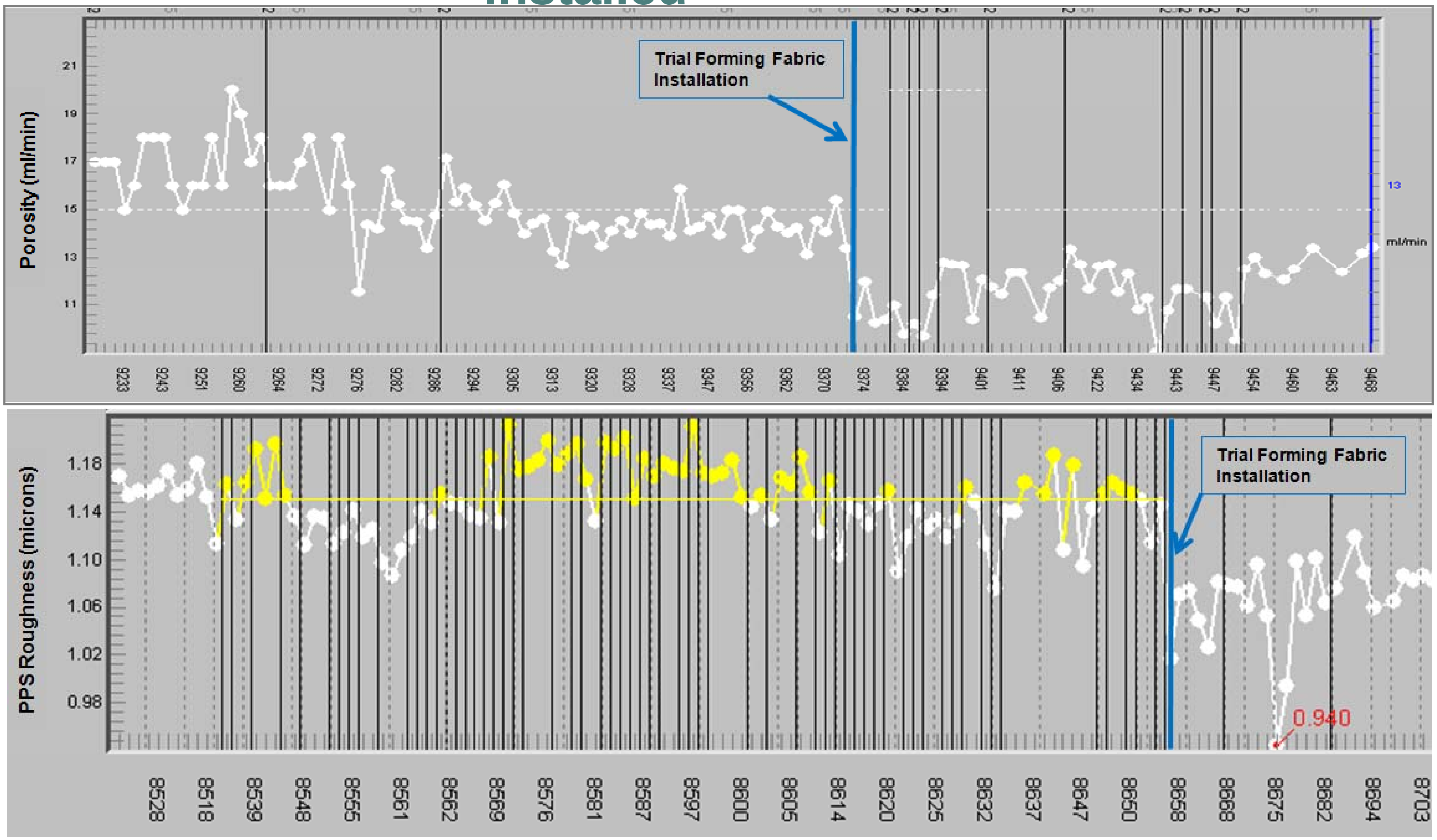


- Standard design Fabric B on both positions
  - 34.5/cm^2 mesh, 2:1 CD ratio
- 1st trial – Fabric C on both positions
  - 38.0/cm^2 mesh, 2:1 CD ratio
- Improvements in sheet porosity and PPS roughness, same level wet end breaks, former cleanliness

Metso and Optiformer are trade names of Metso Corporation

Case Story 1

Sheet porosity and PPS roughness before and after set of trial Fabric C installed



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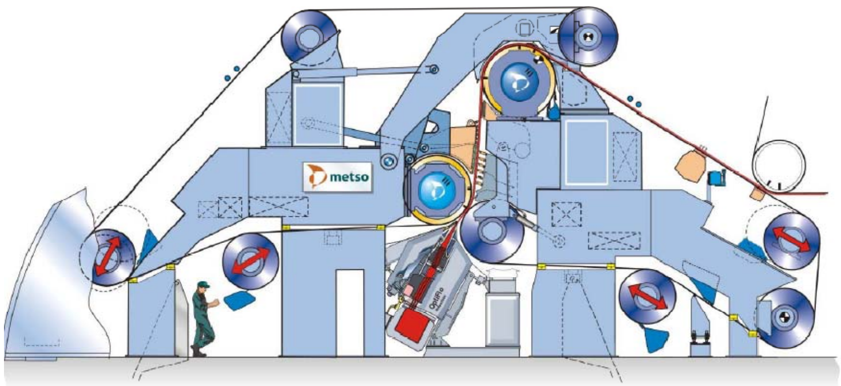

- Standard design Fabric B on both positions
  - 34.5/cm² mesh, 2:1 CD ratio
- 1st trial – Fabric C on both positions
  - 38.0/cm² mesh, 2:1 CD ratio
- Improvements in sheet porosity and PPS roughness, same level wet end breaks, former cleanliness
- 2nd trial – Fabric E on outer position, Fabric B on inner
  - 34.5/cm² mesh, 3:1 CD ratio outer
  - 34.5/cm² mesh, 2:1 CD ratio inner
- Reduced wet end breaks
- Improved top side gloss, PPS roughness and missing dots

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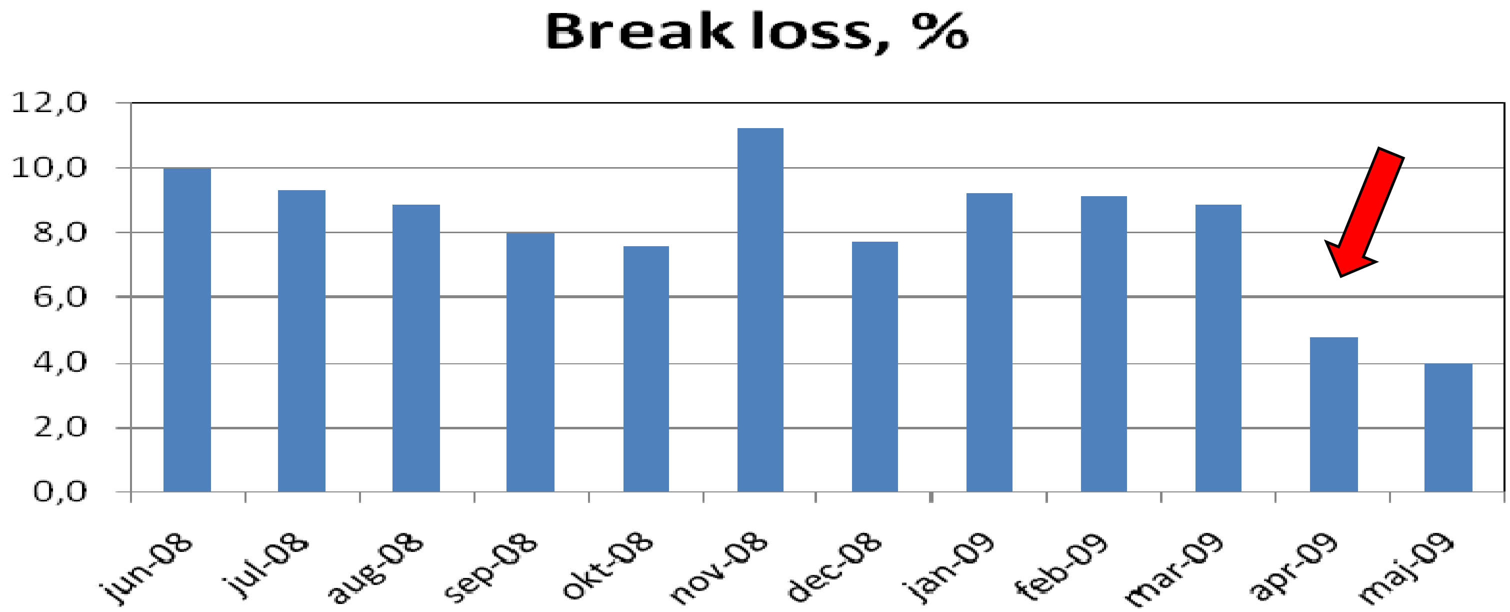
Case Story 1

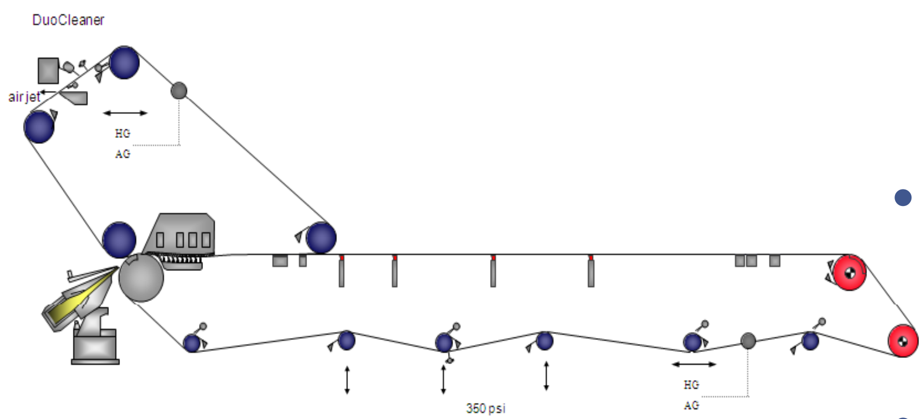
Sheet break reduction and sheet surface improvements with High Support Fabric E on outer (top) position



Fabric	Gloss [TS]	PPS [TS]	Missing dots [dots/unit area]	Sheet breaks* [%]
B	53,1	1,1	1,7	9,0
E	55,3	1,0	1,0	4,5

*Lost production

Case Story 2 — Voith Duoformer CFD producing LWC grades at 1250 mpm

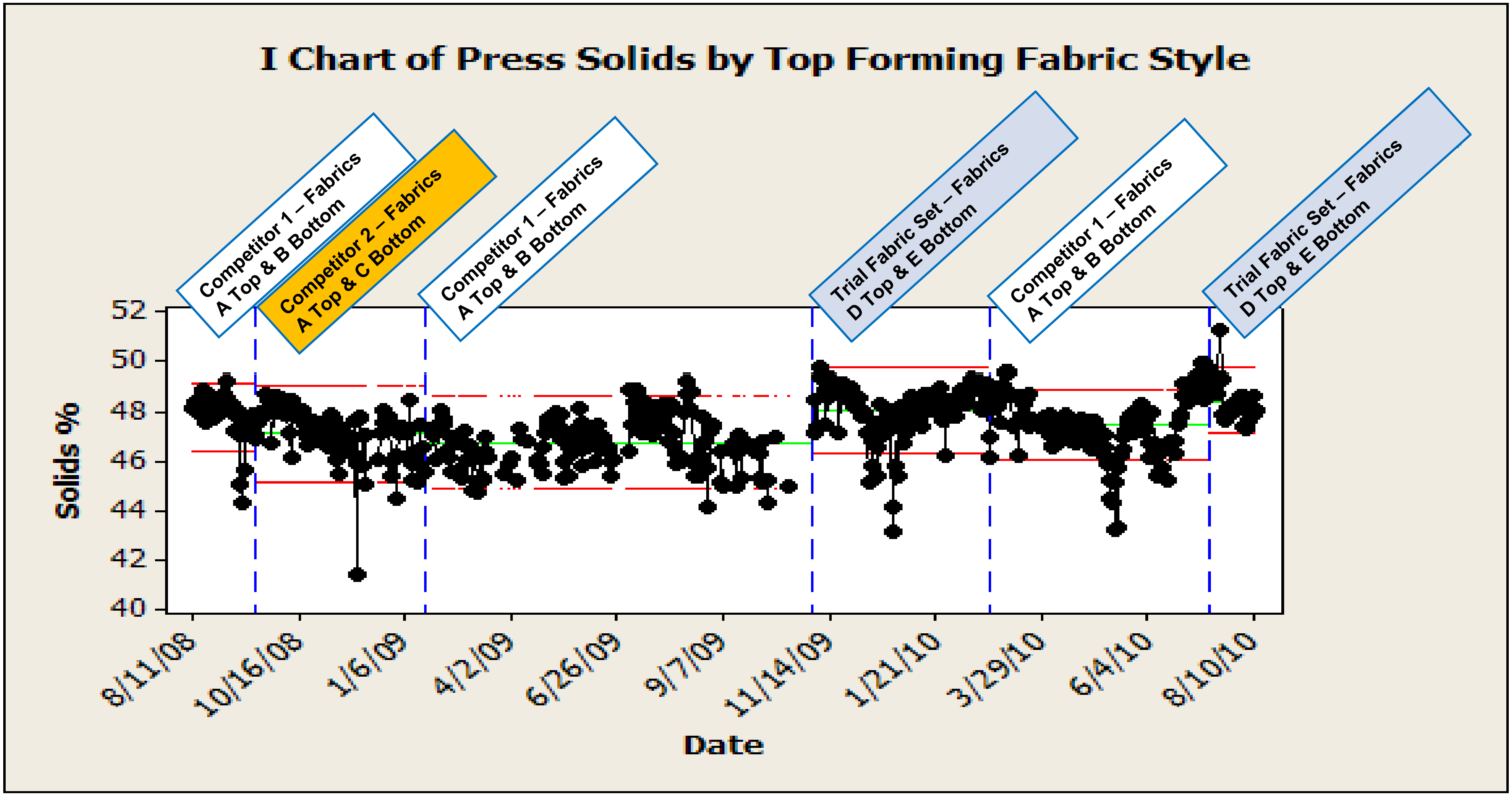


- Standard design Fabric A on top and B on bottom positions
  - 28.5/cm^2, 34.5/cm^2 mesh, 2:1 CD ratio
- High Support Trial set – Fabric D on top and E on bottom positions
  - 28.5/cm^2, 34.5/cm^2 mesh, 3:1 CD ratio
  - Top fabric surfaced enhanced
- Increased couch solids by avg. 0.8%, press solids by 1.0%
  - Improved sheet formation and lower press draws contributed
- Steam consumption reduced 4.1%

Voith and Duoformer CFD are trade names of Voith Paper Holding GmbH & Co. KG

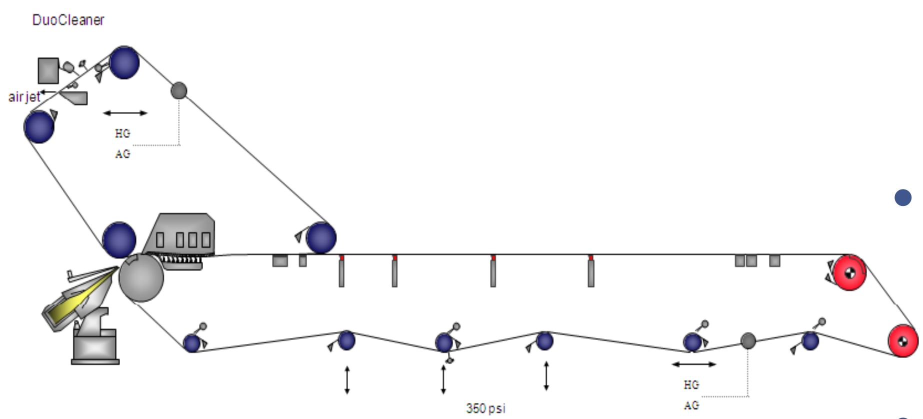
Case Story 2

Daily average press solids gain while running trial set of high support fabrics with the top fabric being surface enhanced



Case Story 2

Voith Duoformer CFD producing LWC grades at 1250 mpm



- Standard design Fabric A on top and B on bottom positions
  - $28.5/cm^2$, $34.5/cm^2$ mesh, 2:1 CD ratio
- High Support Trial set – Fabric D on top and E on bottom positions
  - $28.5/cm^2$, $34.5/cm^2$ mesh, 3:1 CD ratio
  - Top fabric surfaced enhanced
- Increased couch solids by avg. 0.8%, press solids by 1.0%
  - Improved sheet formation and lower press draws contributed
- Steam consumption reduced 4.1%
- Improved former cleanliness resulted in wet end break reduction from 2.0 to 1.4 per day avg.
- Speed increased 15 to 45 mpm depending on sheet basis weight

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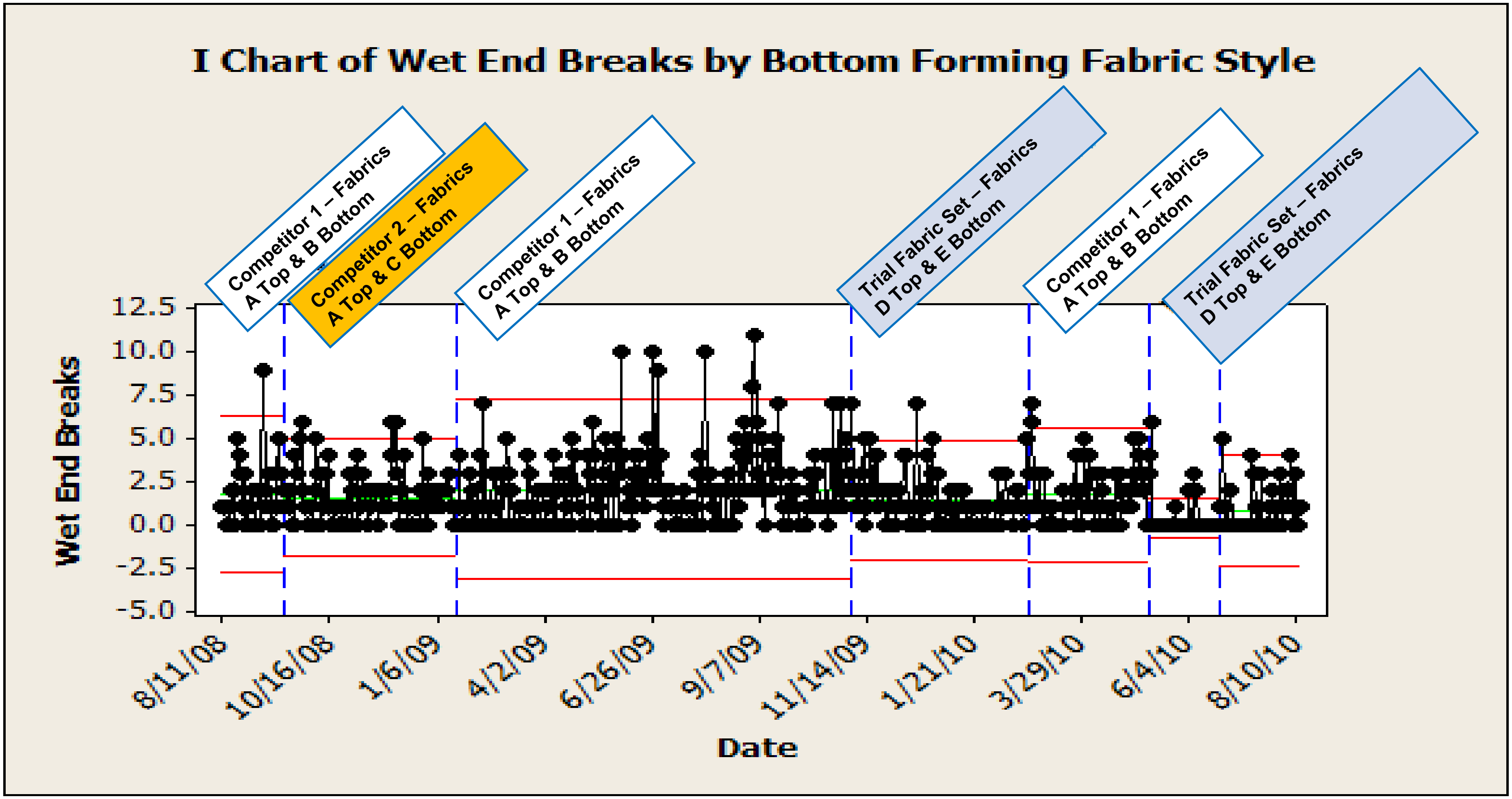
Case Story 2

Daily average wet end breaks reduced while running trial set of high support fabrics with the top fabric being surface enhanced



Conclusions

- Demands for operating efficiency gains and particularly energy consumption reductions are more critical for all paper grades regardless of size, speed or age of machine
- PMC clothing suppliers have responded by developing new structures that can enhance overall paper quality as well as operational efficiency
- Two new examples were introduced here
  - Ultra High Support structure for sheet quality
    - Formation, porosity, smoothness, print quality, fines/filler retention
  - Surface Enhancement for machine runnability
    - Vacuum dewatering efficiency, couch solids, former cleanliness, wet end breaks
- Both concepts have been proven separately and in combination on commercial publication grade machines worldwide

Questions?

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