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NEW ZEALAND RADIATA PINE MARKET KRAFT PULP REFINING DEMAND, FREENESS, AND STRENGTH PROPERTIES

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Radiata pine and northern softwood market kraft pulps can have different refining requirements to develop selected freeness and strength properties, but such differences decrease with decreasing proportions of softwood fibre included in eucalypt:softwood pulp blends. Thus, for 80:20 eucalypt:softwood blends, freeness and tensile strength values are similar whether the softwood component consists of northern species or radiata pine pulp. It is only in refining energy demand that the 80:20 eucalypt:northern softwood blend may have an advantage over corresponding radiata pine blends. Furthermore, the same effects are obtained whether furnish components are refined separately or co-refined, although separate refining requires the least energy and develops the highest tensile strengths at given freeness values.

Radiata pine market kraft pulps have good strength, with refining energy requirements between those of softwoods from the interior region of British Columbia, eastern Canada, and Scandinavia, and the southern USA (southern pine). Furthermore, refining requirements and other properties of radiata pine pulps can vary greatly depending on their fibre qualities. In New Zealand, radiata pine represents the only softwood resource available for pulp and papermaking; it is fast grown with a natural variation in wood properties and fibre qualities. For this reason low, medium, and high coarseness categories of radiata pine market kraft pulp are recognised in New Zealand to ensure market pulp uniformity and to optimise end-use applicability (1).

The higher refining energy demand of radiata pine kraft fibres, relative to market pulps from northern species, is recognised in the world market place and by New Zealand's manufacturers of kraft pulp. Thus, the refining energy, freeness, and tensile strength relationships are compared for radiata pine pulps of low (Low) and medium (Medium) coarseness, for a softwood pulp from interior British Columbia (McKenzie), and for eucalypt (Aracruz):softwood pulp blends. Eucalypt:softwood blends are in proportions of 100:0, 50:50, 80:20, and 0:100, and effects of separate refining and co-refining are assessed using a laboratory scale Escher Wyss refiner, a unit which is considered to give results indicative of commercial-scale refining operations (2).

Softwood Pulp and Refining Interrelations

The Medium and McKenzie pulps have almost identical mean length weighted fibre lengths but very different coarseness values (Table 1). Thus, the response to refining of the two pulps can to a large extent be explained by their different coarseness values and relative numbers of fibres per unit mass of pulp. The coarseness values of 0.279 and 0.204 mg/m for the Medium and McKenzie pulps can be equated to relative numbers of fibres in the respective furnishes of 77 and 105. Thus, the McKenzie pulp can be expected to contain 27% more fibres than the Medium pulp. In contrast, the Low pulp contains short fibres of coarseness intermediate between those of the Medium and McKenzie furnishes. As expected, the eucalypt fibres are roughly one-third the length and coarseness of the softwood fibres.

Table 1: Fibre length and coarseness, and numbers of fibres

Pulp	FS-200 fibre length (mm)	FS-200 fibre coarseness (mg/m)	Relative number of fibres
Eucalypt	0.74	0.082	857
Low	2.14	0.243	100
Medium	2.46	0.275	77
McKenzie	2.49	0.198	105

The fibres of each of the three softwood pulps are shortened by about 24% when refined at 3 Ws/m whereas eucalypt fibre lengths are unchanged when refined at 0.5 Ws/m (Figure 1).

Mean freeness values for the unrefined softwood pulps are very different with Medium highest and McKenzie lowest. Such freeness differences between unrefined pulps continue to exist when softwood kraft pulps are refined (Figure 2). The unrefined eucalypt pulp is of low freeness compared with the softwood pulps. With tensile strength the converse occurs (Figure 3). Mean tensile strengths for the unrefined softwood pulps are very different with Medium lowest and McKenzie highest.

Figure 1: Refining input and fibre length

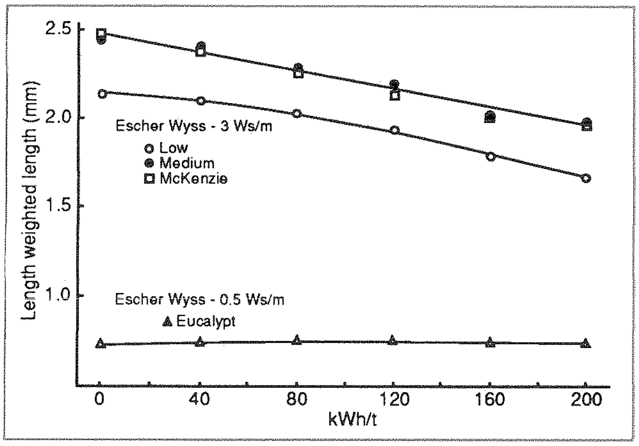


Figure 2: Freeness and refining energy demand

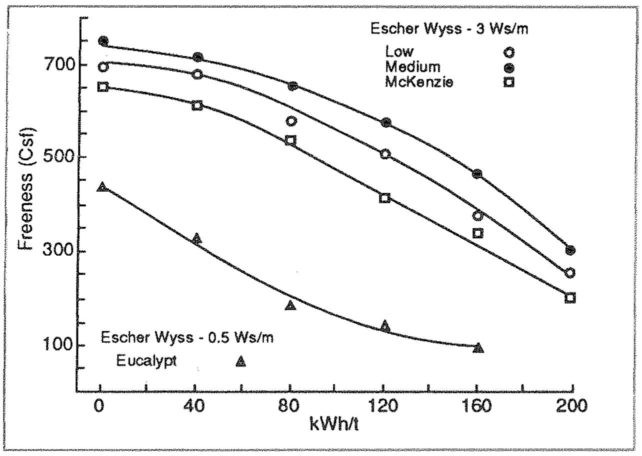
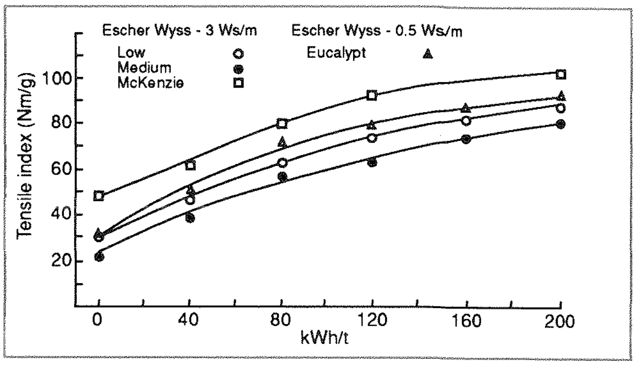
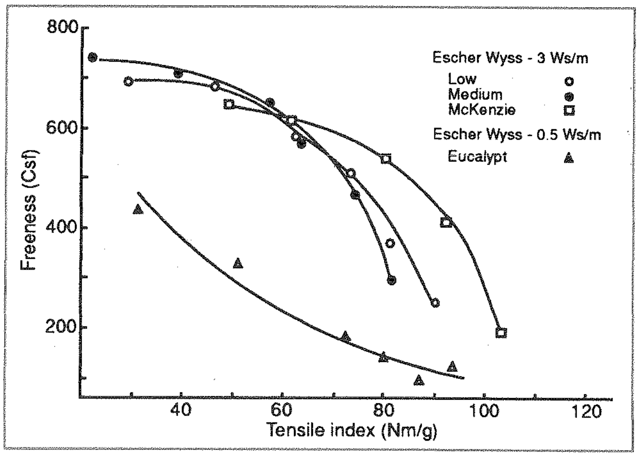


Figure 3: Tensile strength and refining energy demand



For a papermaker, the tensile strength development, freeness, and refining demand of a pulp are together indicative of papermaking potential. For most situations the most desirable option for papermakers is to have a pulp which refines easily to their machine stock freeness but retains adequate strength for machine runnability. Hence, the high tensile strength at a given freeness of the McKenzie pulp (Figure 4) is indicative of the high regard in which this type of pulp is held by papermakers. Furthermore, the papermaking potential of a pulp is determined by unrefined fibre properties, and is independent of refining input. For example, the low freeness and high tensile strength of the unrefined McKenzie furnish are predictable because of high numbers of low coarseness fibres of similar length relative to the Medium pulp (Table 1). Thus, for given freeness values the Medium pulp, which contains coarser and fewer fibres than the McKenzie furnish, develops with refining relatively low tensile strengths. The Low pulp, on the other hand, develops intermediate tensile strengths for given freeness values—short fibres of lower coarseness than the Medium furnish, and short fibres of higher coarseness than the McKenzie pulp.

Figure 4: Freeness and tensile strength



Specific Edge load Effects

Wide differences in softwood pulp freeness are obtained with specific edge load treatments at 1, 3, and 5 Ws/m. While treatment at 1 Ws/m is marginally the most effective in developing handsheet tensile strengths, it is by far the least effective in shortening fibres and decreasing pulp freeness (Figures 5,6,7). Similar trends are shown for each of the three softwood pulps. Thus, if manufacturing constraints and priorities demand papermachine runnability and/or high product strength, then refining at low specific edge load needs to be considered. Alternatively, if manufacturing constraints relate to energy requirements to a given freeness, then refining at an intermediate specific edge load needs to be considered.

Eucalypt/softwood Pulp Blends

For separate refining the softwood component is processed at 3 Ws/m and the eucalypt at 0.5 Ws/m. Furnish blends are co-refined at both 0.5 and 1.5 Ws/m.

Figure 5: Specific edge load effects—refining input and fibre length

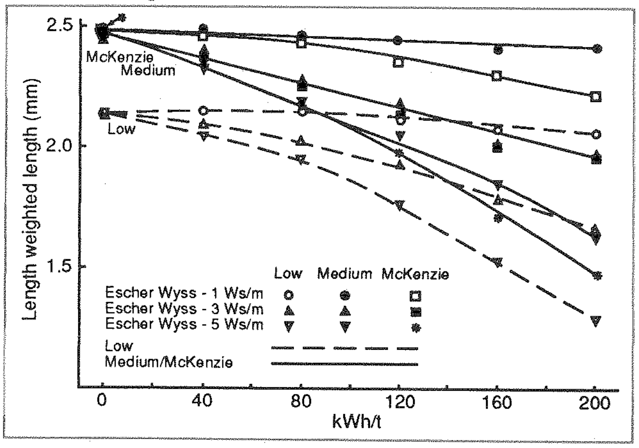


Figure 6: Specific edge load effects—freeness and refining energy demand

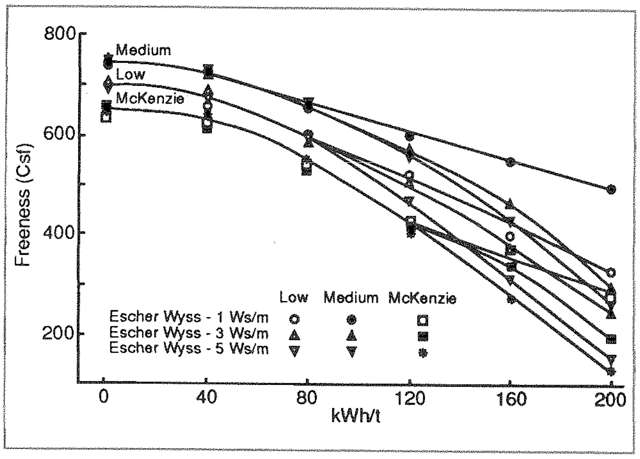
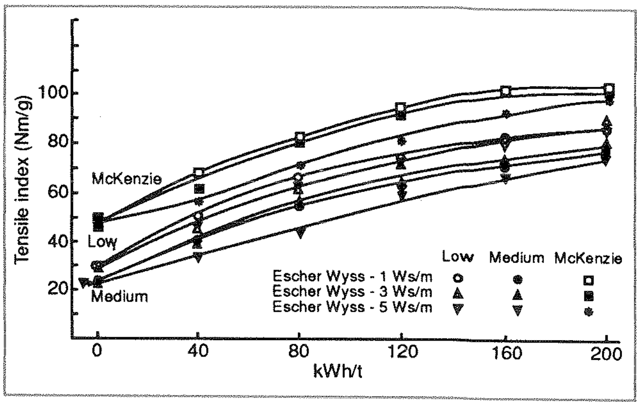


Figure 7: Specific edge load effects—tensile strength and refining energy demand



The differences in freeness, tensile strength, and refining energy requirements of the three softwood pulps are eliminated or greatly minimised when these pulps are blended with the eucalypt pulps either before or after refining (Figure 8). This effect is greatest with the 80:20 eucalypt:softwood blends. An 80:20 hardwood: softwood proportion is considered a realistic level for the manufacture of many printing and writing grades and is therefore indicative of the refining and papermaking potentials of market kraft pulps. Tensile strength development at given freeness values is roughly the same for the three 80:20 eucalypt:softwood blends, although different regressions were obtained with separate and co-refining. It is only in terms of refining energy requirements that the 80:20 eucalypt:McKenzie blend may have an advantage over the corresponding Low and Medium blends (Figure 9). Co-refining at 1.5 Ws/m is more effective than at 0.5 Ws/m in developing tensile strength, probably because of selective treatment of the softwood component (2).

Figure 8: Freeness and tensile strength for 80:20 eucalypt:softwood blends

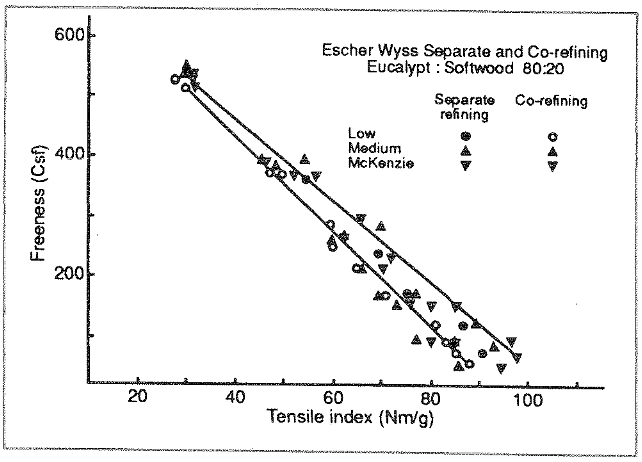


Figure 9: Tensile strength and refining energy for 80:20 eucalypt:softwood blends

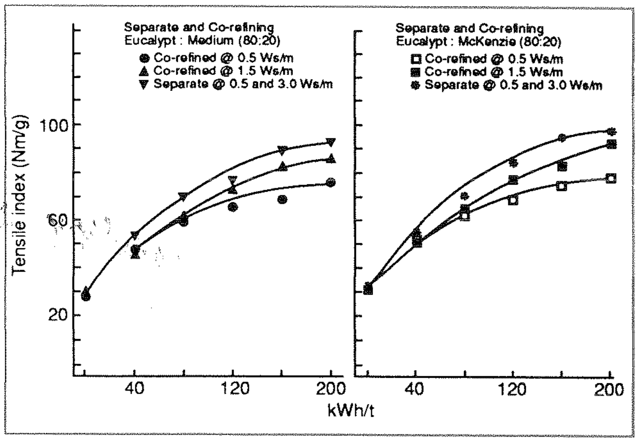
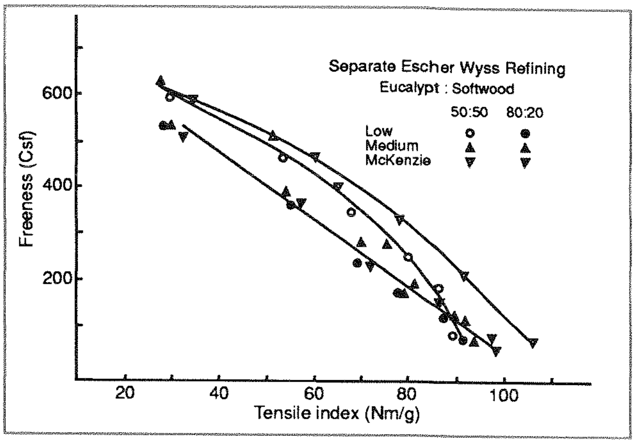


Figure 10: Freeness and tensile strength for 80:20 and 50:50 eucalypt:softwood blends



Eucalypt:softwood 50:50 blends reflect freeness/tensile strength properties which lie between those of the unblended softwood and the 80:20 eucalypt:softwood blends (Figure 10). Freeness/tensile strength properties of the eucalypt and three softwood pulps are very different while those of the 80:20 blends are roughly the same. Hence, the eucalypt component primarily determines freeness/tensile strength relationships of 80:20 eucalypt:softwood blends. For the 50:50 blends, separate relationships are obtained for the McKenzie and the radiata pine softwood components, although the influence of softwood fibre quality on 50:50 blend tensile strengths for given freeness values is relatively small. Finally, the influence of softwood fibre quality on blend tensile strength and freeness is also expected to remain insignificant for softwood proportions of 30–40%.

Separate refining is more effective than co-refining in developing freeness/tensile strength properties for given energy inputs, although any freeness/energy differences are minimal for the two refining options. With separate refining of the eucalypt and softwood components, refining energies and pulp responses can be optimised.

References

1. Kibblewhite, R.P.: New Zealand radiata pine market kraft pulp qualities. PAPRO-New Zealand (1989)
2. Kibblewhite, R.P.: Refining energy, freeness and strength of separate and co-refined softwood and eucalypt market kraft pulps and blends. PAPRO B Report No. 115 (1993)

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PAPRO, The Pulp and Paper Research Organisation of New Zealand, is the Division of the New Zealand Forest Research Institute for fundamental and applied pulp and paper research in the national interest and for the benefit of the New Zealand industry. The emphasis of PAPRO research is on the processing, papermaking, and environmental aspects and the equipment available includes a full-scale mechanical pulping and fibre processing pilot plant facility.

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