INCREASING WET END TURBULENCE IN MOLDED FIBER PRODUCTION

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A Kiefel-Solenis Collaboration Project

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BGU, Dover, NH

Impetus for the Study

Customer Driven

- The market is always searching for the means to make a better product faster.
  - How can we improve strength properties?
  - How can we reduce cycle time?
  - How can we improve OGR and other barrier properties?

A Critical Papermaking Parameter- Formation

- Approach System, Headbox, Slice lip and Table
  - All setup to create an even distribution of fiber and keep flocculation to a minimum until the sheet is set.
  - Significant time and technology spent on this part of the papermaking process.
  - Improved formation, or minimum flocculation of the fiber mat, provides
    - Improved strength
    - Improved drainage and drying- speed improvement
    - A less porous sheet
    - Better printability (might translate to holdout in MF)

Densification of the Fiber Mat

Hubbe, Martin. (2002).

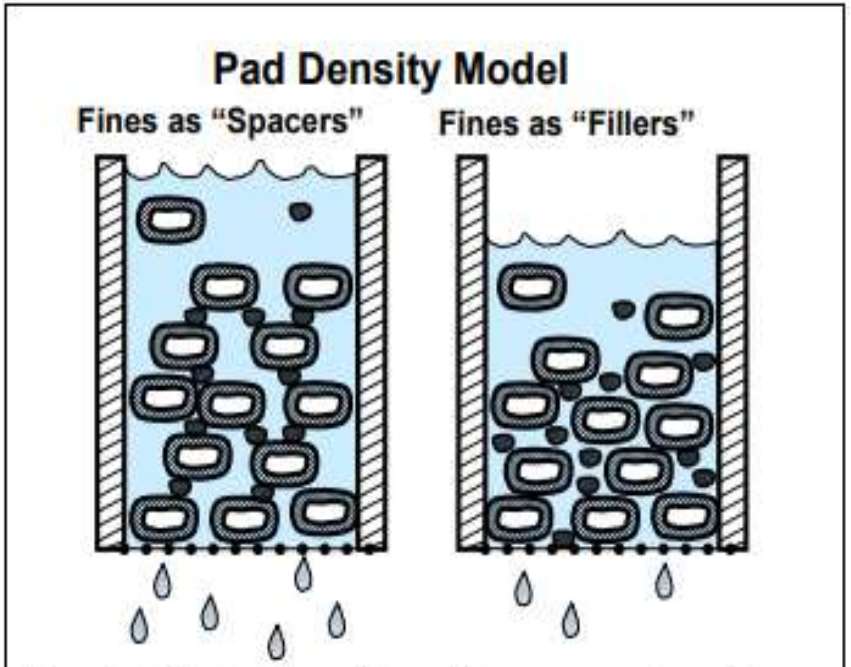


Fig. 4 – Illustration of how fines may act as either spacers or fillers in a wet mat of fibers, thus affecting its density and permeability.

Examples of Formation

Good Formation- Even Fiber Distribution

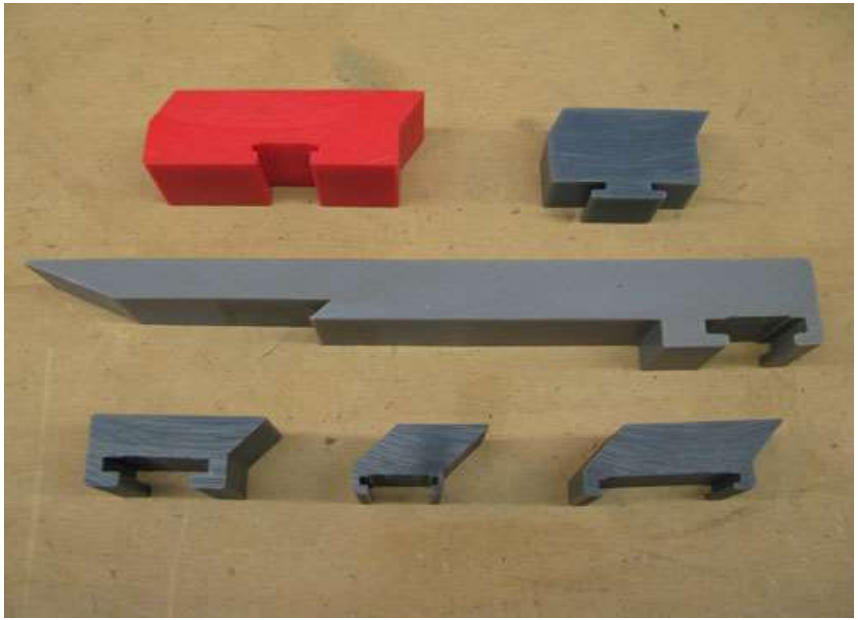
Poorer Formation- Heavy Floc Formation

Impetus for the Study

Papermaking Experience

- Turbulence is key to wet end forming on a paper machine.
  - Improves drainage.
  - Improves formation.
    - Improves strength
    - Improves hold out
  - Can we take this base knowledge and transfer it to molded fiber?

Table Foil Elements Designed for Turbulence



Equipment

List of Equipment

- Regmed Lab Refiner
  - Fine Bar Refiner Plates
- L&W Fiber Analyzer
- Kiefel Natureformer KFT Lab
  - Shallow Tray
- Modix 3D Printer
- Testing Equipment at Solenis Technical Center
  - Paper-perfect Formation Tester
  - Caliper Meter
  - Porosity Tester
  - Tensile Tester
  - Mullen/Burst Tester

Equipment

Regmed Lab Refiner

- Refiner Specs
  - 7.5 hp, 1750 rpms
  - 50-liter capacity

Equipment

Fine Plate Specifications

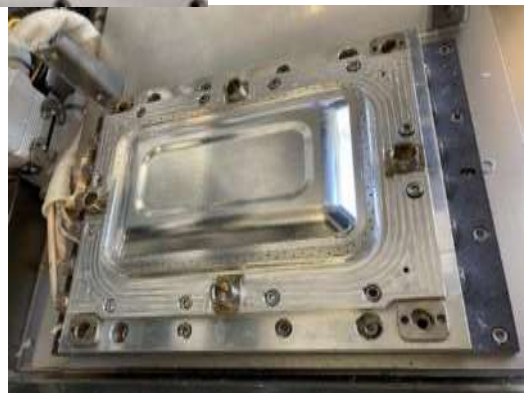
- Sectors – 20
- Angle- 12.5
- Bar- 1.2 mm
- Groove- 2 mm
- CEL – Cutting Edge Length- 0.89 km/rev
- Cutting Speed- 25.96 km/s
- SEL- Specific Edge Length- 0.1 W.s/m

Equipment

Kiefel Natureformer KFT Lab

Equipment

Shallow Tray



Pulp Specifications

Cascade White Gold

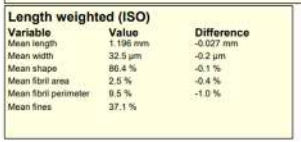
Length weighted (ISO)

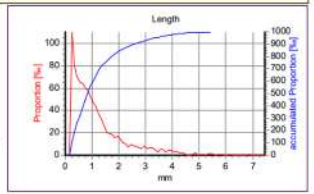
Variable	Value	Difference
Mean length	1.196 mm	-0.027 mm
Mean width	32.5 µm	-0.2 µm
Mean shape	86.4 %	-0.1 %
Mean fibril area	2.5 %	-0.4 %
Mean fibril perimeter	9.5 %	-1.0 %
Mean fines	37.1 %	

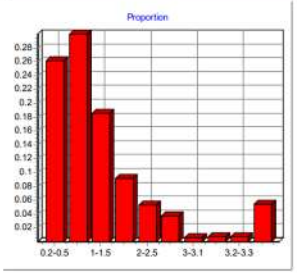
Lorentzen & Wettre
A MEMBER OF THE ABB GROUP

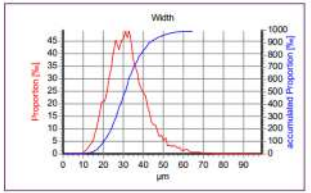
Sample name: Cascade 400 CSF
Sample type: Default
Time: 8/30/2024 8:58:18 AM
Comment

Number of fibers 20008 (324840)
Number of images 8068
Temperature 44.1 °C

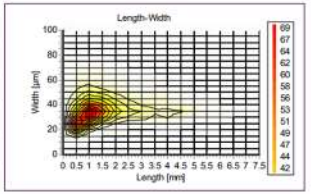






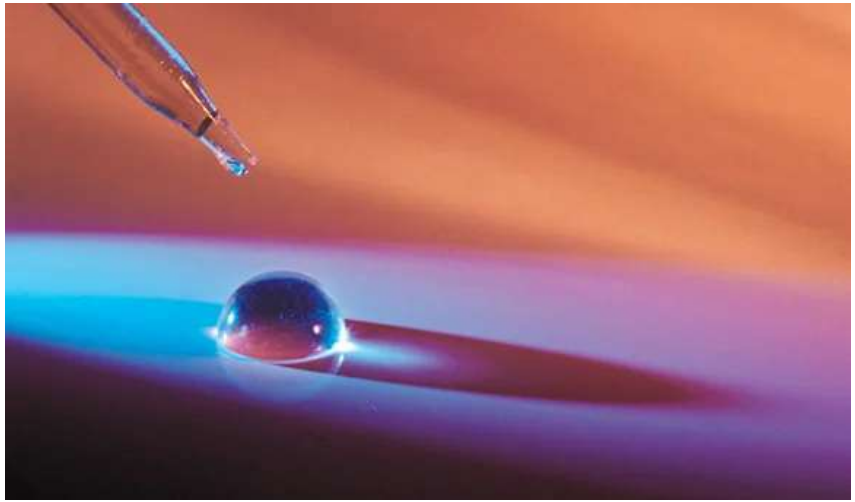


Variable	Weighting	Value
Fines	Length	37.1 %
Number of fibers		20008 (324840)
Number of images		8068
Temperature		44.1 °C
Fiber Wall Thickness		- µm



Chemistry Package

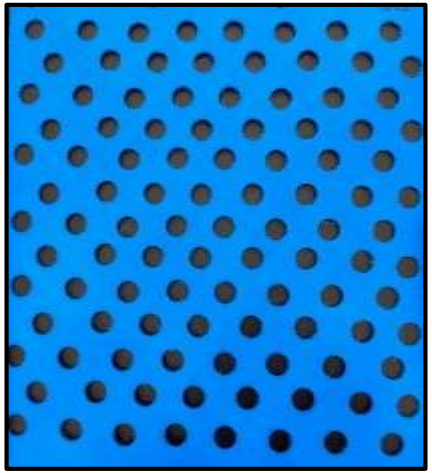
- Same chemistry package for all
- Chemistry in order of addition
  - OGR
    - Topscreen MF-305 @ 8%
  - Water sizing (AKD)
    - Topscreen MF7900 @ 1%
  - Drainage and sizing promotor
    - Xelorex RS1200 @ .5%
- All chemistries added to stock tub- 1 minute between each addition
- As received based on dry fiber



Turbulence Creation

Machine and Parameter Changes

Pump speed



Changing the pulp flow pattern

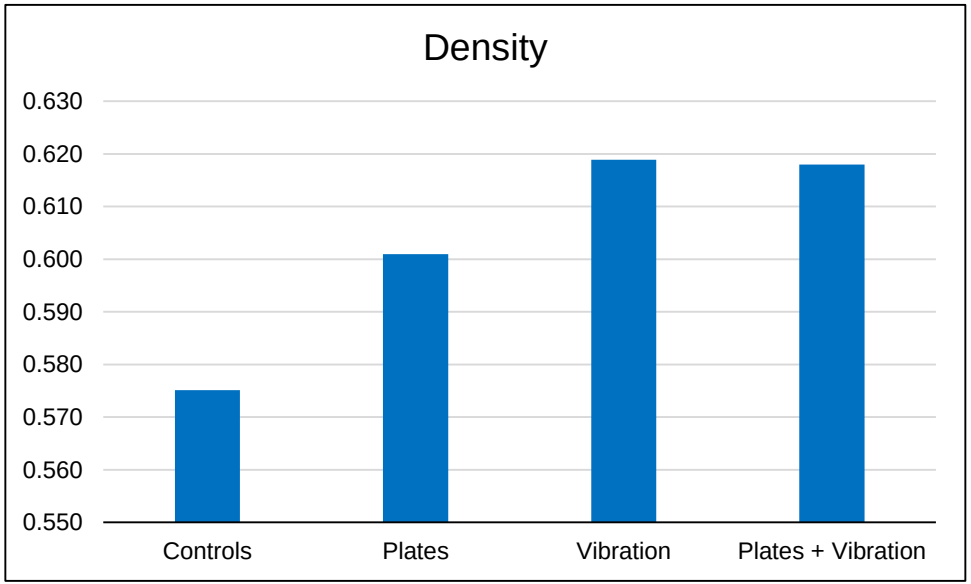
Vibration

Post-Trial Testing

Testing at Solenis' Wilmington Research Center

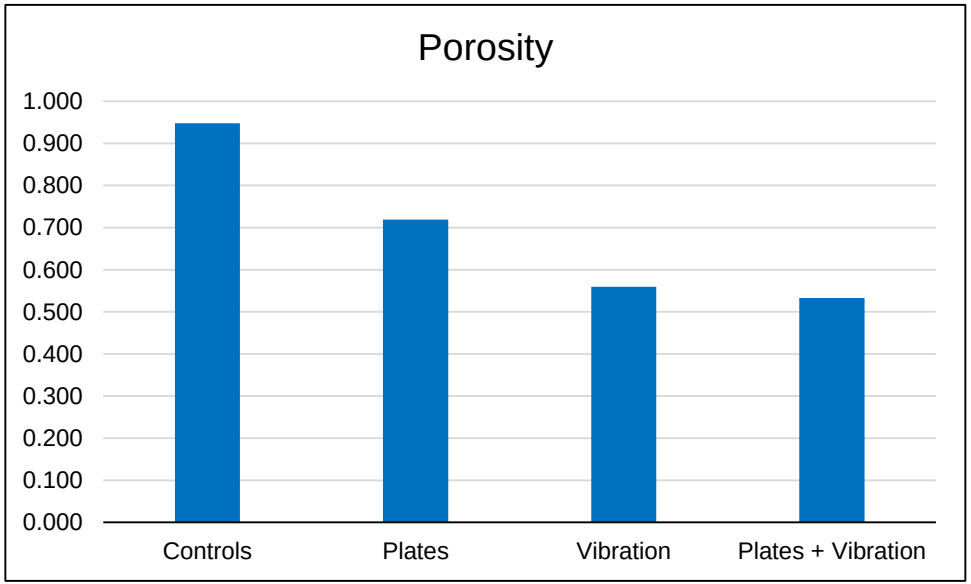
- Basis Weight
- Caliper
- Density
- Porosity
- Dry Tensile
- Dry Stretch
- Dry TEA
- Dry Mullen
- Formation
- Oil Holdout
- Water Holdout

Stock Turbulence vs Density



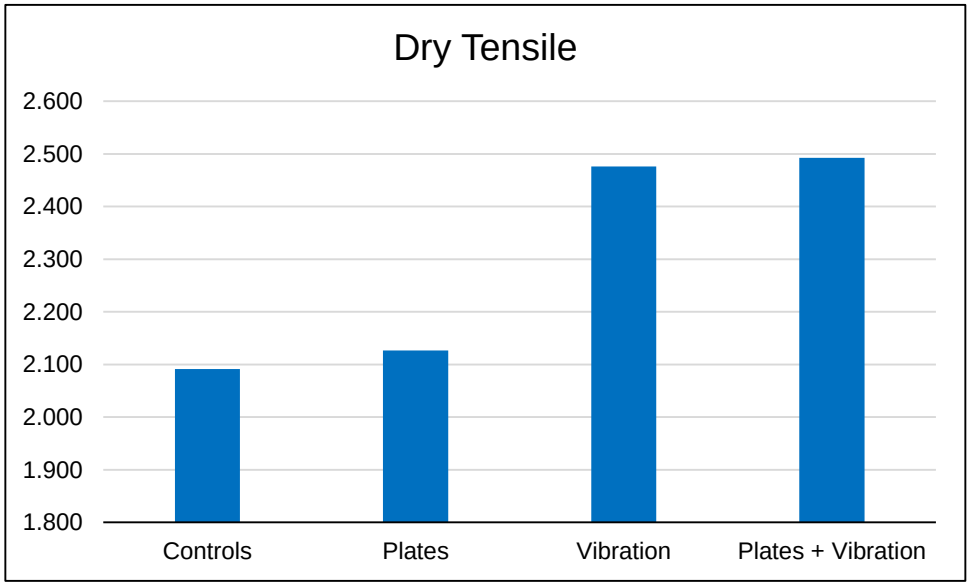
Stock Turbulence vs Porosity

Normalized for Weight

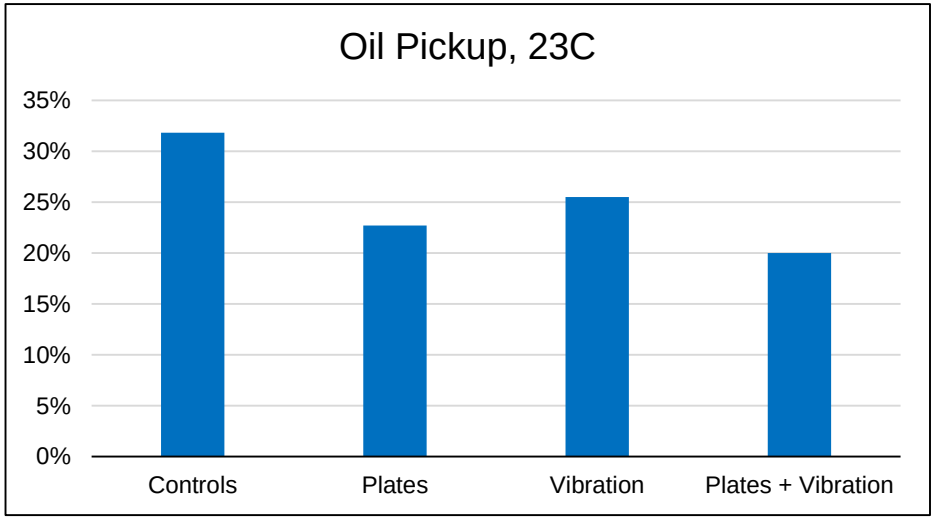


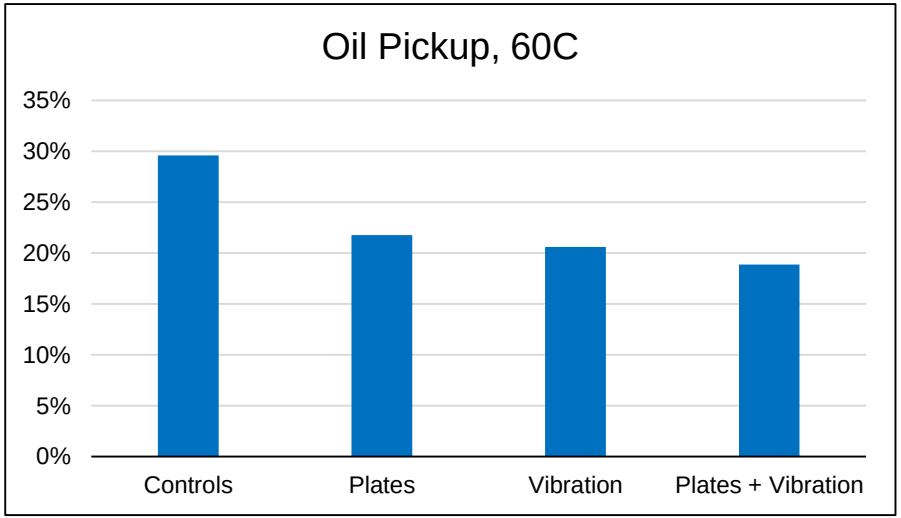
Stock Turbulence vs Dry Tensile

Normalized for Weight



Stock Turbulence vs Oil Pickup





Main Take Aways

Turbulence During Forming Appears Impactful

- Not all turbulence generation has the same effectiveness
- Increasing turbulence increases density and decreases porosity.
- If turbulence is too low/porosity too high, oil hold out will fail.
- Improvements in strength were observed in some conditions.
- Cycle time decreased with additional turbulence.

Next Steps

Trial Conditions

- Increasing sample size for promising conditions
- Reduce weight of shallow trays
- Reduce OGR dosage
- Repeat test with:
  - Different fiber type
  - Higher fines content
- Test different methods of vibration
  - Intensity
  - Location
  - Frequency
- Install a larger pulp pump

Additional Process Testing

- Moisture content after forming
- Moisture content after Pre-press
- Moisture content of finished article
- Temperature of finished article
- Cycle time
- First pass retention

Citations

- Hubbe, Martin. (2002). Fines Management for Increased Paper Machine Productivity.

Questions?

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