



APRIL 22 - 26, 2023 • ATLANTA, GA

# Production of Microfibrillated Cellulose (MFC) using stirred media mills and applications in paper and board

David Skuse, Lewis Taylor, Tom Larson  
Fiberlean Technologies

Presented by: David Skuse



**FiberLean**<sup>®</sup>  
Technologies

# Outline

- **Introduction**
- **Stirred media mills**
- **Applications**
- **Regulatory clearances**
- **Running trials with low solids materials**
- **Conclusions**
- **Questions**

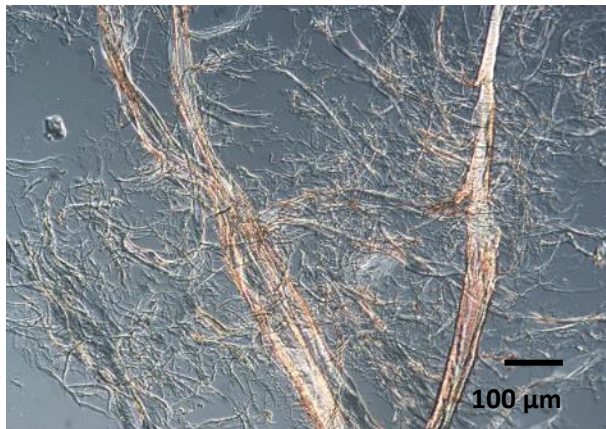
# Introduction

- MFC – produced by mechanical treatment of cellulose
- Highly viscous suspension in water
- Typically 1-2% solids content
- Satellite production adjacent to final use location
- Produced using stirred media mills

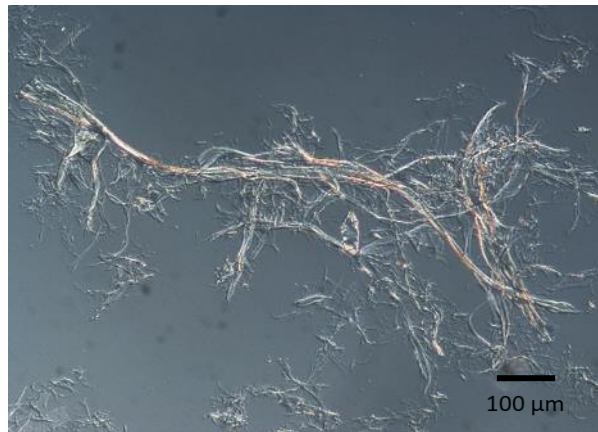


## Product families

- MFC from 100% virgin pulp
- MFC from recycled fibres
- MFC mineral composites
- NB Two of these families have no added minerals. MFC only



**Coarse MFC**

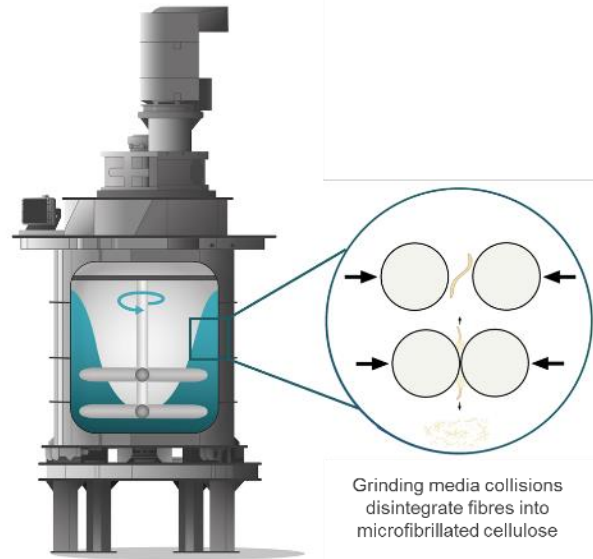


**Medium MFC**



**Fine MFC**

# Stirred Media Mills



**Stirred vessel containing small grinding media beads, which are agitated by an impeller**

- **Grinding media collide with each other, breaking and fibrillating fibres that are caught in the interstices**
- **High media surface area enhances fibrillation**
- **Highly tunable**

## Advantages

- **No close tolerances or precision engineered components**
- **Robust proven technology**
- **Continuous single stage process**
- **Availability > 95%**
- **Low Capex and Opex**
- **High throughput**
- **Small footprint**
- **Modular easily-scalable design**
- **No additives or pre-treatments**

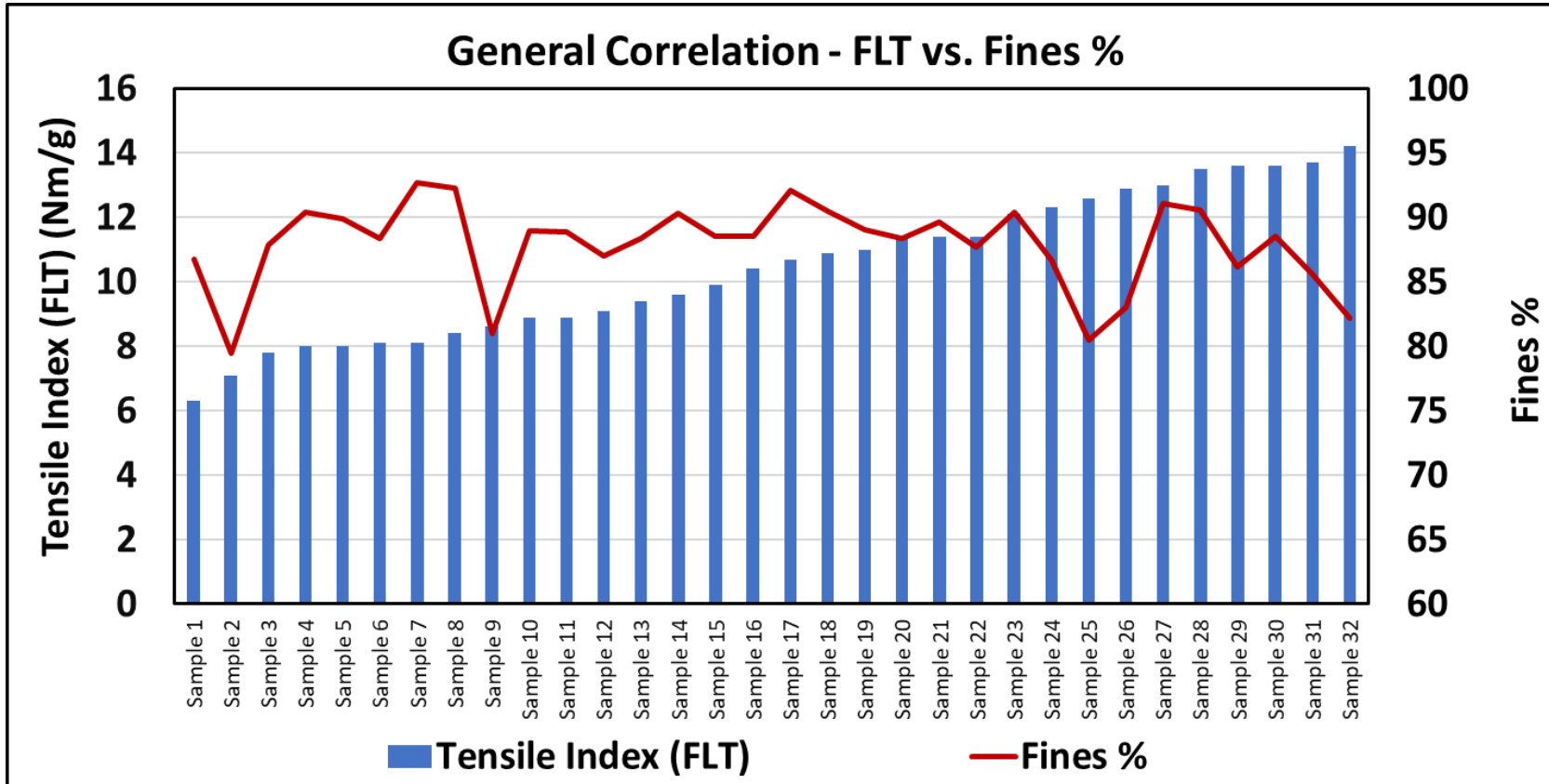
# Stirred Media Mills: Product characterisation

- **Particle size and morphology analysis** - Microscopy, fibre analysers, laser diffraction
- **Viscosity** - Over a range of shear conditions
- **Permeability and drainage**
- **In-application testing**
- **Mechanical properties** – “**FLT – FiberLean Tensile**” strength test - Fast, accurate & precise, correlation with in-application mechanical properties

**Particle size alone is not sufficient to characterise MFC performance. A test of performance is also required**



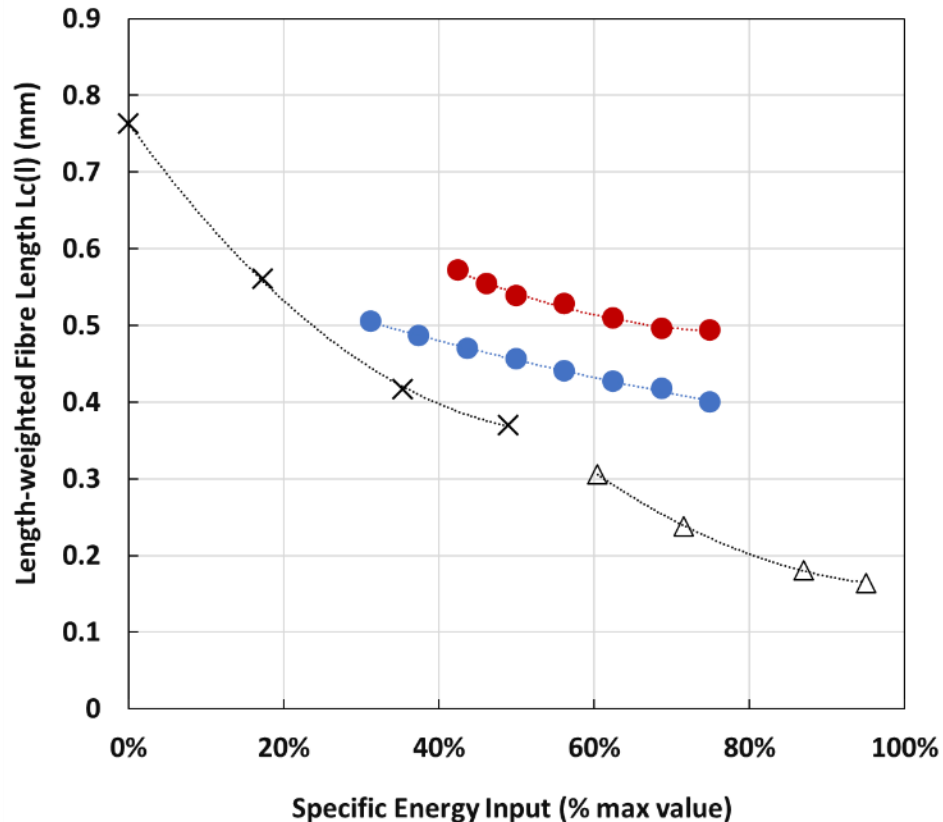
# Stirred Media Mills: Product characterisation



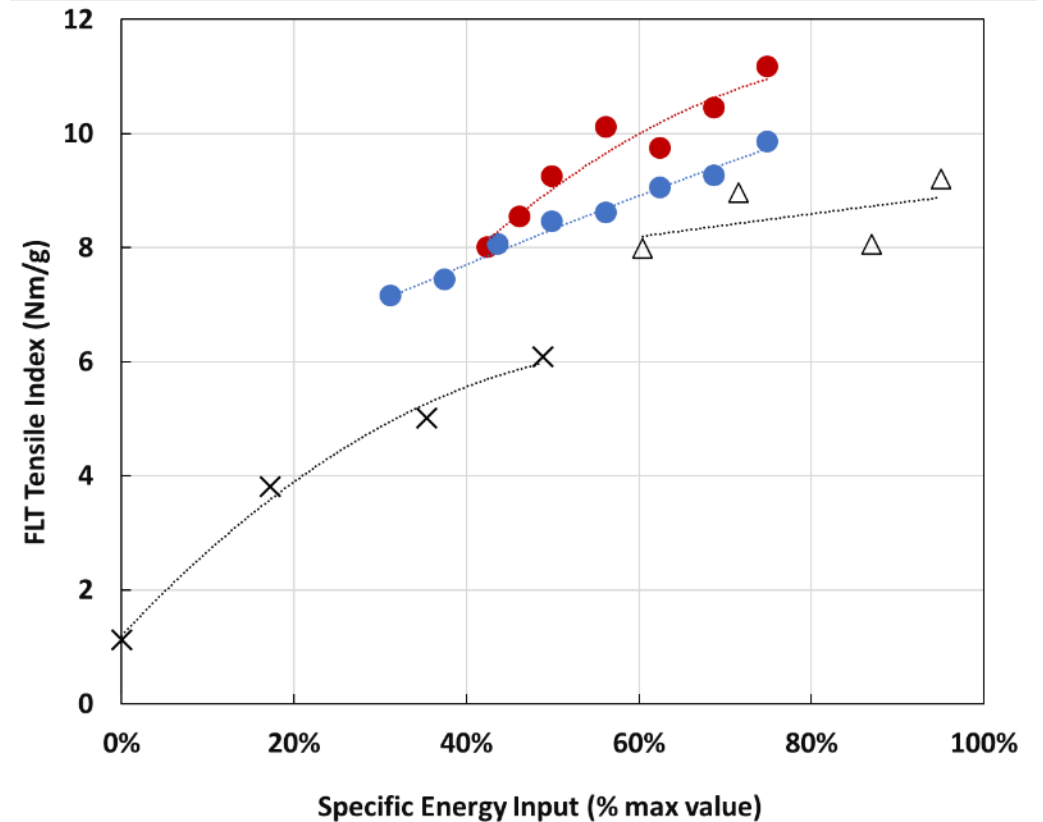
Particle size alone is not sufficient to characterise MFC performance. A test of performance is also required

# Stirred Media Mills: Tunable behaviour (i)

Tunable nature of stirred media mills allow increased capability to decouple MFC size and fibrillation and improve MFC performance



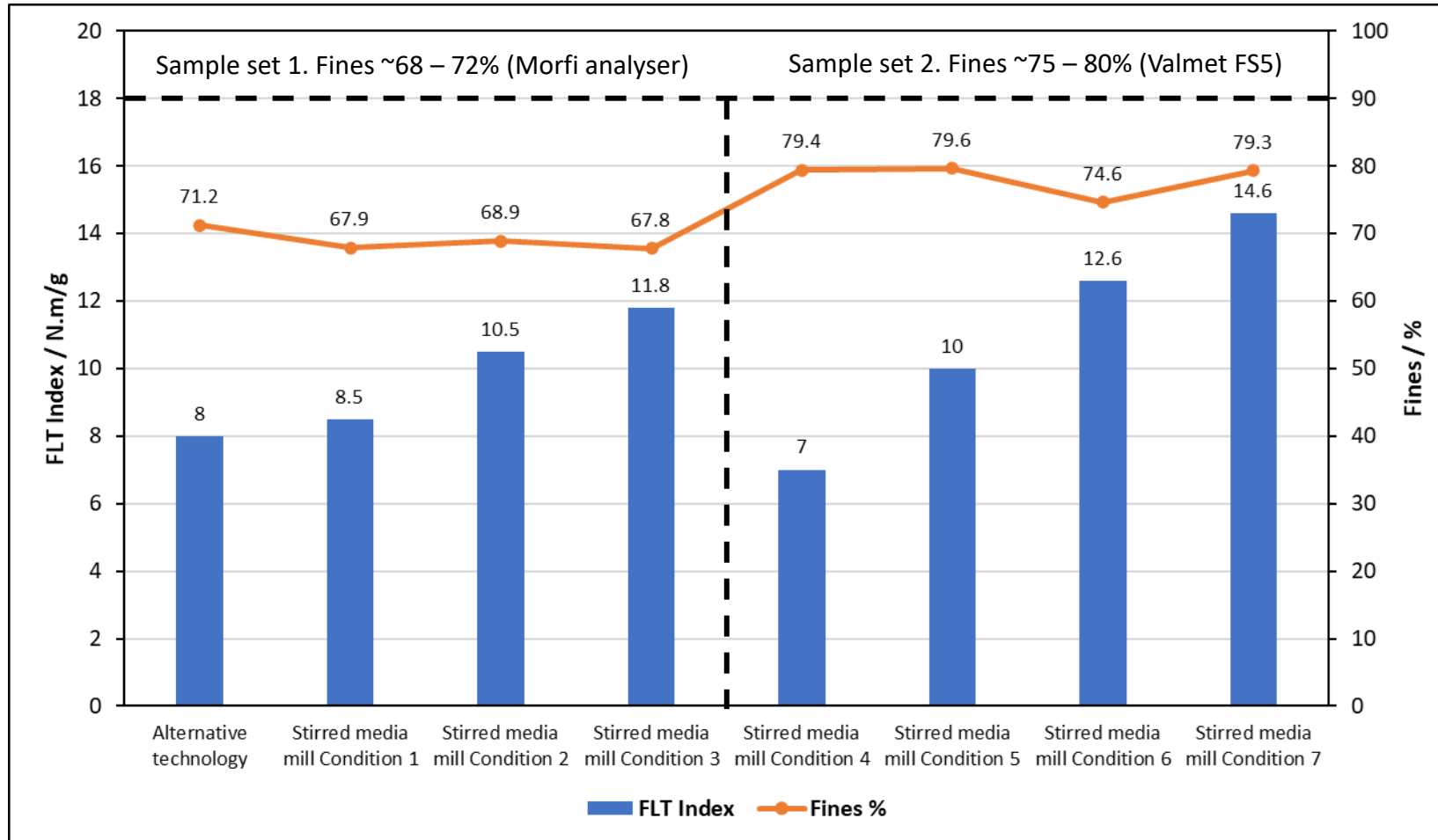
● Stirred Media Mill Condition 1    ● Stirred Media Mill Condition 2  
× Alternative technology 1st stage    △ Alternative technology 2nd stage



● Stirred Media Mill Condition 1    ● Stirred Media Mill Condition 2  
× Alternative technology 1st stage    △ Alternative technology 2nd stage

# Stirred Media Mills: Tunable behaviour (ii)

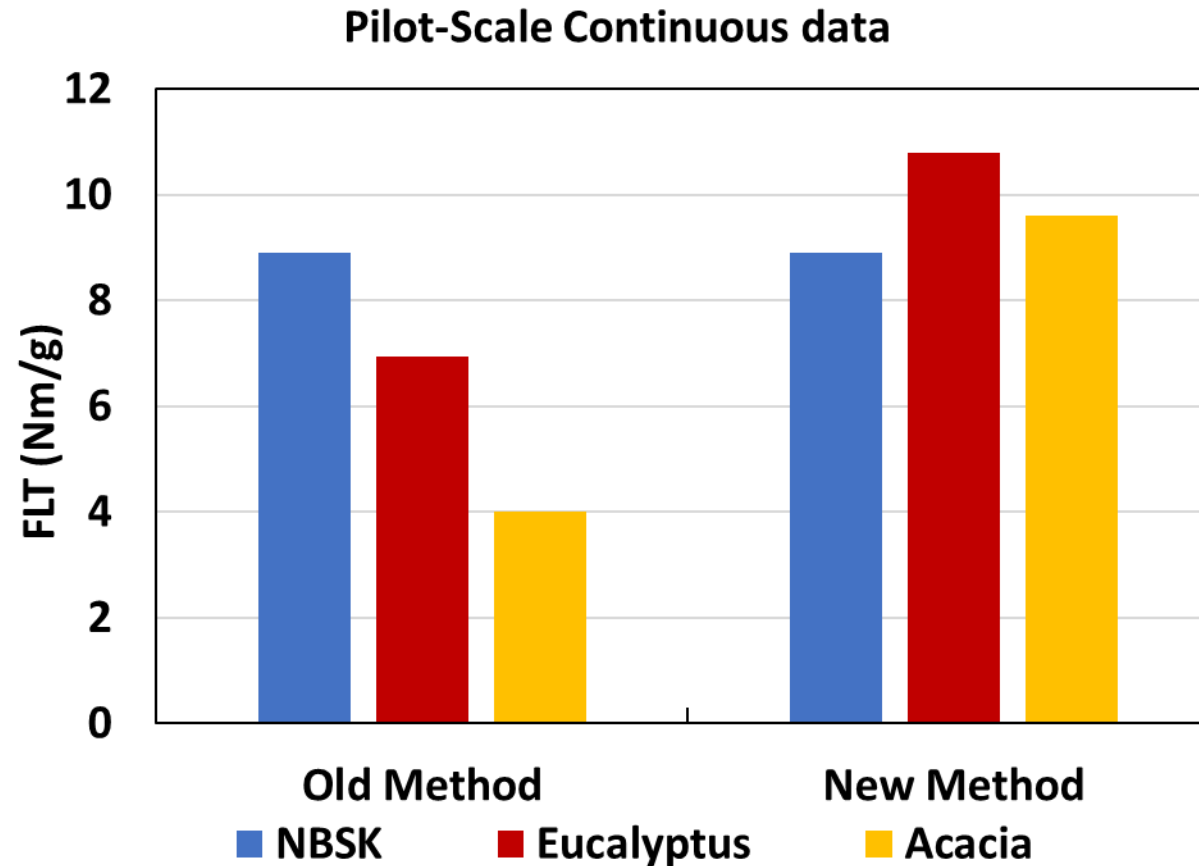
Tunable nature of stirred media mills allow increased capability to optimise MFC size and fibrillation and improve MFC performance





# Stirred Media Mills: Optimisation for substrate

Tunable nature of stirred media mills allow process to be optimised for the substrate



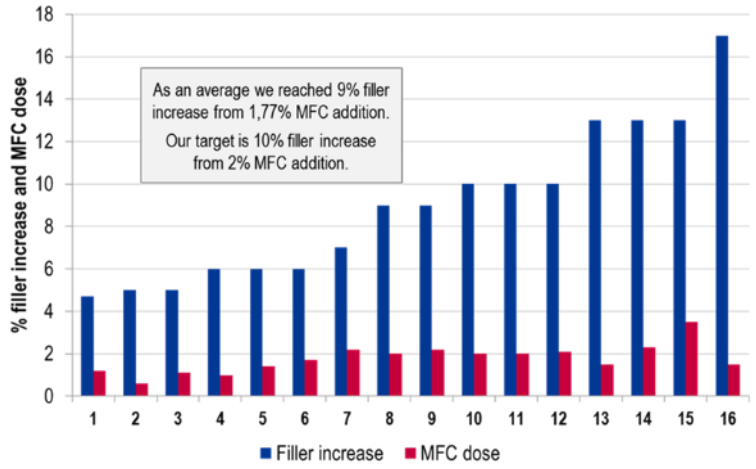
# Applications (i)

- **Use of MFC generally allows:**
  - **Increased bonding in web-based structures**
  - **Increased viscosity, highly shear thinning**
  - **Formation of barrier layers**
  - **Reinforcement (of green polymers)**
- **Use of MFC in paper and board allows:**
  - **Generally improved mechanical properties**
  - **Lower porosity and hence improved coating hold out**
- **Many applications, including:**
  - **Wood free printing and writing paper**
  - **White top liner packaging**
  - **Newsprint and magazine papers**
  - **Barriers**
  - **New product development opportunities**

# Applications (ii)

## Wood free printing and writing papers

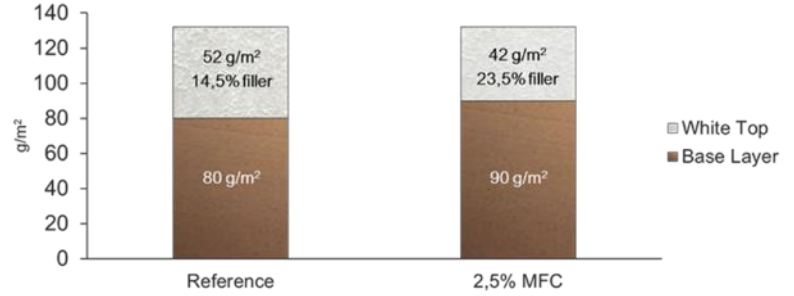
100+ full scale paper machine trials



**MFC from virgin pulp**  
**MFC mineral composite**

- NBSK, BSK, BHK, UBHK, sulphite
- GCC, PCC, kaolin, talc

## White top liner

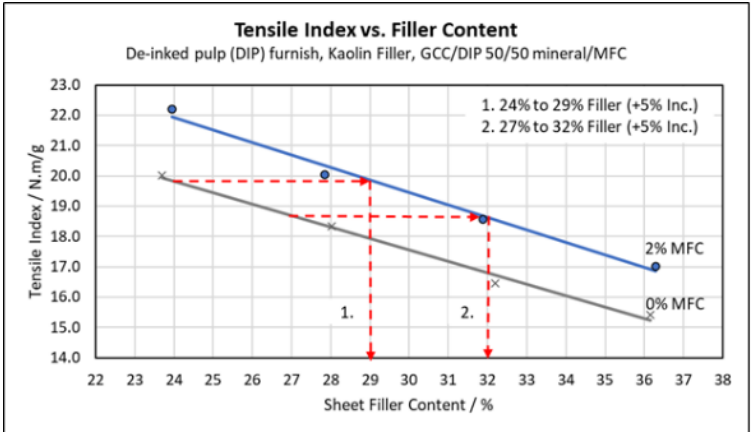


- MFC addition to the top layer improves strength, enabling the filler content to be increased.
- Increased filler content improves the optical coverage of the dark base, enabling the top layer thickness to be reduced.
- The base layer can then be increased proportionately to maintain/improve overall WTL properties.
- This substitution of white top fibre reduces overall costs whilst maintaining critical properties.

**MFC mineral composite**

- Office waste
- GCC

## Newsprint and magazine papers



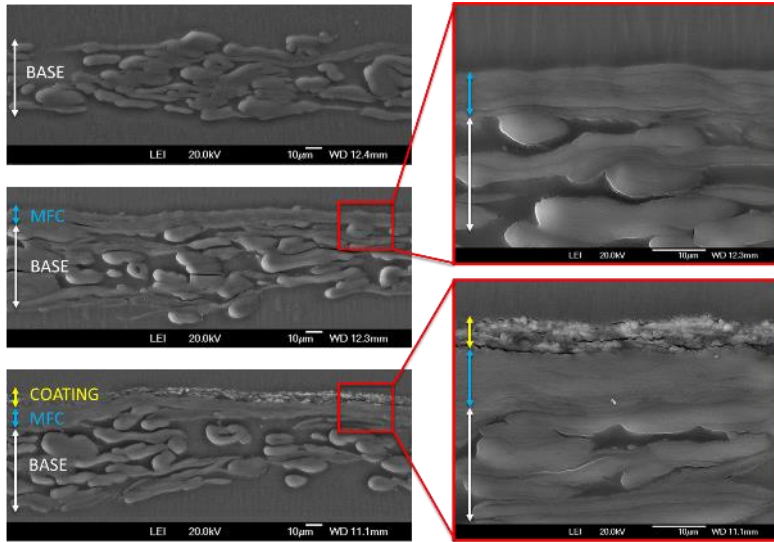
- Use of MFC based on DIP fibre enables sheet strength to be maintained when increasing the filler content, reducing overall costs.

**MFC from virgin pulp**  
**MFC from recycled pulp**  
**MFC mineral composite**

- NBSK, BHK, DIP, OCC
- GCC

# Applications (iii)

## Barriers applications



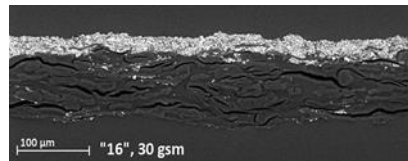
Cross-section Imaging: Scanning Electron Microscopy (SEM)

- Barrier properties of MFC: Oil & Grease, Oxygen, Aromas, Mineral Oils.
- Very smooth and closed surface for combining with additional functional coatings (e.g., To achieve water/moisture barrier).

### MFC

- Virgin and recycle fibres
- BSK, BHK, UBHK

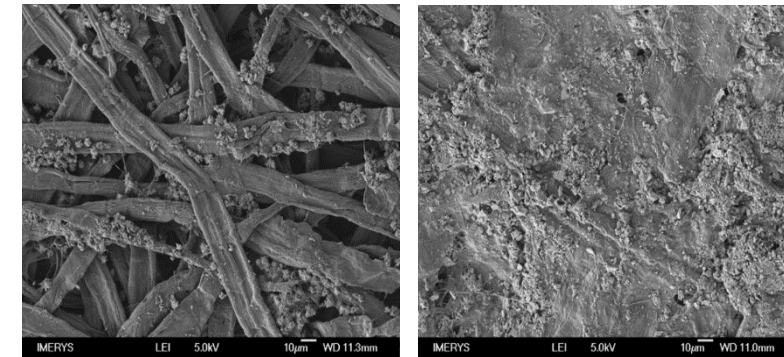
## New product development directions: Wet end coating



### MFC mineral composite

- Virgin and recycle fibres
- GCC (very high loading)

## New product development directions: Very high filler loadings



Scanning electron micrographs of uncoated wood free sheets; 17% GCC filled sheet with no MFC (left, control) and 55% GCC filled sheet with 4.5% MFC fibrils (right)

### MFC mineral composite

- Virgin NBSK
- GCC

# Regulatory clearances

## USA

EPA – existing substance under TSCA. Not subject to reporting under EPA nano rule

Food contact clearance through FDA (5wt.% fibrils in packaging), FCNs 1582 and 1887

Covers all ratios of mineral: MFC including mineral-free

Food coating FCN 2022

FDA GRAS – in progress, part of Vireo led consortium. For food use

## Canada

Environment and climate change Canada – existing substance under CEPA

Health Canada opinion – “...we see no reason to object...to the use of FiberLean in food contact packaging, under conditions as described on the FDA website in the FCN 1582”

Covers all ratios of mineral: MFC including mineral-free

## China

The National Health Commission of the People’s Republic of China approved microfibrillated cellulose pulp (CAS 65996-61-4) as an additive in paper and paperboard used for contact with all types of food, subject to a maximum usage of 5% (based on the dry weight of fiber) and no specific migration level requirement

Covers all ratios of mineral: MFC including mineral-free

## Germany

Acceptance confirmed for BfR XXXVI and XXXVI/2 at up to 5 wt.% fibrils when produced with minerals at between 50% and 83% mineral content

Mineral-free application has been filed with BfR

## Netherlands

Cellulose microfibrils produced with calcium carbonate, kaolin and/or other permitted mineral fillers are included in Chapter 2 (Paper and board) of the Dutch commodities act regulation at up to 5wt.% fibrils



# Running trials with low solids materials

## Slurry



**Production plant in the UK, 2000 dry metric tonnes pa of fibril capacity. Operational since Q4 2013: Slurry and press-cake product forms**

## Press cake





# Conclusions

- **MFC and mineral/ MFC composites are produced using cost-effective, robust stirred media mills and have proven full-scale availability**
- **MFC and Mineral/ MFC composites can be produced using a wide range of virgin and recycle pulps**
- **The tunable nature of stirred media mills allows high quality MFC to be prepared from a wide range of pulps**
- **A range of regulatory clearances are in place**
- **MFC and mineral/ MFC composites are important additives for a wide range of paper and board applications**



APRIL 22 - 26, 2023 • ATLANTA, GA

**Thank you for your attention  
Questions?**

Presented by:  
David Skuse  
Fiberlean Technologies  
[david.skuse@fiberlean.com](mailto:david.skuse@fiberlean.com)



**FiberLean**  
Technologies