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GRESSO INTERNACIONAL DE CELULOSE E PAPEL
RÊNCIA IBEROAMERICANA SOBRE BIOECONOMIA

MICROFIBRILLATED CELLULOSE PROVEN TO CREATE VALUE IN FULL SCALE PAPERMAKING

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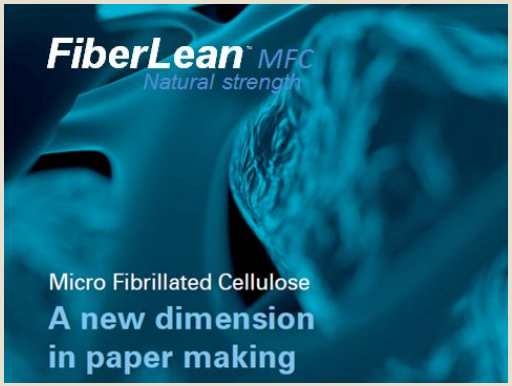


REALIZAÇÃO
CORREALIZAÇÃO

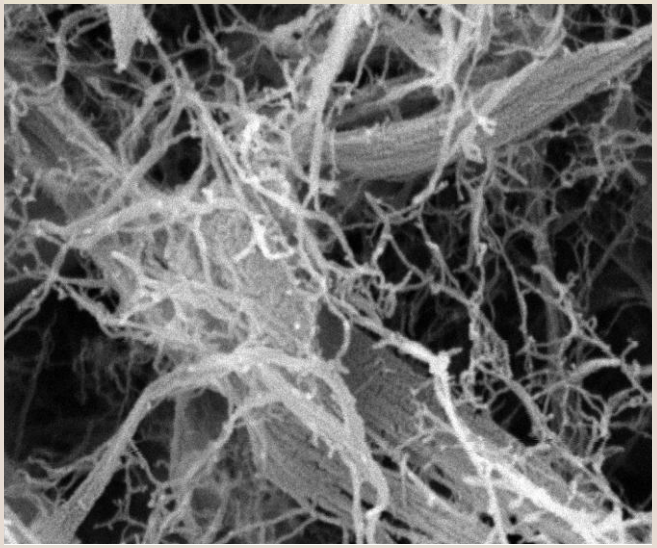
ABSTRACT

Imerys recently announced the commercial break-through in processing of pulp to microfibrillated cellulose (MFC) for use in paper industry applications. Imerys´ MFC offers paper makers the opportunity to become more cost competitive or to develop new differentiated products. Application experience from full scale papermaking is presented with emphasis on how cost savings can be achieved when replacing market pulp with filler and MFC. Further there are examples of how MFC can help the paper maker improve quality of paper as well as paper coatings.

Keywords: *MFC, microfibrillated cellulose, filler, opacity, porosity, coating.*

History and current state of the art of ”conventional” MFC.

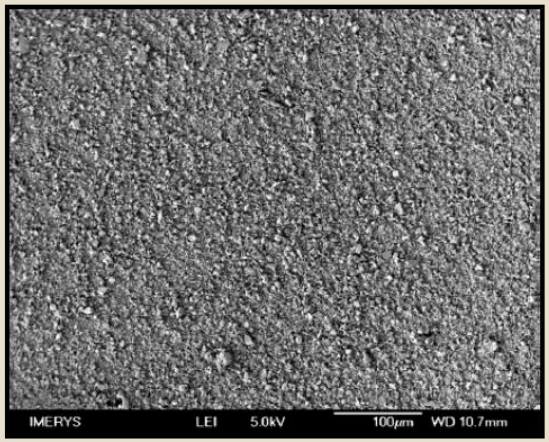
- First made in the 80´s
  - Very high energy demand (25-30 MWh/ton)
  - Using expensive and sophisticated grinding equipment
  - Expensive and very high capex/capacity ratio
- Known to be ideal as a strength aid in paper.
- Conventional state of the art MFC
  - Pulp pre-treatment to soften up the fibers
  - Significantly reduced energy demand
  - Still using expensive and sophisticated grinding equipment resulting in high capex/capacity ratio
  - Low solids product in gel form, often with high surface charge
  - Scale limitations preventing large volume applications



In practice ”conventional” MFC is still restricted to high value applications.

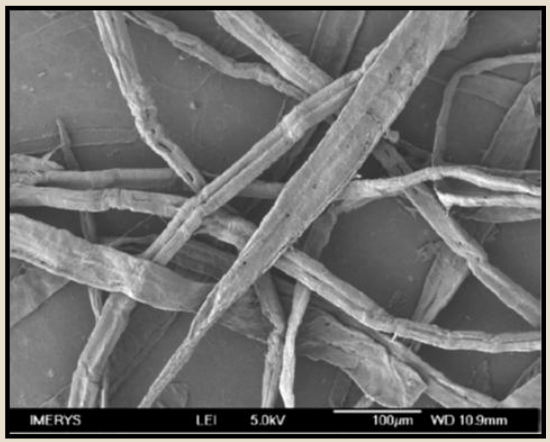
FiberLean MFC is made from co-grinding pulp with filler

Intracarb 60, Ground Calcium Carbonate filler (GCC)



100 µm

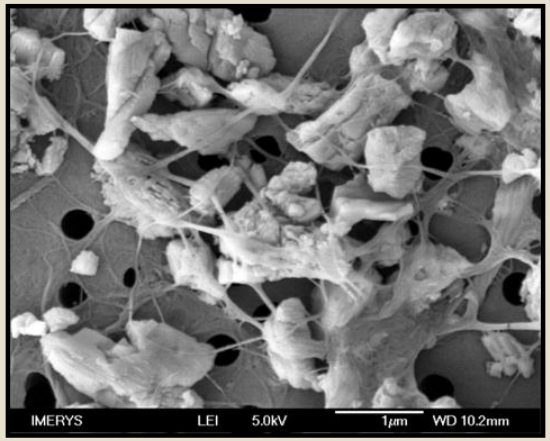
Northern Bleached Softwood Kraft pulp (NBSK)



100 µm

Process input (2 above) and output (to the right). Note the difference in magnification.

FiberLean composite with GCC and MFC visible



1 µm

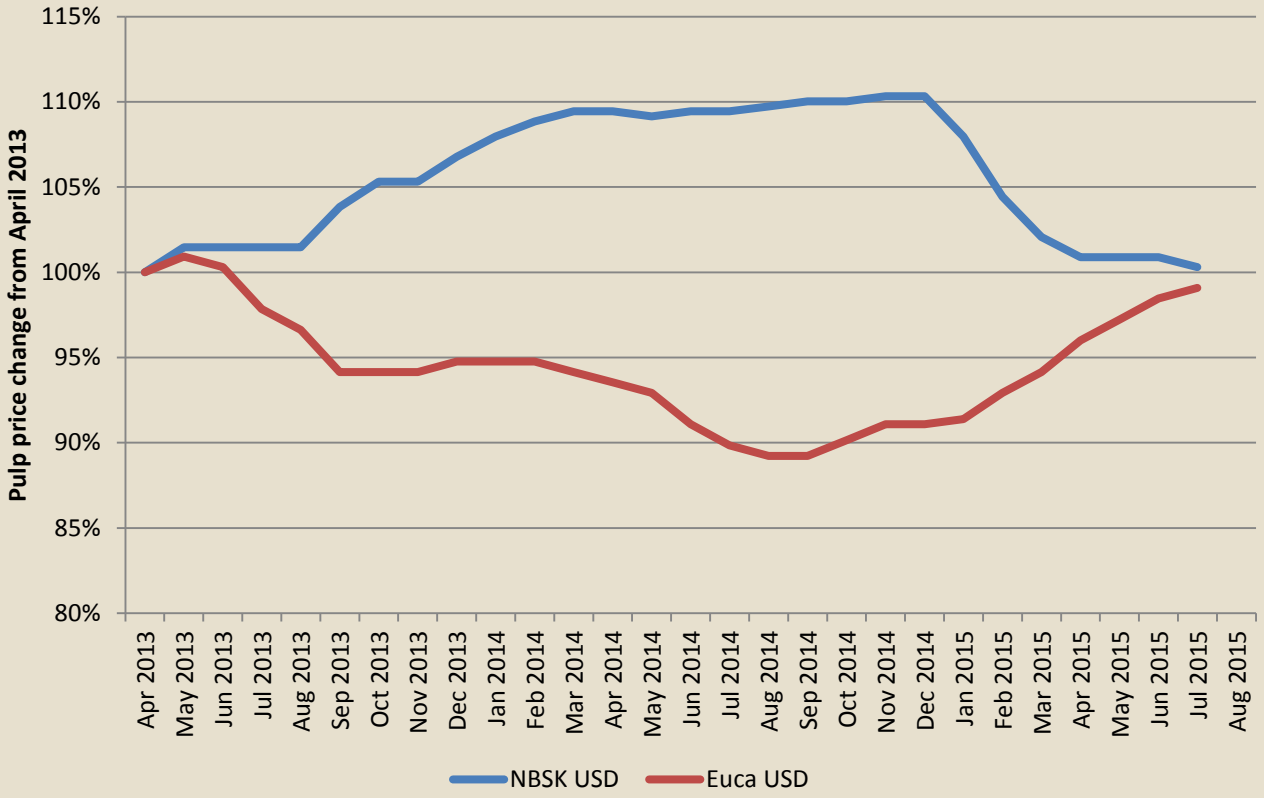
Full scale trial experience with FiberLean

- Close to 50 full scale trials on 21 paper machines to date
  - In Europé, North America, South America and Asia.
- Trials ranging from a few hours to several days.
- Extensive experience across segments
  - 6 mills in UWF
  - 6 mills in speciality and mechanical paper
  - 8 mills in CWF
  - 2 mills in Packaging
- 3 commercial contracts for on-site MFC plants.

FiberLean MFC base concept:

Facilitating increased filler content in papers.

Relative USD pulp price trend from April 2013



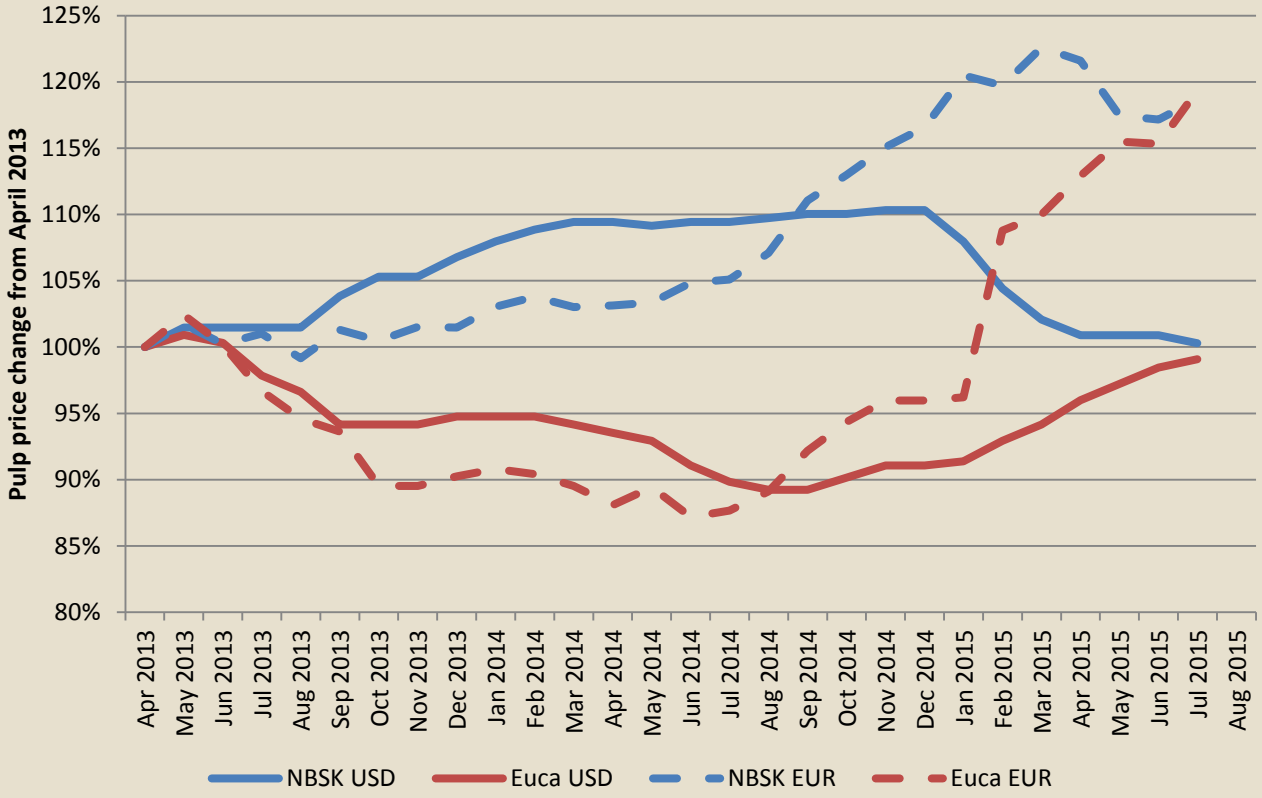
July -15 list prices:

NBSK: $850

Euca: $805

- **The gap between long and short fiber is back to what it was**

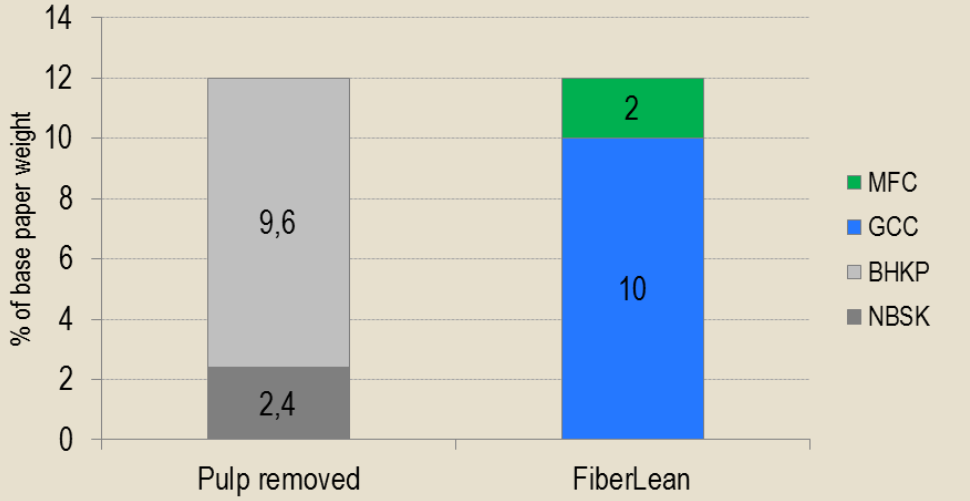
Adding price trend in EUR paints another picture



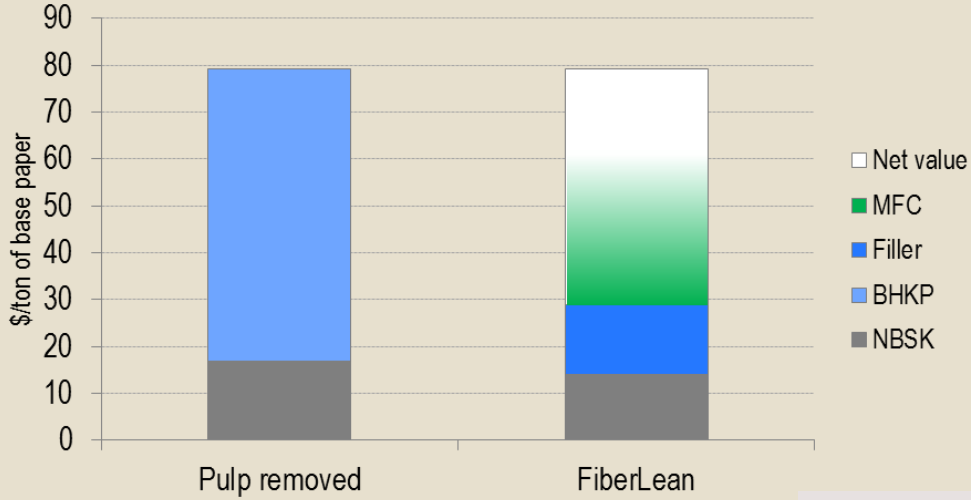
- **In EUR terms the price of pulp is now 15-20% higher!**

Simplistic value calculation model for filler increase with MFC

Mass balance



Value balance



Assumptions:

NBSK	$ 700/bone dry ton
BHKP	$ 650/bone dry ton
Filler	$ 150/bone dry ton
MFC	range indication

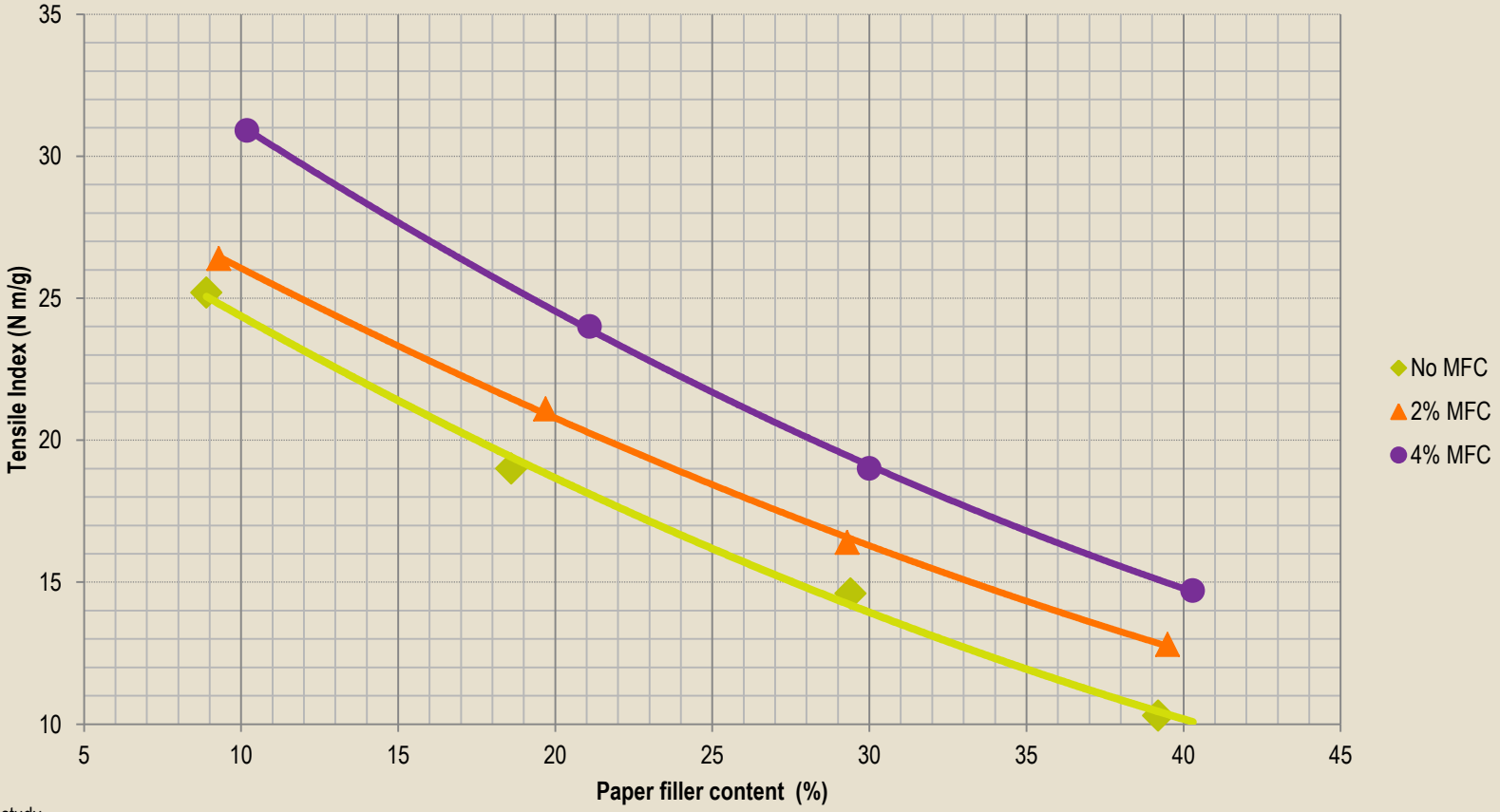
Numerics of value calculation model for filler increase with MFC

OUT	800 kg of BHKP at:	$650 =	$520
	200 kg of NBSK at:	$700 =	$140
	1000 kg of pulp mix:		**$660**

IN	167 kg of NBSK to convert to MFC at:	$700 =	$117
	(167) kg of MFC conversion charge at:	$2 500 =	$418
	833 kg of filler at:	$150 =	$125
	1000 kg of MFC/filler mix at 2/10 ratio:		**$659**

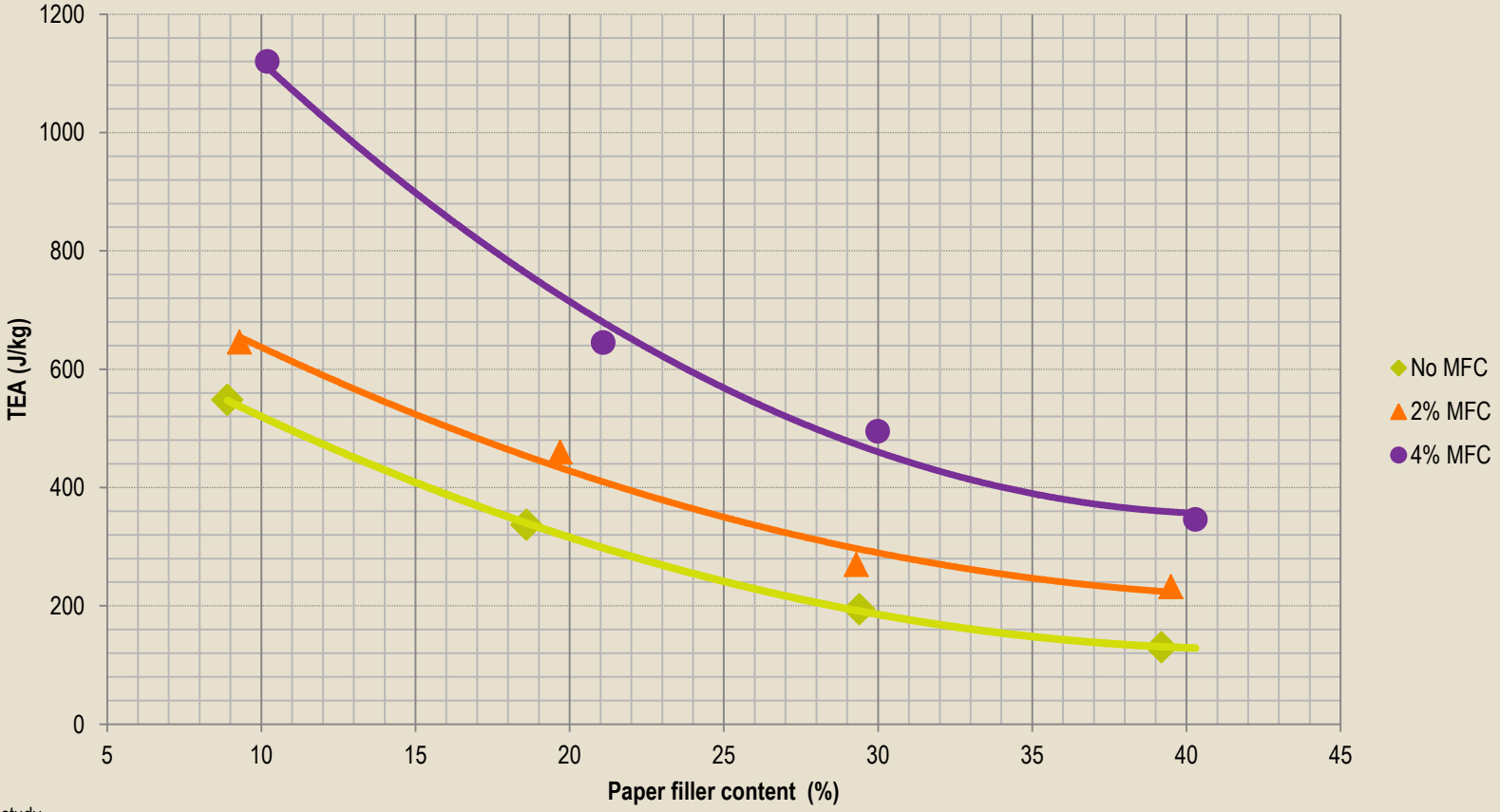
- In order to start creating value the price of MFC conversion needs to be below 2 500 $/dry metric ton.
- Obviously it needs to be well below this to make filler increase worthwhile for the paper maker.

Tensile strength is improved by MFC addition



Lab study
Mesmer recirculating hand sheets (12 sheets)
70% Eucalyptus, 30% NBSK, 500 CSF
Intracarb 60 filler

Tensile Energy Absorption increases more than tensile, i.e. stretch is improved.



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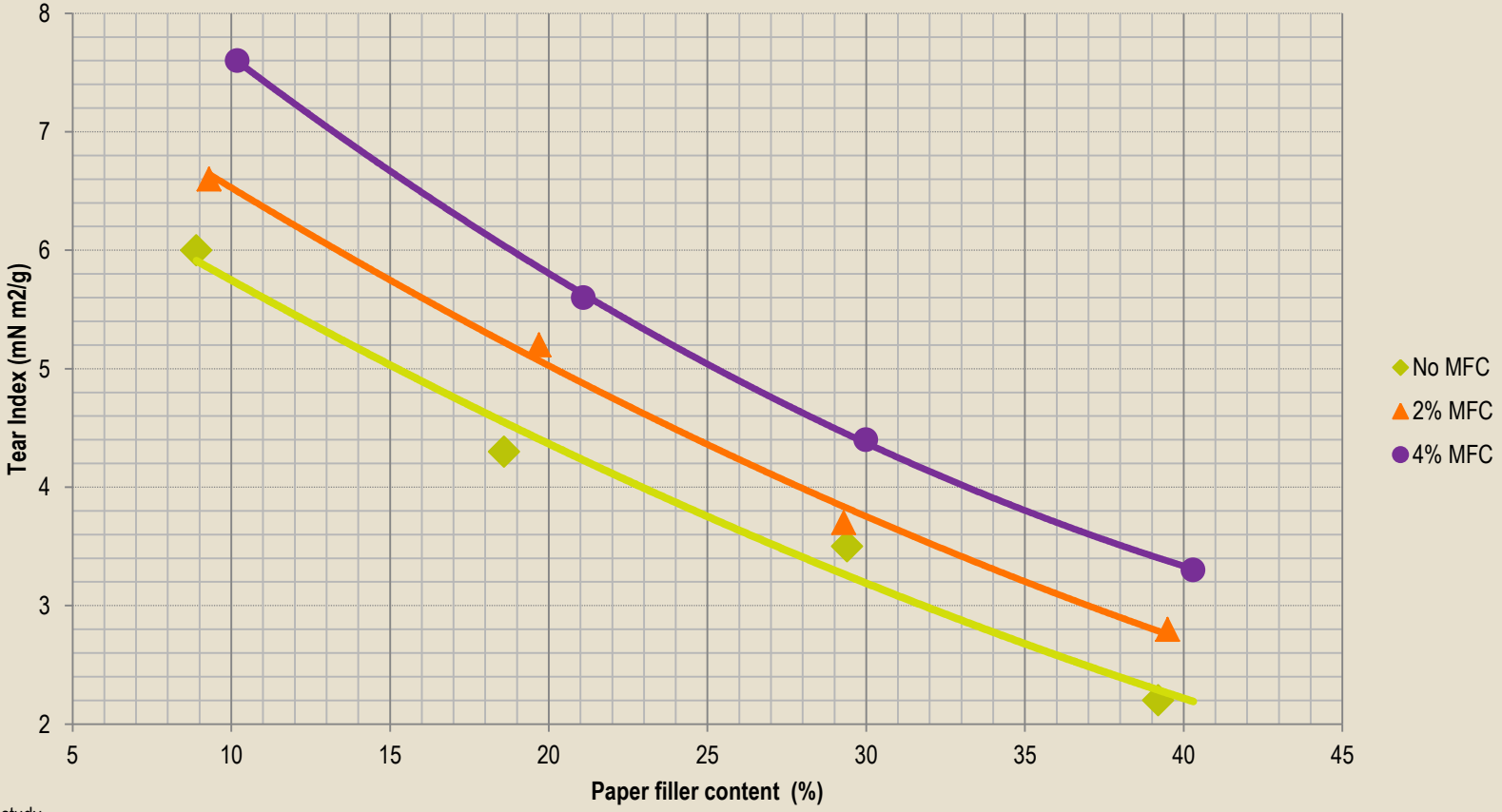
Tear strength improves too, a result of better fiber network bonding.



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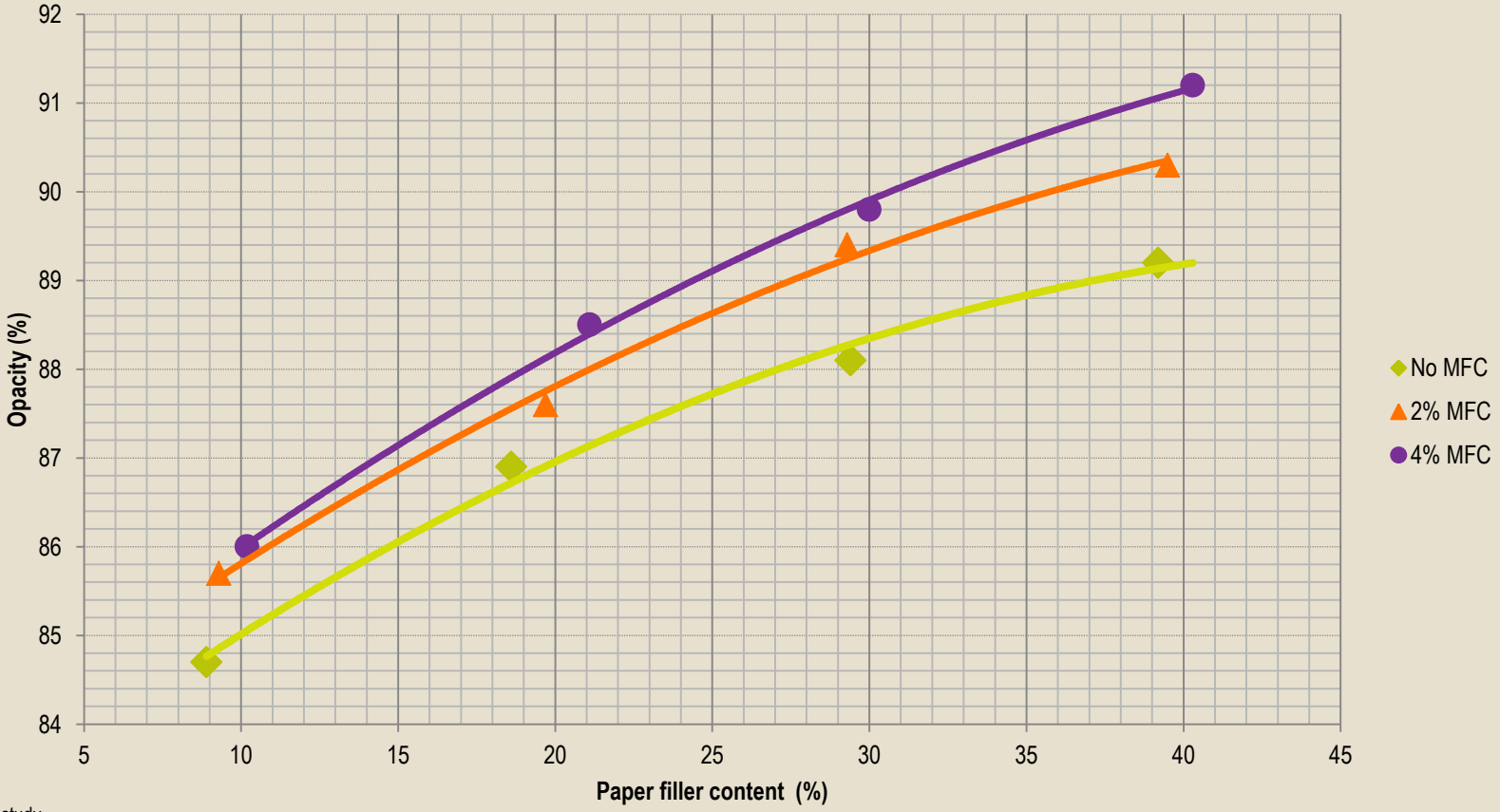
Opacity improves with higher filler loading, but also from MFC



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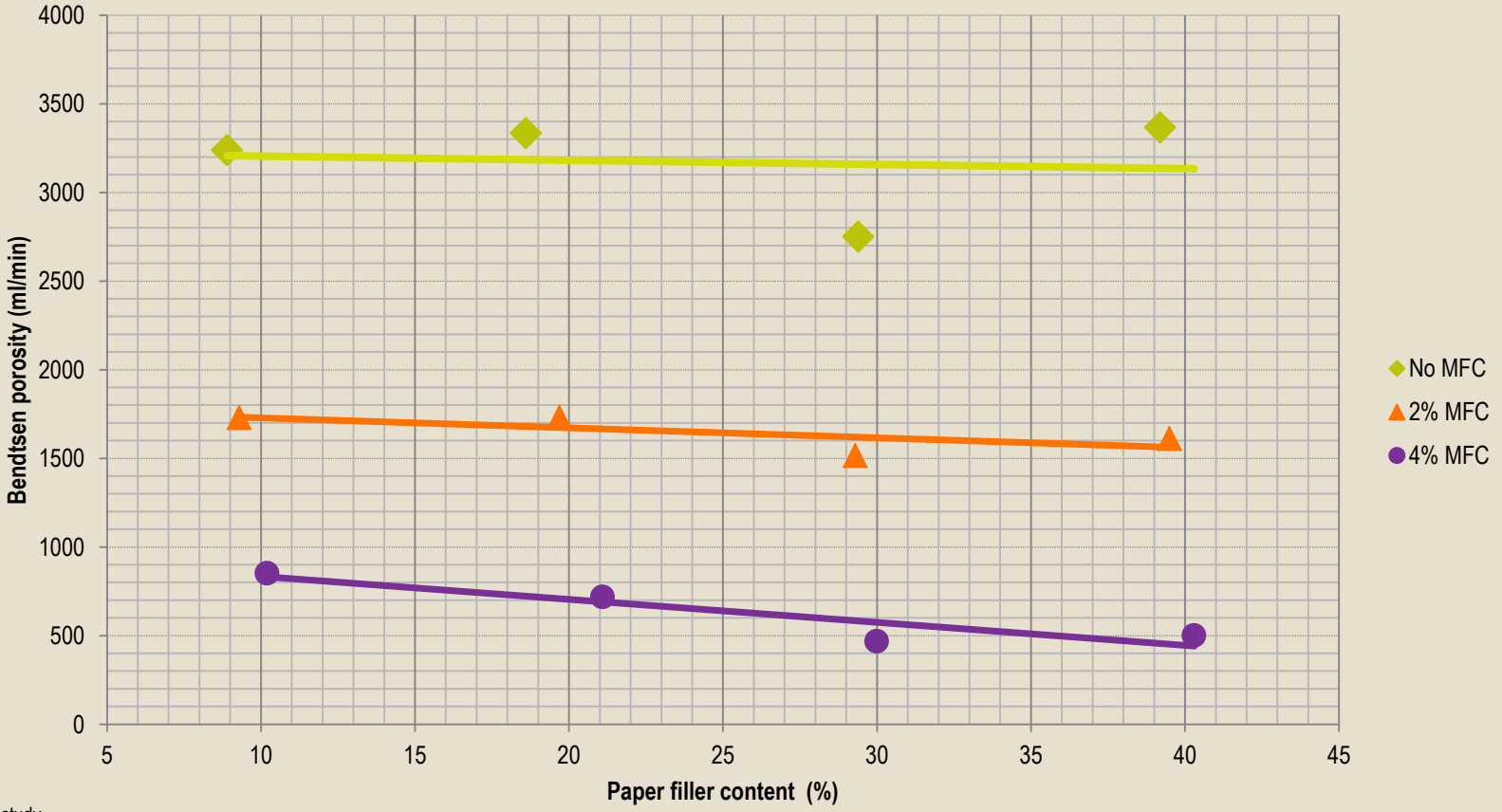
The impact of MFC on porosity is quite profound



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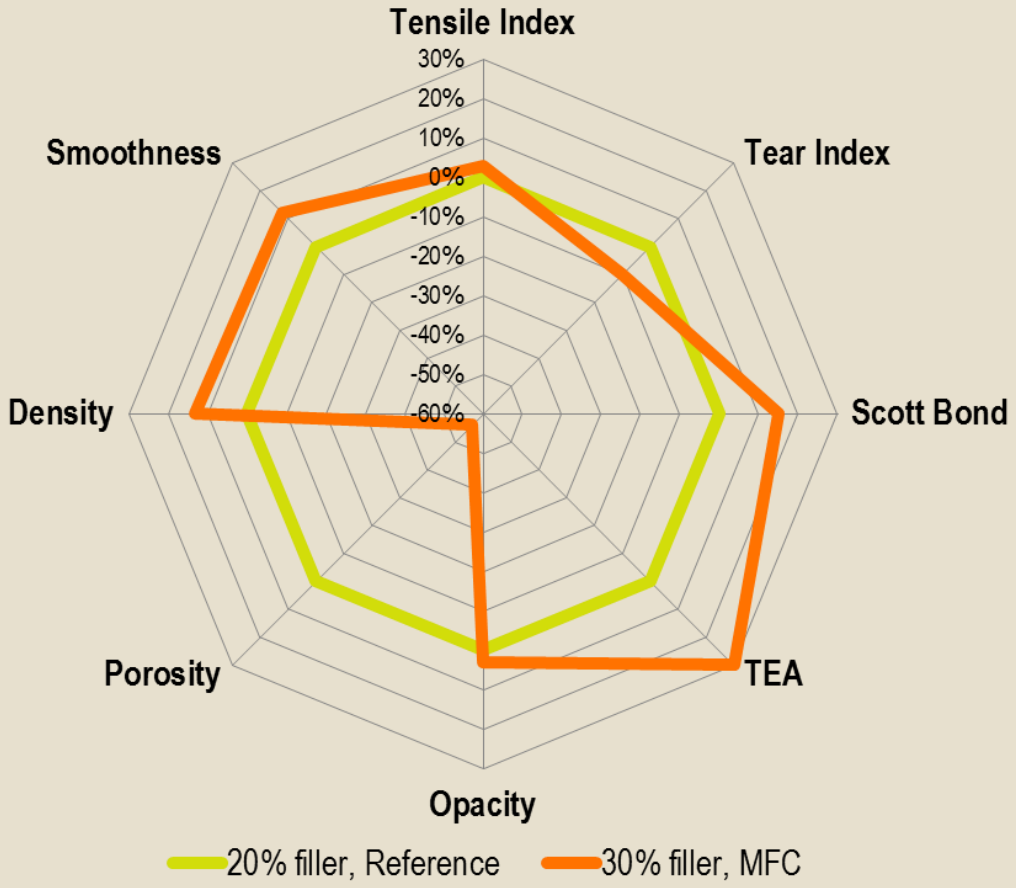
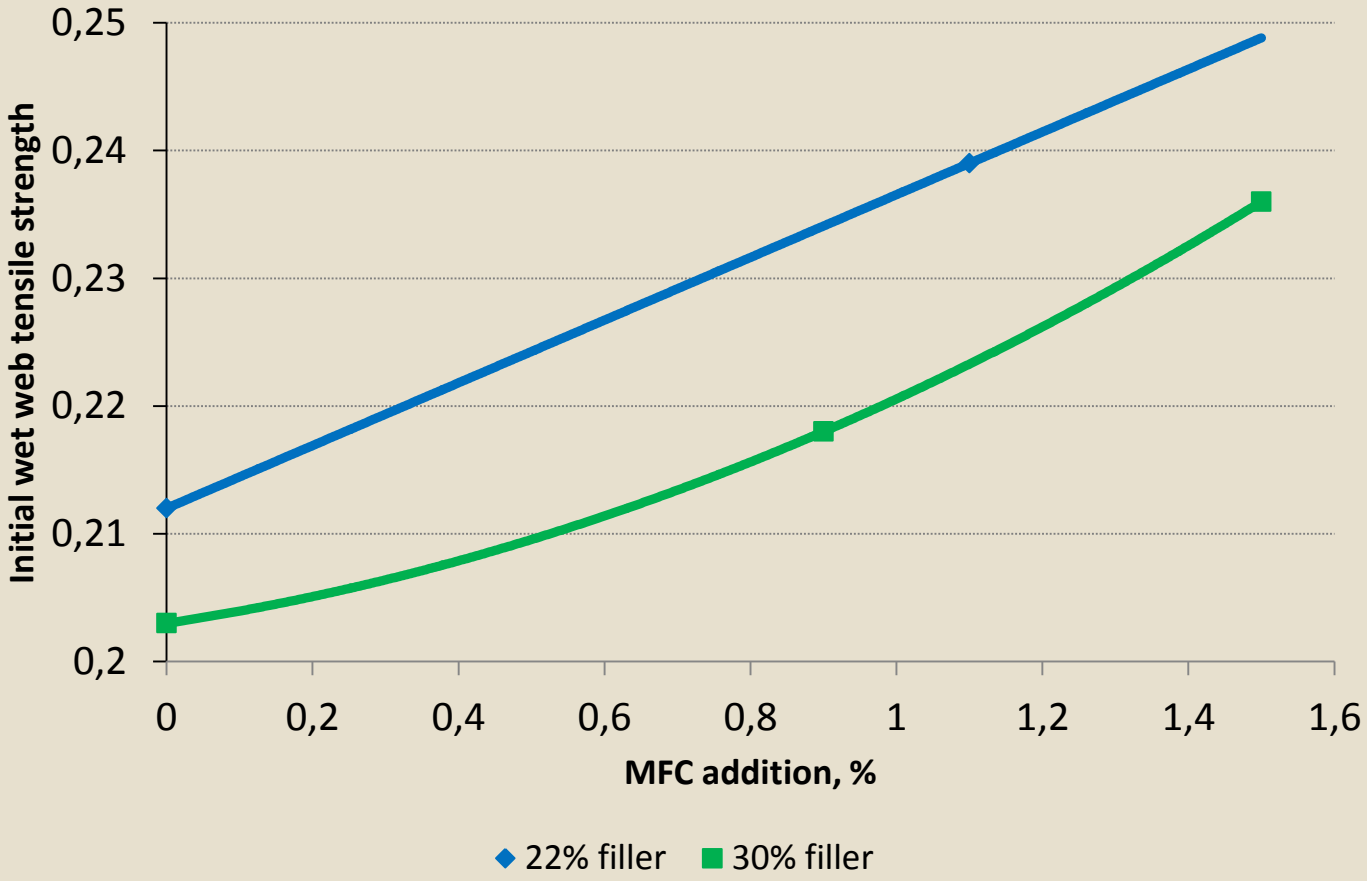

Tensile Index
30%
20%
10%
0%
-10%
-20%
-30%
-40%
-50%
-60%
Tear Index
Scott Bond
TEA
Opacity
Porosity
Density
Smoothness
20% filler, Reference
30% filler, MFC

Base paper	Reference	FiberLean	Comments
Ash	16%	29%	+13% filler
Gurley porosity	26	58	Much tighter sheet
Scott Bond	550	605	+10%
IGT	490	490	=
Final paper	Reference	FiberLean	Comments
Bulk	0,76	0,75	1% bulk loss
Stiffness	218	194	-11% stiffness
Gloss	70	70	=
Scott Bond	604	634	+5%
IGT	164	165	=
Calendering pressure*	200	170	With 20 parts less kaolin in the coating colour.

* Also going from 9 nips to 6 nips.

MFC has a strong positive impact on initial wet web strength



MFC is a good fit for increased filler loading

Impact on:	Increased filler	Increased filler with MFC	Comments:
Cost savings:	+++	+	Cost of MFC…
Opacity:	++	+++	Even higher with MFC
Brightness:	++	+	
Smoothness:	+	++	Better with MFC
Drainage:	++	+	MFC holds back some of the benefit
Strengths:	---	+/-	Wet-strength – runnability, dry strength – quality
Porosity:	-	+++	Much lower porosity with MFC
Bulk:	-	--	MFC doesn´t help. Needs paper making trade off´s

Key differerentiators compared to chemistry based concepts

Impact on:	Increased filler	Increased filler with MFC	Comments:
Cost savings:	+++	+	Cost of MFC…
Opacity:	**++**	**+++**	**Even higher with MFC**
Brightness:	++	+	
Smoothness:	+	++	Better with MFC
Drainage:	++	+	MFC holds back some of the benefit
Strengths:	**---**	**+/-**	**Wet-strength – runnability, dry strength – quality**
Porosity:	**-**	**+++**	**Much lower porosity with MFC**
Bulk:	-	--	MFC doesn´t help. Needs paper making trade off´s

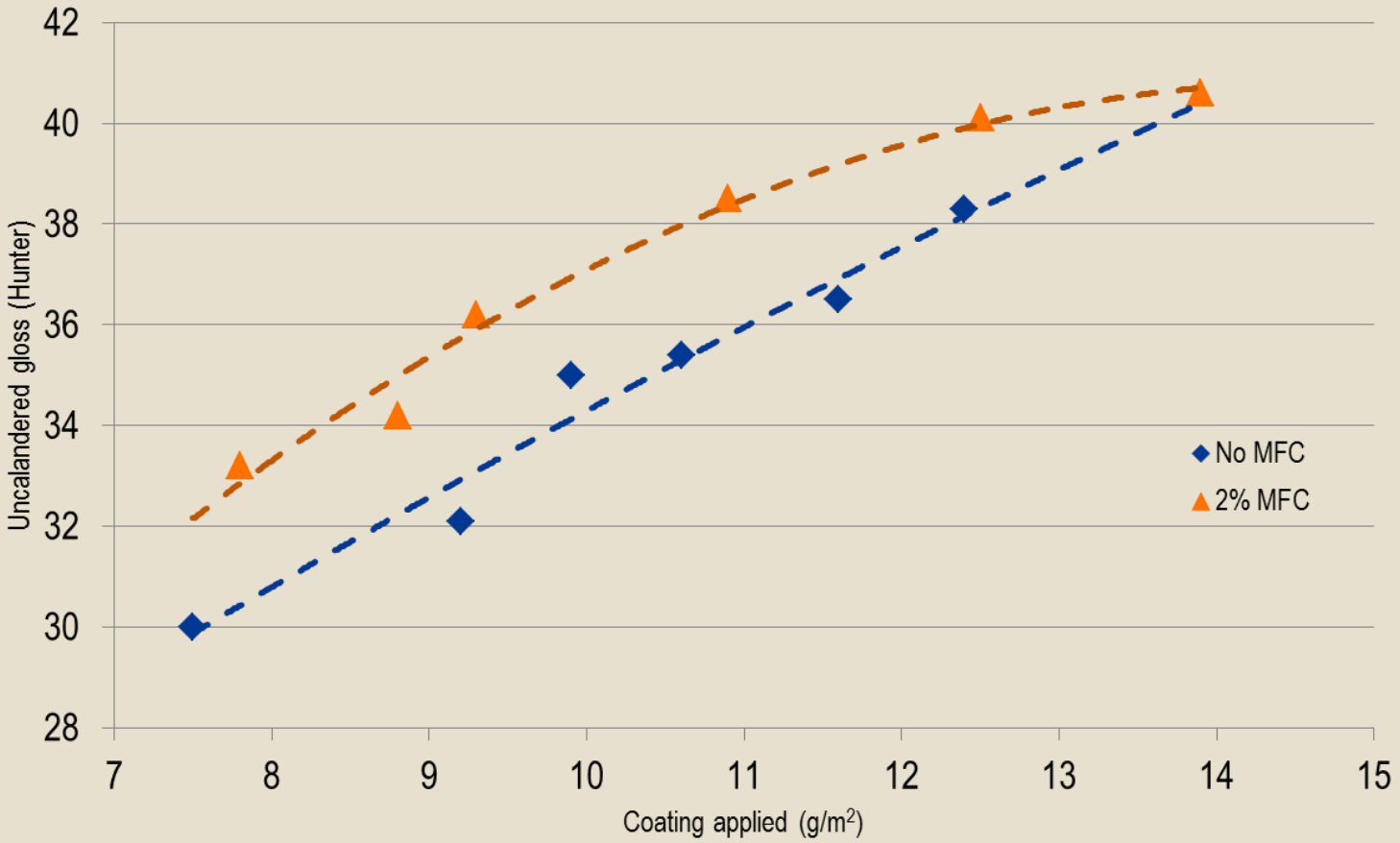
FiberLean MFC coating improvements:

Improved coating performance through better base paper hold-out.

Opportunities from porosity reduction in base paper

- Reduced coat weight
- Improved gloss and smoothness
- Reduced calendering to win bulk (to compensate for filler increase)
- Use of cheaper coating pigments
- Reduced binder demand
- Better coater runnability

Less coating needed to get good coverage



Thermal printing paper, 45 g/m2
Constant addition of 10% GCC filler
Bendtsen porosity from 300 to 200 ml

FiberLean MFC for product development:

Improved paper quality through use of MFC.

Adding MFC to a 250 CSF base at constant filler content (20%) to improve paper properties

	Tensile Energy Absorption *J/kg*	***Tear Index*** *mN m² /g*	***Scott Bond*** *J/m²*	***Bendtsen Porosity*** *ml/min*	***Opacity*** *%*
Reference	792	5,7	209	258	87,8
1% MFC	924	5,7	288	180	88,2
2% MFC	859	5,8	291	114	88,3
4% MFC	1224	6,5	377	104	88,8

Adding MFC to a 550 CSF base at constant filler content (20%) to improve paper properties

	Tensile Index *N m/g*	*Tensile Energy Absorption* *J/kg*	*Tear Index* *mN m^2/g*	*Scott Bond* *J/m^2*	*Bendtsen Porosity* *ml/min*	*Opacity* *%*
Reference	14,8	200	4,1	40	2500	89,0
3% MFC	22,0	500	5,3	70	1300	89,5

Conclusions:

- ✓ **Use of MFC for P&W paper cost reduction or quality improvement is now established in the market.**
- ✓ **Cost of MFC conversion needs to be (well) under € 2 500 per dry ton.**
- ✓ **This is possible using an on-site MFC process with economy of scale.**

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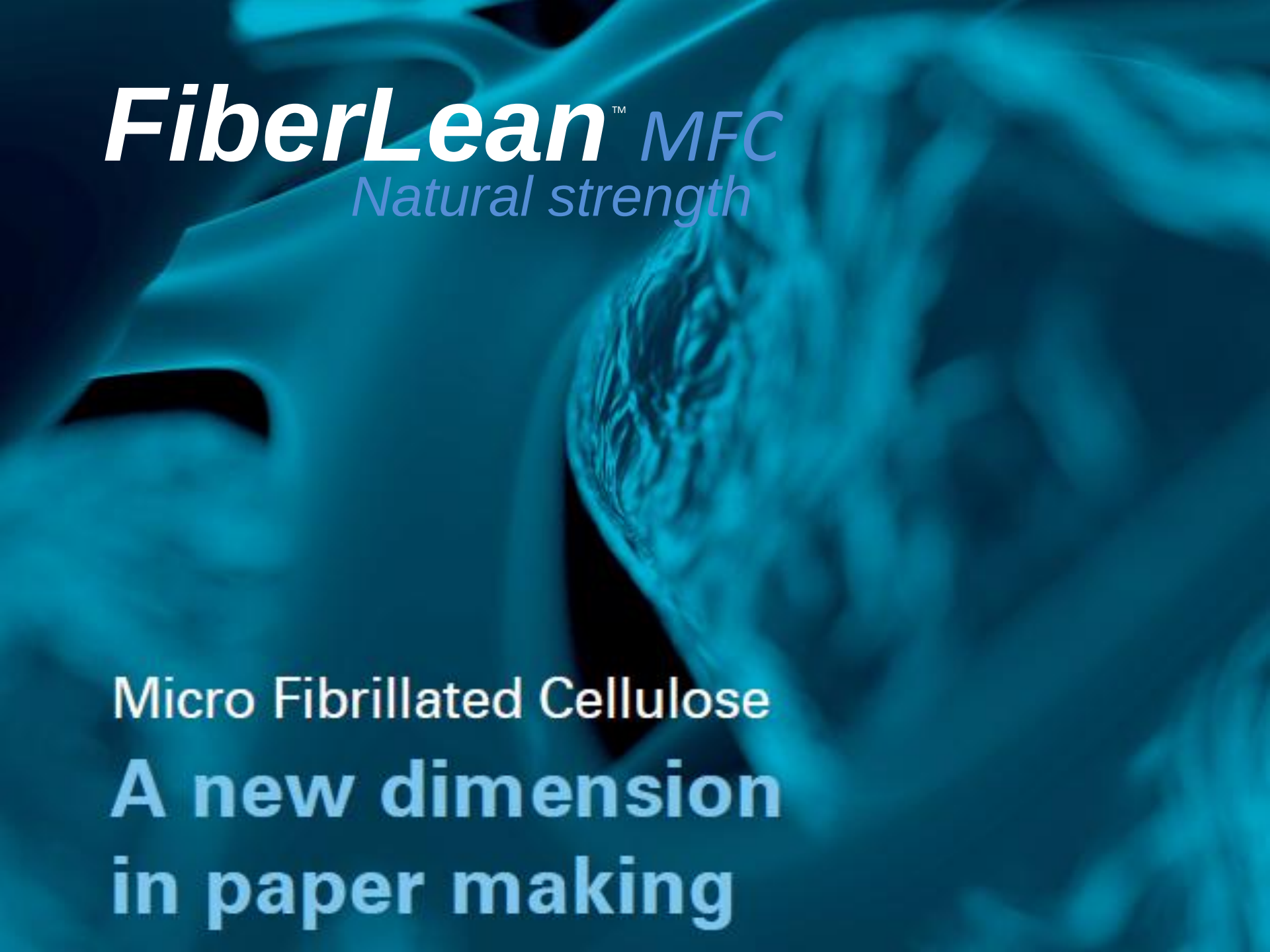
FiberLean™ MFC
Natural strength
Micro Fibrillated Cellulose
A new dimension
in paper making