ACACIA (BAKP) – The Fibre of Choice

Ann Burman

BAKP, Acacia Bleached Kraft Pulp, is a new short fibre pulp introduced on the world market by South East Asian suppliers in the late 1990's. Acacia being a short, thin-walled fibre shows several similarities with Eucalyptus pulp, in terms of good bulk and stiffness. Refining energy and strength properties are very similar, but the shorter fibres and thinner cell walls give an outstanding opacity and formation compared to all other commercial short fibre pulps. The collapsed and band-shaped nature gives a matchless smoothness, enabling less calendaring and exceptional printing properties. Acacia is shown to give several advantages to fine paper makers, compared with a number of established short fibre pulps as Brazilian and Chilean Eucalyptus, Canadian Aspen and Indonesian Mixed Hardwood. It is important to consider refining and calendaring conditions to achieve optimum performance. For outer layers of multiply board, acacia gives excellent coverage, due to the high opacity and uniform fibre distribution. The low roughness gives improved printability. For tissue products, acacia gives unique properties as superior softness, both in terms of handfeel and bulk softness. The high fibre population gives an impression of a more exclusive product, due to the higher opacity and good formation.

INTRODUCTION

Acacia or BAKP (Bleached Acacia Kraft Pulp) is a relatively new fibre entering on the world pulp market. APRIL, Asia Pacific Resources and International Holdings Ltd., is one of the world's biggest manufacturers of pulp and paper as well as a leading developer of fibre plantations.

APRIL operations are worldwide but main manufacturing plant is in Riau Indonesia. The group has also recently acquired a mill in Rizhao Shandong.

APRIL products are MWH (Mixed Hardwood), BEKP (Bleached Eucalyptus Kraft) and BAKP (Bleached Acacia Kraft) market pulp, uncoated Woodfree paper and paperboard.

Suitability of short fibre pulp

This presentation will introduce the features of different short fibre pulps, with eucalyptus as a benchmark. Mixed Hardwood from Indonesia is used as comparison in some discussions, being a well-known fibre in this part of the world.

Asia Pacific Resources International Holdings Pte Ltd (APRIL)

For Uncoated WF and Coated WF the requirements are almost the same. Paper formation and opacity is superior with acacia. Strength is more or less

Table 1
Suitability of short fibre pulps for UCWF

	MHW	BEKP	BAKP
Formation	-	0	+
Opacity	-	0	+
Smoothness	-	0	+
Strength	–	0	0
Bulk	++	0	(-)
Bulk/Smoothness	-	0	+

Table 2
Suitability of short fibre pulps for CWF

	MHW	BEKP	BAKP
Formation	-	0	+
Opacity	-	0	+
Smoothness	- -	0	+
Strength	–	0	0
Bulk	++	0	(-)
Bulk/Smoothness	-	0	+
Porosity	-	0	+

similar between Eucalyptus and Acacia. When it comes to bulk and smoothness, MHW has the highest bulk, while Acacia gives best combination of highest bulk at a specified smoothness.

For coated papers Acacia gives a more closed surface, which is an advantage for penetration of the coating colour, especially for single coating. It should be noted that both uncoated and coated paper are produced from both Mixed Hardwood and Eucalyptus, where especially Asian paper makers in India, Korea and China have gained skills to produce excellent coated paper.

Table 3

Suitability of short fibre pulps for Paperboard

	MHW	BEKP	BAKP
Farmation	-	0	+
Opacity	-	0	+
Smoothness	–	0	+
Strength	-	0	0

Table 4

Suitability of short fibre pulps for tissue

	MHW	BEKP	BAKP
Softness	-	0	+
Formation	-	0	+
Opacity	-	0	+
Low fines content	-	0	0
Bulk	++	0	0

Requirements for surface layers of paperboard are very similar to printing paper, where Acacia provides best coverage by combination of best formation and highest opacity. The roughness of Acacia is lower, which gives improved printability both for coated and uncoated surfaces. Strength is similar, but on the lower side for MHW.

Pulp properties suitable for tissue are quite different from other papers, where softness and bulk are the most important parameters. Acacia gives generally a better softness than eucalyptus. Bulk is on the other hand much better for MHW compared to the other two. Formation and opacity are important as tissue consists of very light weight products, where the inherent individual fibre properties have a higher importance. At last fines content, which is important for dusting and drying capacity, is significantly lower for acacia, than for eucalyptus.

As acacia is a new fibre for pulp and paper making, several independent Pulp and Paper institutes were commissioned by APRIL to make basic investigations of the fibre morphology, refining response and paper making potential.

In this presentation basic concepts of fibre morphology are explained and results are presented from a study at STFI, the Swedish Forest Research Institute, comparing acacia to two different grades of Eucalyptus, one from Brazil and the other Iberian.

In the second part results from a refining study, comparing some different grades of pulp available in Asia, is discussed from a papermakers view. The study is made at MoRe Research, formerly MoDo Research; an independent laboratory specialized in pulp and paper, located in Sweden.

RESULTS

Morphology study

In this study at STFI three different short fibre pulps were studied, Iberian and Brazilian Eucalyptus and Indonesian Acacia.

Fibre dimensions are characterized by length, width, wall thickness and wall area. The methods used at STFI are

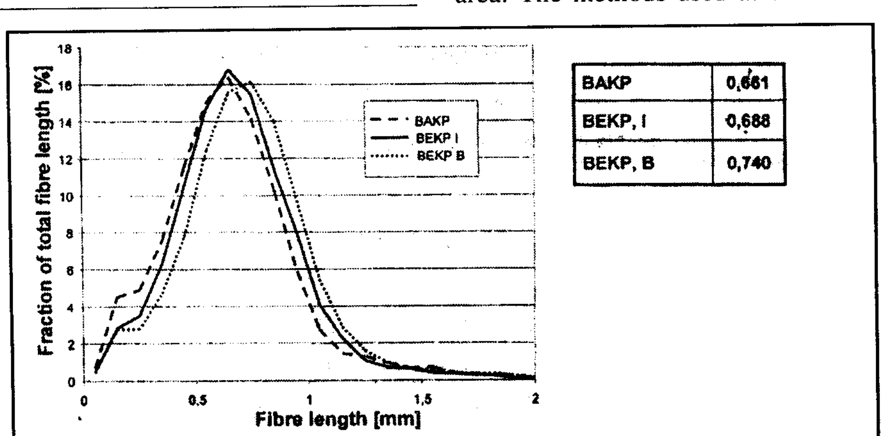


Fig. 1 Fibre length distribution (length weighted)

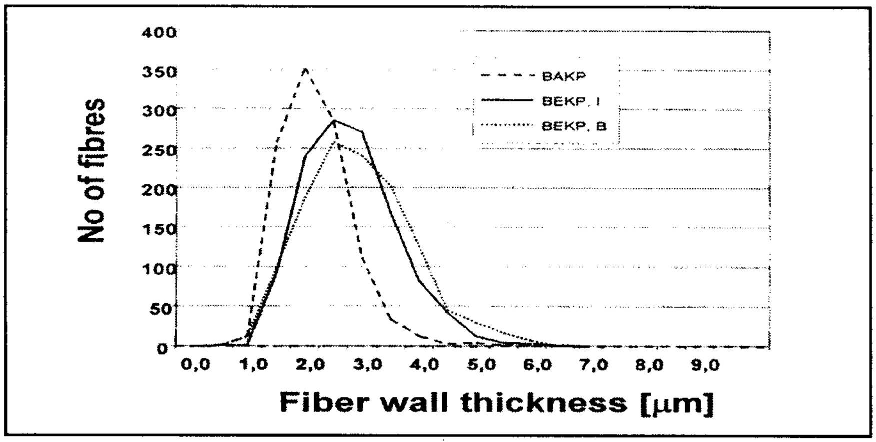


Fig. 2 Fiber wall thickness distribution

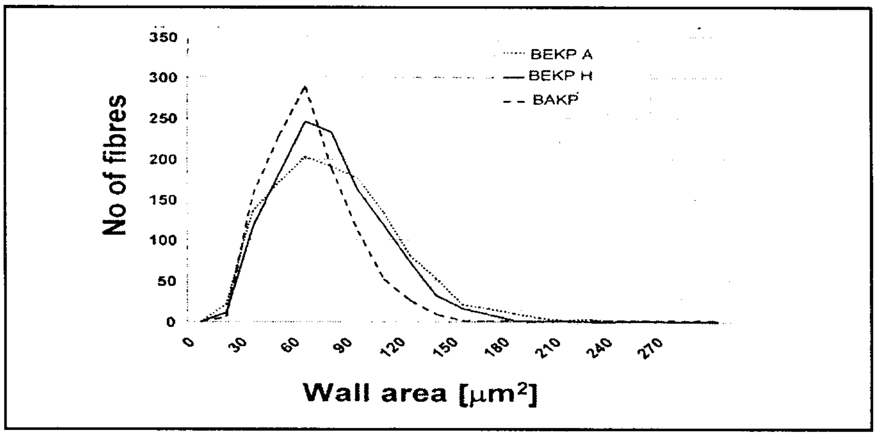


Fig. 3 Fiber wall area distribution (proportional to fibre coarseness)

	Fiber length	Fiber width	Fiber perimeter	Fiber wall thickness
	mm	mm	mm	μm
Acacia	0,661	14,8	41,3	1,96
Eucalyptus, I	0,688	15,5	39,4	2,55
Eucalyptus, B	0,740	15,4	38,9	2,70

besides traditional light microscopy, confocal microscopy and STFI Fibermaster.

Acacia has similar narrow fibre length distribution as the two eucalyptuses, all being single species, although average fibre length is shorter, 0,66 mm compared to 0,69 for Iberian and 0,74 mm for Brazilian eucalyptus.

Similar tendency can be seen from the cell wall thickness measurements, where acacia shows significant lower cell wall thickness, 1,97 compared to 2,55 and 2,7 μm respectively for Brazilian and Iberian eucalyptus and even more narrow distribution than both of them. Note that the figures from microscopic evaluation is much less than figures from Kajaani Fiberlab, the optics of this equipment can not measure so thin fibres with any accuracy.

Fibre width and perimeter are quite similar, as shown in the table below, why basically a thinner cell wall at same fibre perimeter and length, gives significantly lower coarseness for acacia.

The conclusion is confirmed by the chart showing fibre wall area distribution, where acacia average wall area per fibre is lower and the distribution is significantly narrower. In practice this means that acacia fibres have a very uniform fibre size, all fibres more or less identical.

Comparing various short fibre pulps coarseness and fibre population give certain specific paper properties.

Low roughness and high population favour tensile strength and initial web strength, at same fibre length, related to good contact between fibres, low

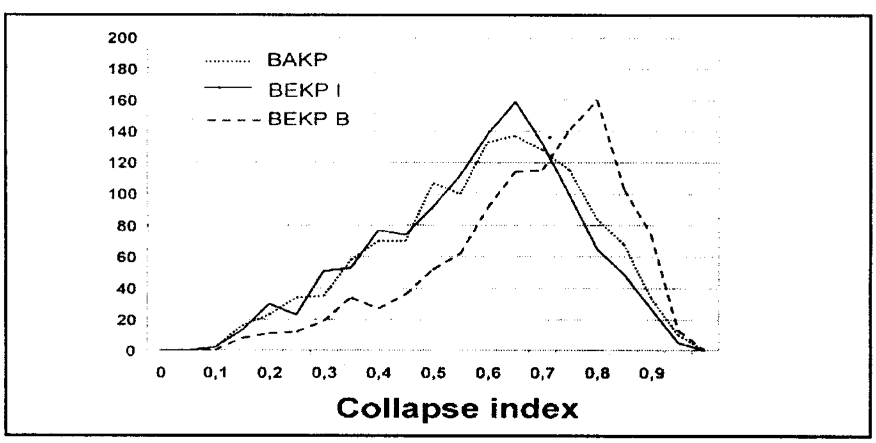


Fig. 4 Fiber collapse index

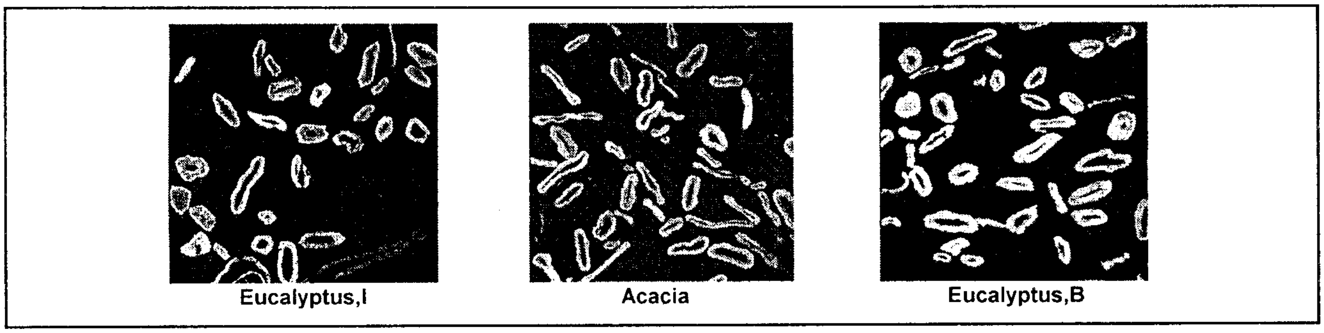
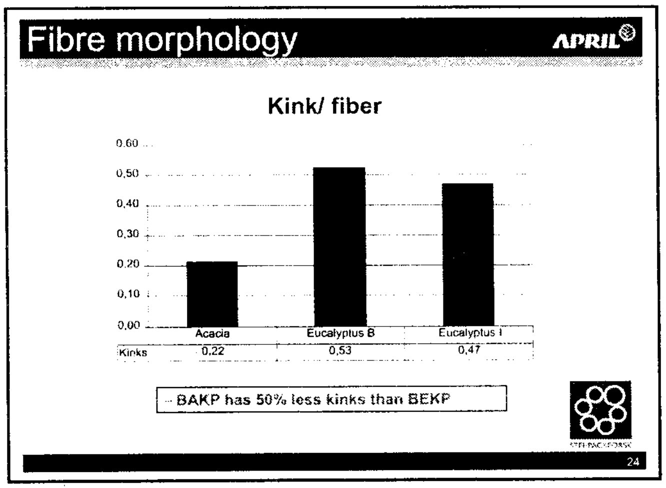
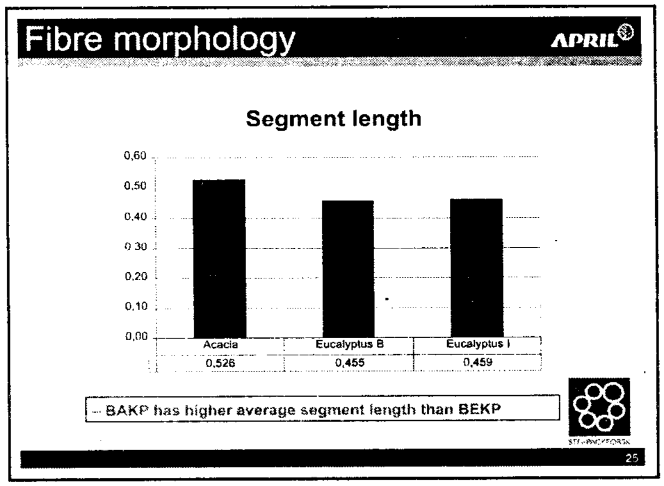


Fig. 5 Cross-Sections of hardwood fibres



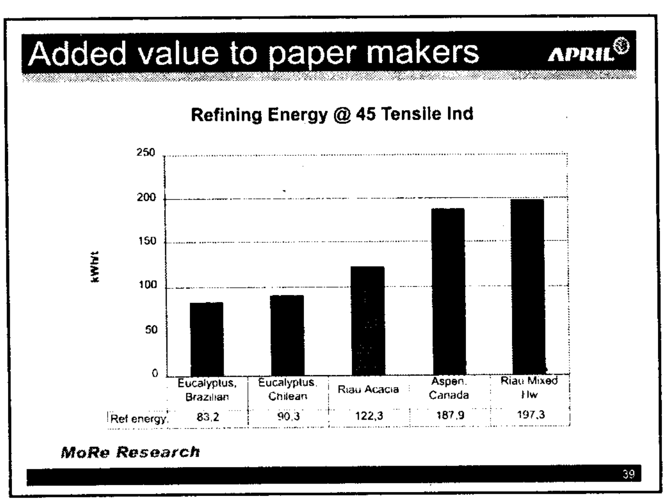


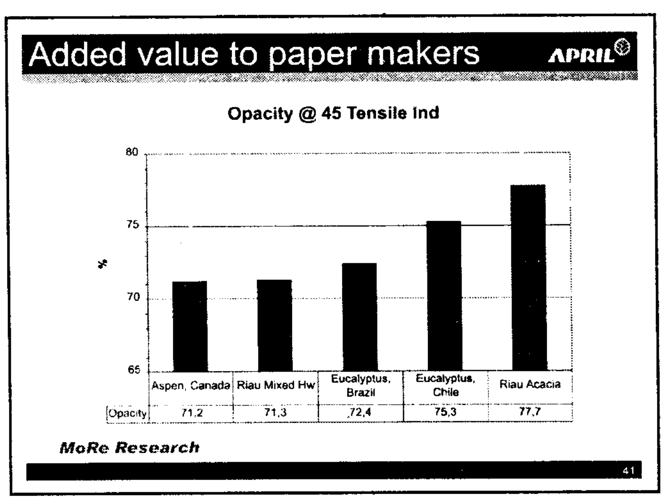
coarseness giving large surface area per weight. Opacity and light scattering is mainly related to fibre wall thickness, while paper formation is similarly improved by increased number of fibres per weight. Surface smoothness is enhanced by thin and collapsed fibres.

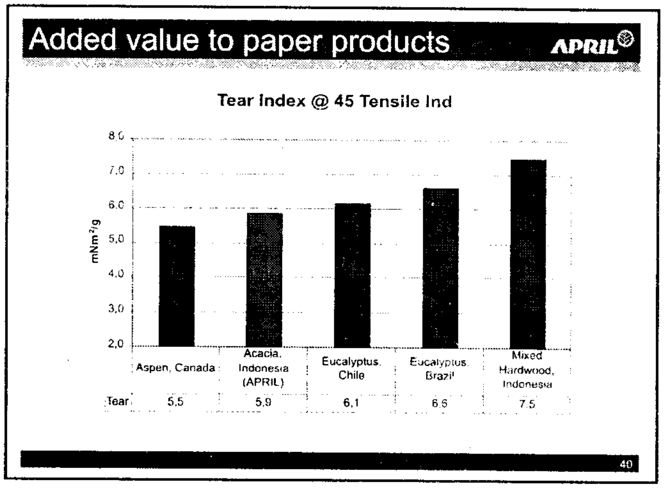
On the other hand high coarseness gives high bulk, which is closely related to high porosity and good drainage. Tear is depending on fibre length, but also bulk can give a positive effect.

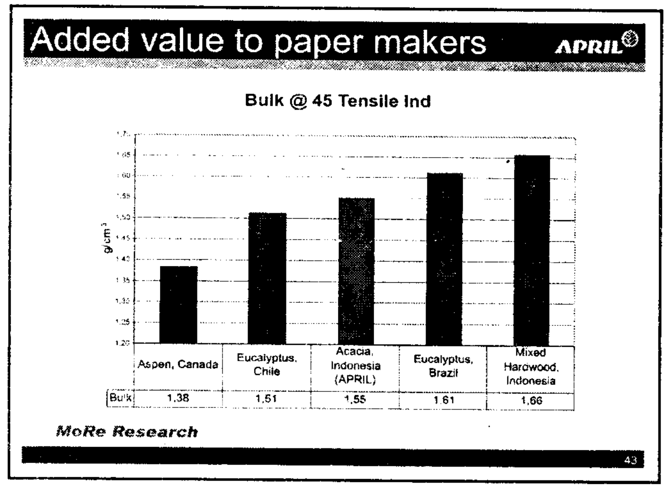
Fibre shape is characterized by on one hand collapse index and on the other hand curl index and kinks. Collapse index is defined as 1 minus lumen area divided by an area of a circle with same perimeter as the lumen. Acacia fibre is in unrefined state already to a great extent collapsed compared to Eucalyptus, due to the thinner cell walls. The effect of sheet consolidation from once-dried pulp is not included.

Acacia appears to be a very straight fibre, kinks per fibre less than half than









from the Eucalyptus, why the segment length and consequently the effective bonding length is slightly higher even if the average fibre length is shorter. The shape factor decreases with fibre length.

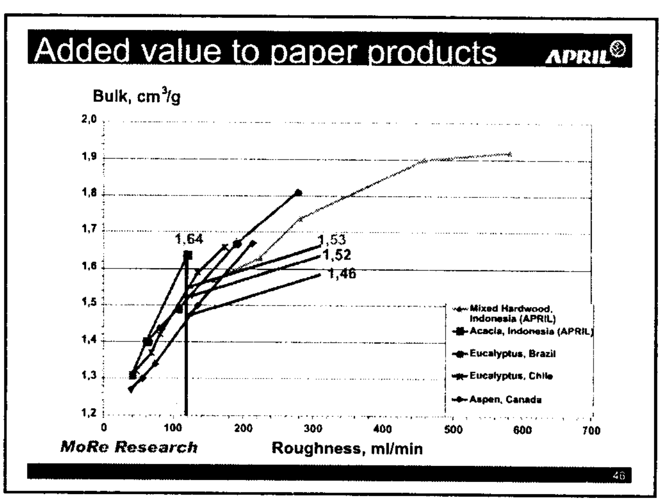
The low number of kinks contributes to a high shape factor, normally as measured in Fibermaster between 92 to 94%, compared to Eucalyptus of 89 to 91,5%. Kinks are often induced by equipment or process conditions in the pulp mill or stock preparation of the paper mill. The impact of lower shape factor is a significant loss of tensile index, about 5 – 8 Nm/g for every percent.

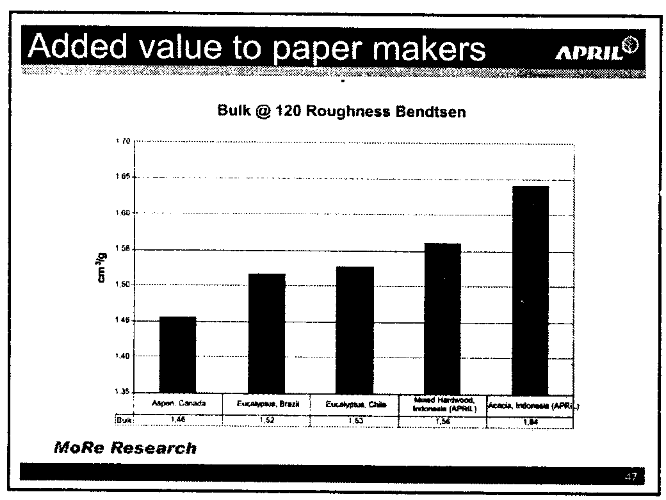
Refining study

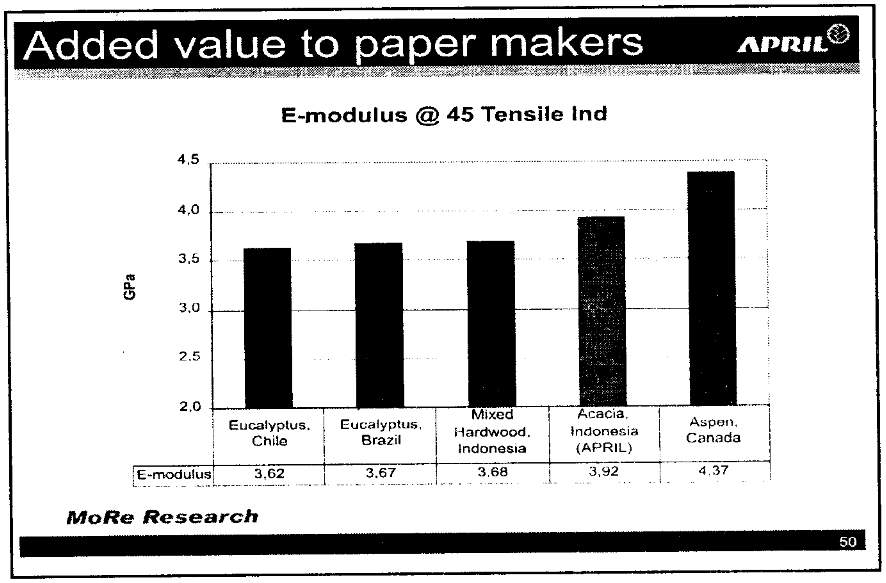
The refining study was made at MoRe Research, an independent laboratory based in Northern Sweden.

The evaluated short fibre pulps are beside Acacia two kinds of South American eucalyptus, Canadian Aspen and Indonesian Mixed Hardwood. An Escher-Wyss conical pilot refiner was used with furnish of 3,5% consistency with water of a specified ionic strength. 63 g/m³ hand sheets were made in a conventional sheet former with deionised water. Refining energy input per ton is for that reason considerably higher than from industrial refining.

Comparisons of paper properties relevant for uncoated printing properties have been made at a constant tensile strength, as freeness or refining energy input not have same importance as the paper specifications to the papermaker. It is of highest importance to select refining strategy taken in consideration not only the furnish but the paper specification as well, not just by routine refine all different pulp in the same way. Type of paper machine will also have a big impact due to different layout in press section and open draws for instance. Tensile Index of 45 Nm/g is chosen as reference level, similar to standard tensile strength of uncoated Woodfree papers.







Refining energy input to achieve reference level is slightly higher for acacia than for eucalyptus, but considerably lower than for Aspen and Mixed Hardwood. Note that the level is higher than industrial refining, but the internal relation should be correct.

Tear strength of Acacia is lower than eucalyptus and considerably lower than Indonesian Mixed Hardwood, due to the short fibres. The tear strength is most important for runnability on the paper machine, not directly for product quality for most uncoated printing paper and many big fine paper machines in Asia is today running at speeds over 1500 m/min, at world class efficiencies..

The focus and importance for many paper makers are today shifting from traditionally strength related properties to optical and printing properties. No fibres or paper making strategies can really combine high strength properties with excellent printing properties, there will always be a trade-off.

The optical properties of acacia are due to the high population and thin cell walls of the fibre, what differs most from other fibres. Opacity is for a handsheet without filler almost 2,5 units higher than for Chilean Eucalyptus and 6 units higher than Aspen and Mixed Hardwood. Using Acacia has in many cases more impact than the filler level. Similarly formation is very much improved comparing papers made from fibres with high population. There is difference against Eucalyptus is in our experience but not as noticeable as for opacity.

Bulk as measured by a pulp hand sheet is average level for acacia, definitely less than Mixed Hardwood and Brazilian Eucalyptus but higher than Chilean Eucalyptus and Aspen. The bulk for paper is on the other hand not entirely related to this property as no consideration is taken to the roughness of the paper to be produced. For book paper and low grades of uncoated printing paper, where there are no requirements on roughness this is relevant, but most printing paper today will have a very precise roughness or smoothness specification to give the desired print result.

Experience from our own paper machine has shown that paper made from acacia has a more "true thickness" as the paper surface already from beginning is noticeably more even than paper produced from Mixed hardwood. This effects the traditional thickness measurement, which only measures the "peak" thickness and not the averages. After calandering the difference becomes less and measured thickness the same.

As already mentioned most papers have a specification on roughness, so if comparing at same roughness will give the actual bulk. At 120 ml/min, measured as Bendtsen roughness, Acacia will give by far the highest bulk, which is confirmed by our own paper mill as by other prominent fine paper producers in the world. This said, there are other factors influencing as the type of the calendaring on the paper machine – if no possibility to unload calender the effect will be less. Leading paper machine suppliers in the world are now offering soft calendars that go down to a linear load of 5 kN/m, compared to around minimum 25 to 30 in the past. For multi nip steel calendars it might not be possible to adjust calandering at all.

For many paper makers stiffness is a very important property, most related to the thickness impacting in 3rd potential. At same thickness the elastic modulus is, as a material constant, proportional against stiffness. Acacia being a very straight fibre with fewer kinks than the evaluated Eucalyptus pulps, has higher E modulus, but still lower than Aspen. From our own paper mill we continuously see a 5 to 8 % higher bending stiffness from paper produced from acacia compared to from Mixed Hardwood at same thickness.

DISCUSSION

The results from the studies can be summarized as the advantages acacia pulp offers the paper maker, provided process conditions are adjusted in an optimum way.

The advantages of acacia for uncoated printing paper is an excellent formation and opacity, important especially for thin and low basis weight products. Provided calandering can be adjusted, a favourable combination of high bulk and a low roughness can be obtained. A good E modulus will improve stiffness in addition.

The disadvantage is obvious, acacia should not be used for products where a rough surface is accepted and high bulk is required. Similarly bulk potential can not be utilized for old machines equipped with multi-steel nip calendars.

Refining conditions has to be considered for all new pulp used, Acacia and Eucalyptus are in this respect quite similar and principal suppliers of refiners recommend using finer fillings and higher consistency before refiners, than for higher coarseness hardwood and softwoods. As mentioned before, calender loadings should be reduced to preserve bulk.

Similar evaluation has been made of unrefined samples of same pulp with requirements for tissue in mind, where the major advantage seems to be a very good softness, both in terms of "handfeel" softness and bulk softness or flexural rigidity. Major tissue companies in the world have showed a huge interest in the fibre, which probably will be next key usage area for BAKP. For very thin sheets of 14 – 21 g/m^2 as facial towels and tissue, the good formation and high opacity give the impression of better softness and a more exclusive product. Low fines content is appreciated due to less dusting tendency and less required drying capacity at the Yankee cylinder. Acacia shows good absorbency due to high fibre population and high unrefined bulk.

CONCLUSIONS

The high fibre population of Acacia promotes excellent formation and outstanding opacity compared to all commercial short fibre pulps. The thin cell walls of Acacia fibres provide unique smoothness of the paper surface. Comparing at same surface roughness of the paper, Acacia gives superior bulk. A straight fibre without kinks, gives higher stiffness at the same thickness due to better E-modulus.

The high population combined with thin and collapsed fibres gives an exceptional softness for tissue.

Quoting a famous consultant in the Pulp and Paper industry, "Competitiveness of pulps can be estimated by the number of fibres per gram. This correlates with most of the important requirements set for fine paper. Large number of fibres improves the smoothness and opacity of pulp and improves the printability properties of paper."

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