NEW APPLICATIONS FOR MICROFIBRILLATED CELLULOSE IN AND ON PAPER AND BOARD

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SUMMARY

The FiberLean process for on-site manufacturing of microfibrillated cellulose (MFC) is now established and has opened the door for practical and economical use of MFC in the paper industry. The main application to date has been to use MFC for improvement of paper strength to facilitate filler increase in wood free P&W papers. In this application FiberLean offers improved opacity, reduced permeability and the possibility to add significantly more filler while maintaining good overall quality and operational efficiency. When filler replaces market pulp there will also be significant cost reduction. The FiberLean MFC is also attractive for use in packaging and specialty papers. So far, good technical fit has been found in Thin Printing Papers, Folding Boxboard and White Top Linerboard.

INTRODUCTION

FiberLean® MFC is a composite produced by co-grinding standard chemical pulp with minerals, such as calcium carbonate, kaolin or other. The output from the proprietary process, MFC (microfibrillated cellulose) and mineral, is a low solids slurry of high viscosity ready to be used in various paper applications. The process requires no additives. It is merely a mechanical upgrade of raw materials already used in the paper mill. In order to be cost-efficient processing is done on-site at the mill, using the local inputs and avoiding costly transportation of water. Made this way the composite will have a combined cost below the market price of chemical pulp allowing cost-savings to be made when filler loading is increased.

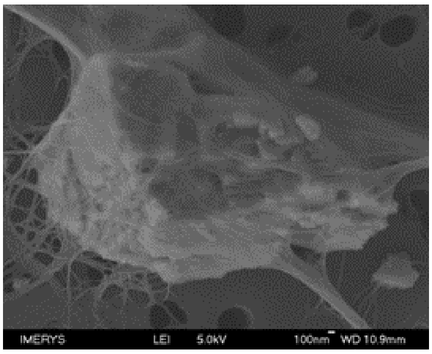

Figure 1. Micrograph of composite with MFC fibrils and GCC particle

Although the main purpose of applying the FiberLean composite to paper is to extract cost savings from having filler replace pulp, there are also some additional quality advantages, such as higher opacity, higher bond strength and notably, a much lower porosity. A summary of the impact on paper properties is found in Figure 2.

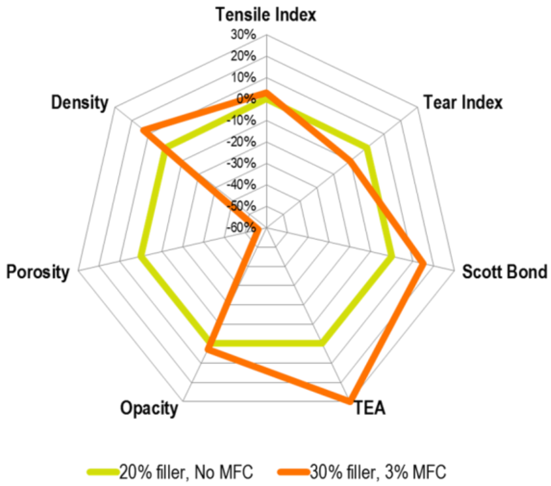

Figure 2. The base effect of using MFC-mineral composite to increase filler loading 10% units in UWF.

From this set of base effects there will be a need for normal paper making compromises to tailor the desired paper properties. Most notably there is normally a need to avoid the negative impact on bulk. This can be achieved through using improvements in smoothness to make changes in calendering conditions and/or through using the increased bond strength to allow changes in fiber mix or refining.

FULL SCALE APPLICATION RESULTS

Our experience from full scale paper making is quite extensive with well over 50 trials across 4 continents and several paper and packaging segments. Most of these trials have been for filler increase application in Woodfree P&W Papers but also various Specialty Papers and more recently also in Packaging Board.

Example 1, Coated Woodfree Paper:

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	=
Tear	39	36	-8%

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	=
Calandering pressure*	200	170	With 20 parts less kaolin in the coating colour.

The example shows a quite radical increase in filler loading from using less than 2% MFC where, despite optimization efforts also including going from 9 to 6 nips in the calender, there was some remaining negative impact on bulk and stiffness. Overall the results were however acceptable to the mill in question and result in significant cost savings.

Example 2, Coated Woodfree Paper:

Property	Reference	FiberLean	Comments:
Brightness	88,7	88,8	
L	93,9	93,9	
a	0,89	0,90	
b	-1,93	-1,99	
Opacity	93,0	93,5	0,5 unit gain
Base ash	14,3%	20,7%	6,4% higher ash
Bulk	0,87	0,86	
Stiffness √(MD x CD)	125	124	
PPS (TS + WS)/2	1,0	0,95	
Gloss (TS + WS)/2	68	68,5	
Tensile √(MD x CD)	25	25	
Tear √(MD x CD)	38	36	5% loss

This mill was more cautious and went for +6% filler loading using 1,2% MFC. The data above shows the properties of the finished coated paper after optimization. Except for some gain in opacity and a minor loss of tear strength there is very little difference between the reference and the paper containing 6% more GCC.

Example 3, Folding Boxboard:

There are two different applications for MFC in Folding Boxboard. The one most similar to the filler increase application in P&W Papers is to add MFC and filler (FiberLean) to the outer plies. With the increase in filler loading comes increased opacity, allowing a reduction in basis weight while keeping the same level of optical coverage. Our experience shows that also the physical coverage after coating can be maintained, or even improved. This is attributed to the improvement in coating hold out resulting from reduction in top layer porosity. The overall reduction in chemical fiber usage will be the combination of filler replacing fiber and reduction in basis weight. As a result of this the impact on economics is very favourable.

The other application in Folding Boxboard is to use MFC and as little filler as possible (bearing in mind that FiberLean is a composite) to enhance strength of the middle ply. The higher strength allows for reductions in refining of the mechanical pulp. The impact of adding MFC at constant mechanical pulp quality can be seen in figure 3 below. The impact from 2% MFC addition is around +100% in Scott Bond, despite also adding 2% mineral filler. This makes it possible to reduce mechanical pulp refining to improve the bulk of the middle ply at maintained delamination strength. Obviously the aim is improved board stiffness. We have also seen possibilities to remove reinforcement chemical pulp, wet-end starch and even spray starch. The latter is of particular interest from an overall operational efficiency point of view.

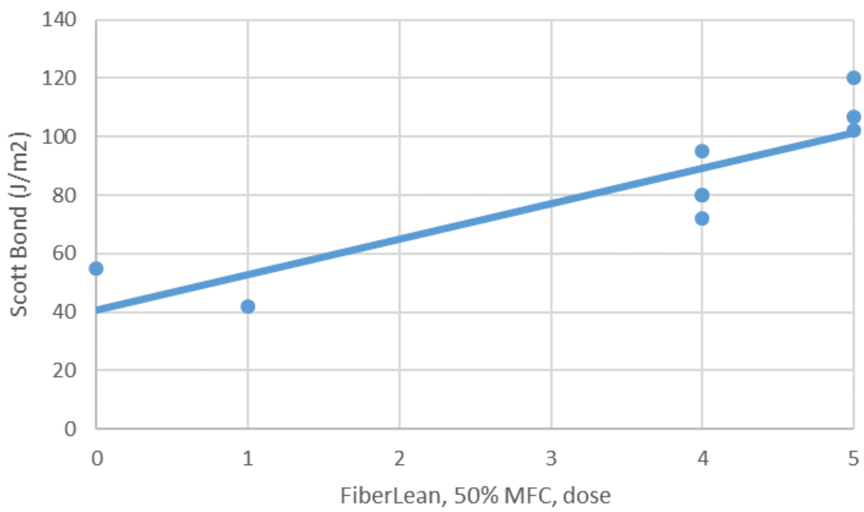

Figure 3, Folding Boxboard mechanical pulp middle layer Scott Bond vs % FiberLean dosage, full scale results.

APPLICATION DEVELOPMENT

MFC and mineral for coating has been high on the R&D agenda for a long time. The combination of good coverage and inherent strength is very attractive. There is however a very important thing to keep in mind. MFC holds a lot of water, so at anything like reasonable coating viscosities the solids of a MFC/mineral composite will be extremely low. This means massive amounts of water to remove after applying the coating. In practice, conventional coating with MFC and mineral has proven impossible, except for a few examples at extremely low coat weights.

So, what if you truly think outside of the box and actually apply the coating at the part of the paper machine that is designed to handle large volumes of water, the wet-end? We have explored this idea and have discovered that it actually works very well, albeit so far only in pilot scale.

In this exciting new concept, we use a simple curtain coater to apply a dilute suspension of FiberLean (MFC and mineral) right after the wet line on the Fourdrinier table. The suspension is drained using remaining foils, suction boxes and the couch to subsequently be pressed and dried just like any ordinary paper.

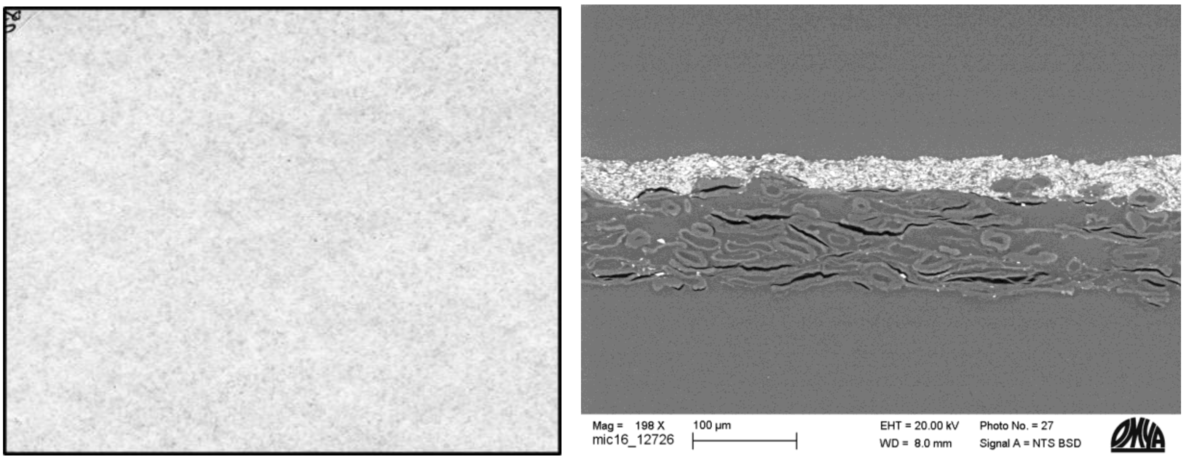

Figure 4 a, Surface picture of wet-end coated kraftliner with brightness exceeding current Coated White Top Kraftliner specifications at ca.40 g/m2 coat weight. b, Cross section view of wet-end coated kraftliner showing minimum coating penetration despite the open base structure.

We still have further work to do in developing this new concept but it clearly shows great promise. A low cost coating can cover a dark base at reduced White Top basis weight and this can be applied with simple equipment without significant impact on total cost of water removal. This could be a low capex and low operational cost option for production of White Top Liner, both kraft or recycled based, at a time when demand for high quality printing on boxes is rapidly increasing. We believe this application for MFC-mineral composites to be a significant breakthrough.

CONCLUSIONS

- Production of MFC in the FiberLean co-grinding concept is now established for use in filler increase application replacing market pulp.
- Further applications using the MFC-mineral composites have been proven, and these may even be more advantageous to paper makers than filler increase.
- With the availability of cost-effective, large scale MFC it seems inevitable that there will be further exciting application development.
- There is clearly an expectation among the early adopters of this technology that they will be able to develop new paper grades.