Advanced Dry Strength chemistries for Packaging Papers

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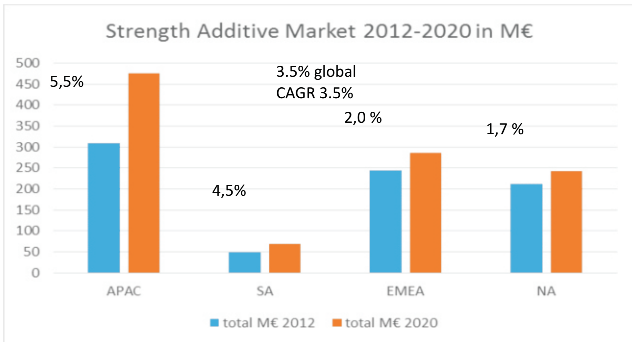
Summary :

The global packaging industry has increased difficulties to access high quality fiber raw materials for the production of its more and more diverse product offering in an economical way. Strength of recycled fibers is one of the key requirements, however, through increased reuse has been continuing to deteriorate in the recent decades. Technologies to impart strength by using high refining and high levels of starch to increase strength of these raw materials are often in conflict with the productivity targets. Also the competition of starch use in food versus industrial applications makes new and more efficient concepts necessary.

This presentation discusses the effects of new a generation of advanced FennoBond dry strength chemicals which can be used to make big differences on the functionality and quality of the end product and also on the productivity of a paper or board. Besides the products the application technology is a key to fully unfold the potential benefits for the customers. Examples from industrial practice will give an illustration about the typical needs and economical and sustainability benefits an investment in these technologies can give to a paper producer.Overall, the benefits of Kemira's strength technologies include quality upgrades, improved productivity and energy savings.

Introduction :

Today and in the foreseeable future the paper and board industry has increased difficulties to access high quality fiber raw materials economically. Dry strength of paper and board is a very important functional requirement for many end uses and has traditionally been adjusted by the paper producer through the use of Kraft fibers, suitable optimization of refining and utilization of natural or synthetic binders.



Graph 1: development of global strength market 2012-2020

As a result of limited availability of high quality virgin and recycled fibers and the growth of packaging and tissue production we expect the growth of the dry strength chemicals market to be higher than the annual average growth of the paper industry (P&P global CAGR until 2020 1-1,5%, India 7%)and estimate it to average out at 3.5% until 2020. The highest growth market will remain to be APAC.

Technologies to impart strength by using refining and high levels of starch or synthetic polymers are often in conflict with the productivity targets. In addition the need for environmental sustainability of packaging materials favors lower unit weight with high protection functionality which can be translated into an even higher demand of strength for fiber based materials if they want to be successful in future markets.

In addition the need for sustainability favors lower unit weight with high protection functionality for fiber based materials competing in the future markets. Kemira has developed EcoFill and FennoBond as new and unique strength technologies with distinct value as a response to these challenges for various paper, board and tissue applications.

During the recent years Kemira has put much R&D effort to develop technologies that meet the technical, economical and sustainability requirements of modern paper and board production lines. We have also used more biomaterials as a basis for our paper chemistry with a focus on areas like dry strength, sizing and coating binders which have a high specific use of functional chemistry. In this contribution we give an overview of recent advances in the FennoBond Technologywith focus on packaging papers, and on the economic value it brings to the paper from the combined view on raw materials, process chemistry and end use properties. Industrial cases will demonstrate how we realize this value for a specific paper grade.

DRY STRENGTH CHEMISTRIES

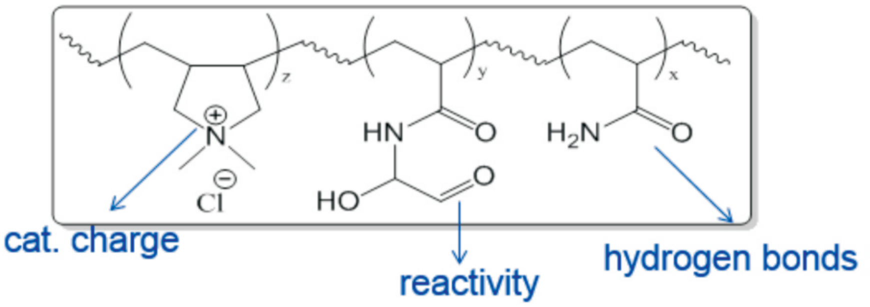
Kemira has developed a range of dry strength technologies which are based on synthetic and natural polymers with different reactive and non-reactive chemistries (Table 1).

	FennoBond 3300E	FennoBond 3150E	FennoBond 55D	FennoBond 85E	FennoBond 46	FennoBond EF Lite	FennoBond 28
Chemistry	GPAM	GPAM	DPAM	APAM	SPAM	Mod. Cellulose	SPAM
Ionicity	cationic	cationic	amphoteric	anionic	cationic	anionic	cationic
Benefits	Strength Dewatering Productivity	Strength Dewatering Productivity	Dewatering Productivity Strength	Dry tensile, burst and stiffness Booster for WE starch or WSR	Strength Dewatering Productivity	Strength Dewatering Productivity	starch boost Starch reduction Productivity
Make-down	"Pump and go"	"Pump and go"	Make-down unit	"Pump and go"	"Pump and go"	Make-down unit	"Pump and go"
Application	Thick or thin stock	Thick or thin stock	Thick stock	Thick stock or size press	Thick stock	Thick stock	Starch cooker

Table 1 : Kemira dry strength technologies (GPAM = glyoxylated polyacrylamide ; DPAM = dry polyacrylamide ; SPAM = solution polyacrylamide ; Mod. Cellulose= chemically modified cellulose; WE =Wet End; WRS= Wet Strength Resin)

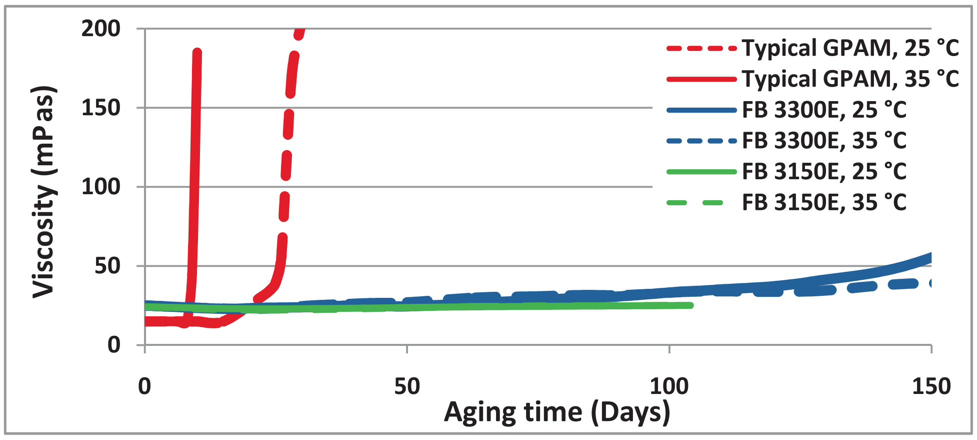
Compared to starch and amphoteric polyacrylamides, which are the most common dry strength additives,these technologies cover a wider window of operation with regard to charge density, molecular weight, sensitivity to pH and conductivity. Thus fiber adsorption characteristics and maximum dosage amounts can be achieved in various conditions, matching different technological needs as well as economy of use. Application technology can also be selected as suitable – wet end addition to different dosing points in the thick stock or approach flow as well as at the size press. Interaction of wet end chemicals are taken into account - some products can function as starch boosters to improve the cost efficiency and runability of wet end starch. Some strength products are useful to gain better retention on the wire and better dewatering in the press.It is also possible to apply cat. Wet end starch together with anionic or amphoteric synthetic dry strength resins.

Glyoxalated polyacrylamide products, FennoBond 3150 and FennoBond 3300 were developed for strength enhancement of test liners and other packaging materials. As a reactive polymer it creates additional strength through covalent bonding.



Graph 2 : Molecular structure and functional properties of Glyoxylated polyacrylamides

It is available in different cationiccharge levels, which can be selected depending on the closure and the level of conductivity of the wet end system. The products are liquid and easy to pump.



Graph 3 : shelf life of advanced GPAMs versus conventional GPAM

Due to their special structure (graphs2; 3) these products have a much longer shelf live than conventional glyoxylated resins.

FennoBond 46 is a liquid solution polymer that is easy to handle, the shelf life is at least four months. The liquid product is usually diluted 1:10 before dosing to the wet end system. It is suitable for the reduction of dusting in printing paper grades.

Fennobond 85 is a liquid, easy to dose, anionic solution polymer, used alone or in a combination with cationic strength additives, e.g. cationic starch or wet strength resin.

Fennobond 55D is an amphoteric dry powder polyacrylamide. It needs to be dispersed on site with a Kemira proprietary make-down rig. The product is used mostly for packaging grades and provides strength and productivity through superior dewatering at low dosage rates.

EcoFill Lite is an engineered cellulosic Additive (ECA), used in combination with a charge control additive (CCA) to treat weak fibers. It provides strength to paper and board by increased bonding through the chemically modified Cellulose.

FennoBond 28 is a cationic dispersion polymer in liquid form, developed to improve the performance and retention of wet end starch. It can be added to the starch slurry before cooking or added to the cooked starch paste.

CUSTOMER BENEFITS

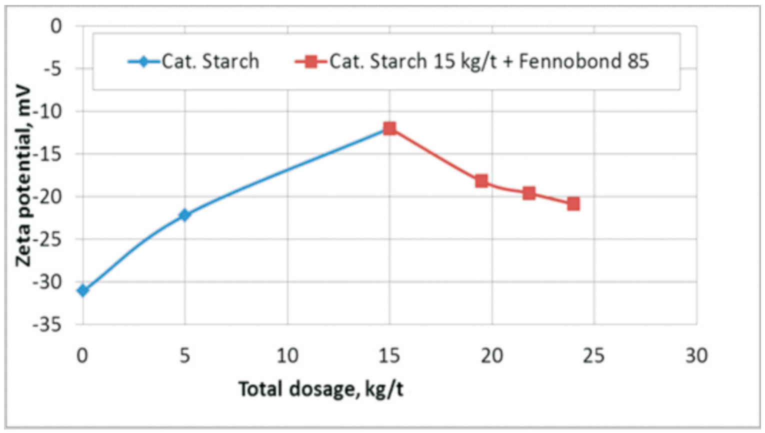
Customer benefits are machine and grade specific and differ from region to region depending on the availability of fiber sources, starch and the local customer market.

For packaging grades mechanical strength and dewatering, reduction of basis weight, enhanced starch performance , reduction of size press starch with production speed gains and substitution with lower cost furnish are the main objectives for the use of strength polymers.

FennoBond 3300 is a solution polymer with a high cationic charge.Compared to traditional strength aids it is less sensitive to anionic trash and high conductivity in the wet end. Normally, a charge control agent is not necessary. It usually helps dewatering in the press section so that increased speed can be achieved, especially when starch is used or partly substituted

FennoBond 55D has an even higher effect on dewatering and is effective at low addition rates with productivity increases of up to 8%. The strength improvement with this product is usually below 10%.

FennoBond 46 is a unique and effective dry strength agent that is specifically developed to provide strength when a high level of ash or filler is present. This product can also improve retention of fines and ash without a loss of strength. Dusting and linting in converting and printing can be reduced even at higher levels of filler and fines in the paper.



Graph 4 : enhanced absorption of strength polymers by combining cationc starch and anionic solution PAM

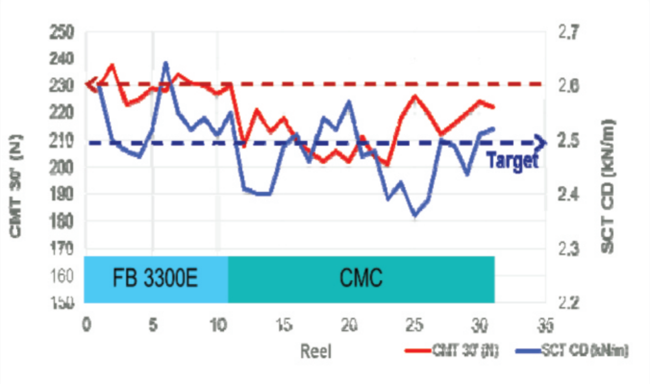
FennoBond 85 is an effective strength agent when a system is already saturated with cationic charge through high levels of alum or PAC. It can also be combined effectively with cationic starch or other cationic strength agents as it balances the fiber charge (graph 4) by forming an electrolyte complex with adsorbed cationic polymers and makes it possible to enhance the total amount of dry strength polymer to the fibers

EcoFill Lite is a robust technology for packaging grades withstanding high closure of the wet end system and high conductivity levels. It is usually applied with a charge control additive. Depending on the case and furnish composition the product can be used to achieve strength increases of over 10% up to 25% when added to the thick stock of the paper machine.

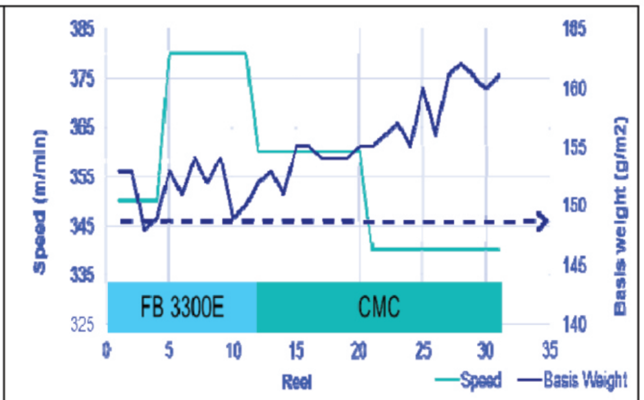
FennoBond 28 can be used at very low dosage rates (2-4% on starch) to improve the efficiency and retention of wet end starch. As a result the starch quality is stabilized and starch can be used more effectively. The investment is returned by the increased efficiency of the starch, less consumption and measurable cleaner wire waters.

INDUSTRIAL CASES : **Case 1: Recycled Testliner production**

Although CMC together with starch was already used as a dry strength agent, a European customer on a two layer machine, 180t/day capacity without size press had to produce testliner at a higher than basis weight to meet the target specifications of 2.5 kN/m SCT and 230 N CMT 30 for the 150 gsm testliner grade. Dosing of **Fennobond 3300E** (3 kg/T dry) to the inlet of machine chest pump made it possible to reach the strength specification at 150gsm. At the same time all of the CMC and 11% of the starch were replaced. An average of 5 % fibers could be saved and an increased speed of 30 m/min resulted in a 9% net production gain.



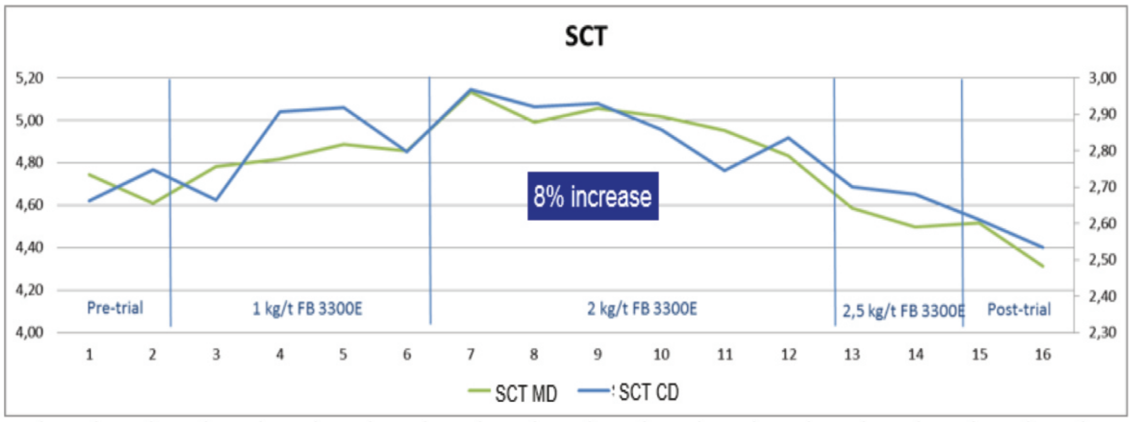
Graph 5a : CMT development during testliner strength trial



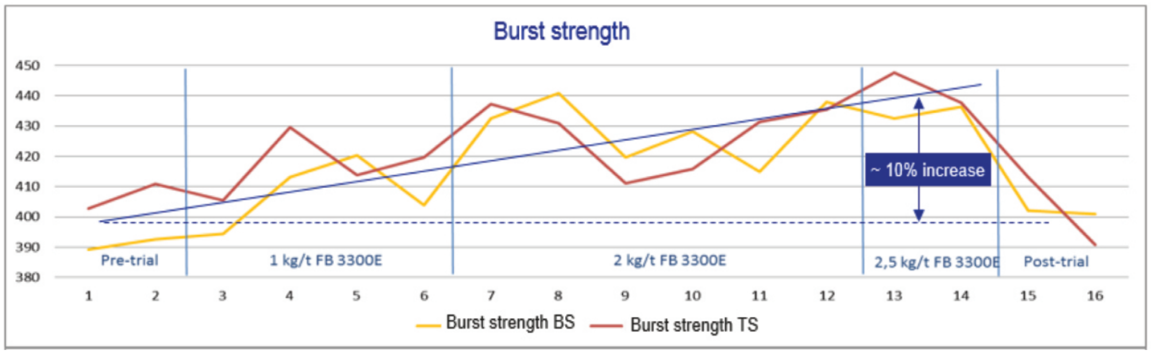
Graph 5b : speed and grammage development

Case 2: High quality recyled testliner production

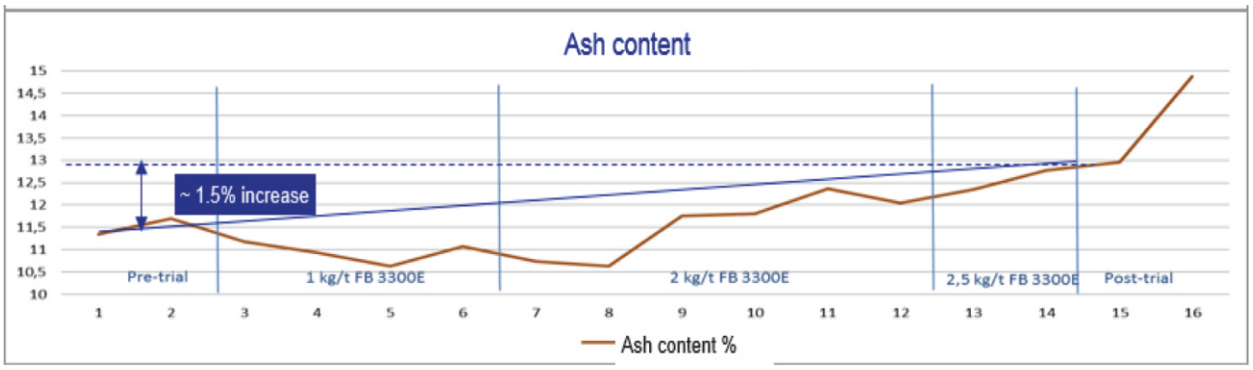
A Central European producer needed a 5-10% improvement in dry strength in order to safely reach SCT specifications in Testliner 1 production. The machine produced 800 t/day 160 gsm grade with recycled mixed waste and OCC furnish at around 980m/min. Dosage of 8-20 kg/t of **FennoBond 3300E** to the inlet of the machine chest was sufficient to increase SCT CD and Burst by 8% and 10% respectively. Burst could be kept on that level at 1,5% higher filler. However, SCT was more sensitive to the increase of filler in that trial and came down by approximately 4%. Fixative dosage could be reduced and ash levels controled so that the production targets could be reached and stabilized.



Graph 6a : SCT (Short Span compression Test) increase in 160 gsm Testliner 1 production. Dosage in dry kg/t



Graph 6b : Burst and Ash development during 160 gsm Testliner 1 production. Dosage in dry kg/t



Graph 6b : Burst and Ash development during 160 gsm Testliner 1 production. Dosage in dry kg/t

Case 3: Core board and Chipboard with improved dewatering and strength

Another Western European producer of chipboard and core board with a 7 layer VAT former machine and a capacity of 250 t/day wanted to increase productivity and substitute recycled OCC by lower quality mixed waste fibers. The current system used 25 kg cationic starch in the wet end and native starch sprayed between the layers. 10 kg/t **FennoBond 3300**to the outlet of the machine chest pump could match the strength specifications (Scott Bond, CMT 30 and burst) while substituting all of the 30% OCC with mixed waste. At the same time production output increased by 8%.

Case 4: Chipboard production with internal bond strength needs

A European manufacturer of chipboard was having difficulties achieving Scott bond targets despite the high levels of starch, up to 150 kg/t. This machine is a 2 layer machine producing chipboard and coreboard at 300-800 gsm in a speed range of 90-170 m/min.Being a very closed wet end system with conductivity levels as high as 5000 μS/cm and high cationic demand, the use of cationic wet end starch was not effective nor economical. The practice is to add native uncooked starch into the thick stock to provide internal bond. High level of starch naturally impedes dewatering and limits machine productivity.

The manufacturer was looking for a solution to maintain high internal bond at the same or improved dewatering rate.When **FennoBond 46** was dosed at 15 kg/t, a significant increase in strength was obtained, including internal bond up to +37% and burst up to 16%. There was also a positive impact on retention and dewatering. Turbidity in the white water decreased by 20%. Machine speed increased by 1,5% on a grade with 35 kg/t starch and remained the same on the other two grades with 83 and 149 kg/t starch.

Case 5: EcoFill Lite in the production of high performance Sack Paper

The next case describes our experience in upgrading of a European sack paper. The customer wanted to produce a kraftfiber based high performance grade with better strength properties and maintained porosity. Addition of the EcoFill Lite system in the thickstock led to an increase in Tensile Energy absorption values of 20%. The additional high performance grades improved the viability of the mill adding over 1 mio € in added value.

Case 6: liner production with increased productivity requirements

A northern European producer of two ply Kraft liner in the basis weight range 200-300 gsm had problems to achieve SCT strength targets. Increased refining of the OCC / unbleached kraft fiber mix and wet end starch dosage did not improve SCT but reduced dewatering on the machine significantly. When 0,5-0,7 kg/t of Fennobond 55D were added before the machine chest the SCT levels increased by 6-8%. Machine speed and production could be increased by 8% the wire water solids were reduced by 50% through better retention and sizing efficiency improved significantly.

CONCLUSIONS AND SUMMARY

The effects of dry strength chemicals are complex but can be used to make big improvements on the functionality and quality of the end product and also on the productivity of a paper or board machine. The investment in these technologies should receive the best possible return. Requirements are different from grade to grade as is the environment of the production line - it is thus important to select the fittest technology to do the specific job from a range of technologies and best application practices available. Kemira has developed FennoBond and EcoFill as new and unique strength technologies with distinct value for packaging grades.

The right application technology is a key for new strength polymers to fully unfold the potential benefits for the customers. Kemira selects products and optimizes value by comprehensive technical and economical surveys. EcoFill is a unique technology used for filler or fiber treatment and is especially powerful when high strength or large substitution with cheaper raw material is required.

Overall, the benefits of Kemira's strength technologies include quality upgrades, improved productivity and energy savings.