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NEW ZEALAND RADIATA PINE MARKET KRAFT PULP REINFORCEMENT AND OPTICAL PROPERTIES

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R. Paul Kibblewhite

Radiata pine and northern softwood market kraft pulps can have different reinforcement strength and optical properties, but such differences decrease with decreasing proportions of softwood fibre included in eucalypt:softwood pulp blends. Thus, for 80:20 eucalypt:softwood blends, reinforcement strengths and optical properties are similar when the softwood component consists of either northern species or radiata pine pulp. With co-refining, reinforcement strengths are decreased and optical properties improved when compared with effects of separate refining.

Radiata pine market kraft pulps have good strength, with refining requirements which are normally less than those of Southern pine but more than those of northern softwoods from the interior region of British Columbia, eastern Canada, and Scandinavia. Furthermore, refining requirements and other properties of radiata pine pulps can vary greatly depending on their 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 mechanical, reinforcement, and optical properties are compared for several eucalypt and softwood pulps and blends. Market kraft pulps examined are radiata pine pulps of low (Low) and medium (Medium) coarseness, a benchmark pulp from the interior region of British Columbia (McKenzie), and a eucalypt pulp from Brazil (Aracruz). Eucalypt:softwood blends are in proportions of 100:0, 80:20, 50:50, and 0:100, and effects of separate refining and co-refining are assessed using an Escher Wyss refiner which is considered to be indicative of commercial scale refining operations (2).

The influence of softwood fibre quality on refining energy demand, freeness, and tensile strength decreases with decreasing proportions of softwood fibre included in eucalypt:softwood blends. Similar trends are obtained whether furnish components are refined separately or co-refined, although separate refining requires less energy and develops the highest tensile strengths at given freeness values (3).

Unblended Eucalypt and Softwood Pulps

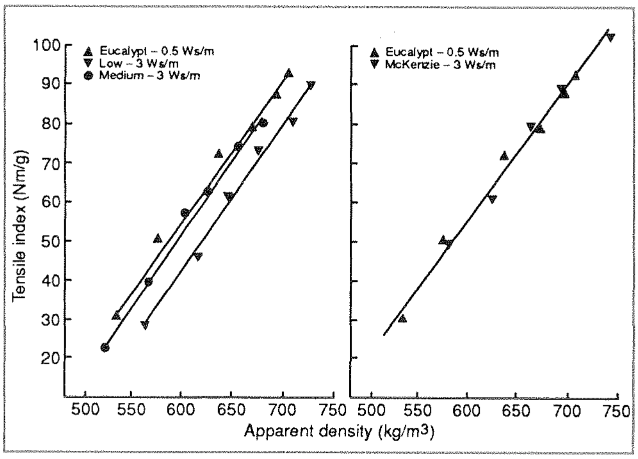
The Medium and McKenzie pulps have almost identical mean fibre lengths but very different coarseness values (Table 1). Thus, the response of the two pulps to refining can be explained to a large extent by their different coarseness values and relative numbers of fibres per unit mass of pulp. In contrast, 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

Tensile strength/apparent density relations for the eucalypt and softwood pulps and pulp blends are roughly the same, except for the Low pulp (Figure 1). The Low pulp has high apparent sheet densities for given tensile strengths when compared with the eucalypt, McKenzie, and

Figure 1: Tensile index/apparent density—unblended pulps



Medium pulps. This difference decreases with decreasing Low proportions included in pulp blends and is not reflected in the reinforcement and optical properties of 80:20 and 50:50 eucalypt:Low blends.

Different softwood market kraft pulps can have very different reinforcement properties as measured by their tear/tensile strength relationships. Tear/tensile strengths are high for the McKenzie and Medium pulps and relatively low for the Low pulp (Figure 2). The Low pulp which is short fibred and of low coarseness compared with the Medium pulp, and short fibred and of intermediate coarseness compared with the McKenzie pulp, has relatively low tear strengths for given tensile indices (Table 1). With the Low pulp some reinforcement strength is sacrificed for enhanced web closure, improved optical properties, decreased refining energy requirements, and an expected improvement in sheet formation.

Light scattering coefficients for each of the three softwood pulps decrease with increasing refining and apparent density (Figure 3). For given apparent densities or bulk the McKenzie pulp gives the highest and the Medium pulp the lowest light scattering values. Light scattering properties of the Low pulp are closer to those of the McKenzie than the Medium pulp, and this is the reverse of trends obtained when apparent density is the basis of comparison (Figure 4).

Figure 2: Tear/tensile strength relationships for the Low, Medium, and McKenzie pulps

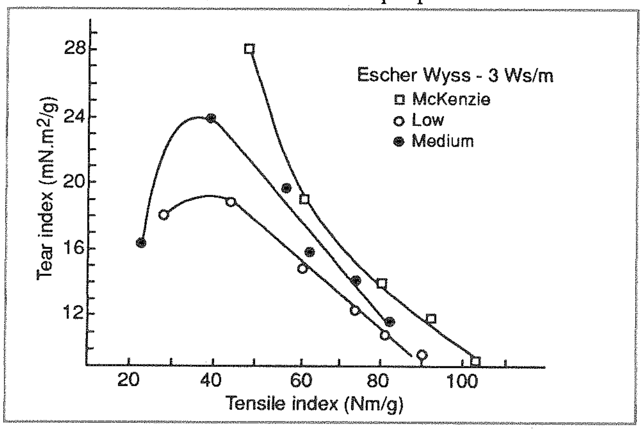


Figure 3: Softwood light scattering coefficient/apparent density relationships

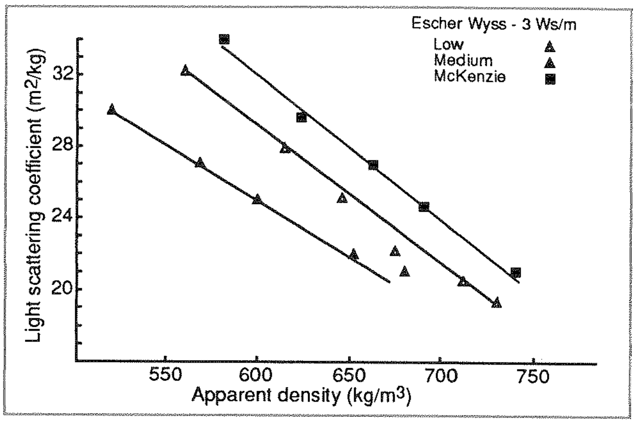
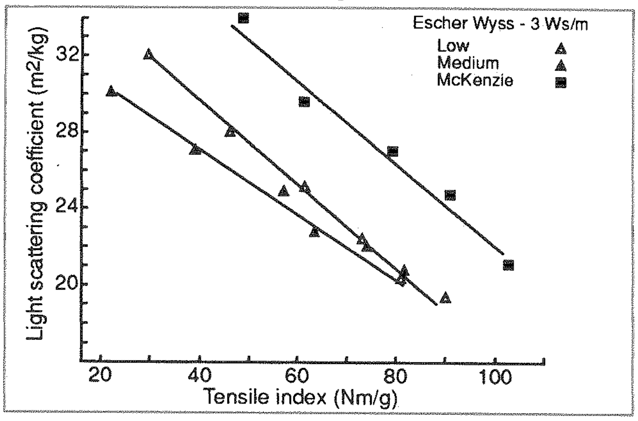


Figure 4: Softwood light scattering coefficient/tensile strength relationships



Eucalypt and Softwood Pulp Blends

For separate refining the softwood component was processed at 3 Ws/m and the eucalypt at 0.5 Ws/m. Furnish blends were co-refined at 0.5 Ws/m.

For the 80:20 eucalypt:softwood blends, furnish reinforcement strengths or tear/tensile relationships are roughly the same and independent of the origin or type of softwood used (Figure 5). Thus, softwood fibre quality differences have minimal effects on the web reinforcement properties of 80:20 eucalypt:softwood blends. Tear strengths for given tensile strengths decrease as eucalypt blend proportions increase from zero to 100%. For the unblended softwood and eucalypt pulps typical tear/tensile strength relationships are obtained with refining. Tear strengths increase with refining to maximum values for the eucalypt pulp, and decrease to minimum values of about 9 mN.m^2/g for the softwood pulps. Also, typical tear index peaks at tensile index values of 40–50 Nm/g are obtained with the softwood pulps.

As proportions of softwood fibre included in pulp blends are progressively decreased, the influence of softwood fibre quality differences also decreases with tear/tensile strengths roughly the same for the 80:20 eucalypt:softwood blends. For the 50:50 blends, tear/tensile strength differences between the three softwoods are very much decreased but remain slightly higher for the McKenzie and Medium furnishes than for the Low blend.

Co-refining is less effective than separate refining in developing the tear/tensile properties of 80:20 eucalypt: Low and eucalypt:Medium blends (Figure 6). For the 80:20 eucalypt:McKenzie blend, on the other hand, web reinforcement properties are roughly the same with either separate or co-refining. However, reinforcement properties of the eucalypt:McKenzie blends lie between those of corresponding separate and co-refined radiata pine blends.

The eucalypt pulp has by far the highest light scattering potential followed by the softwood pulps in the order McKenzie, Low, and Medium (Figure 7). For the eucalypt: softwood pulp blends, light

Figure 5: Blend reinforcement strengths—separate refining

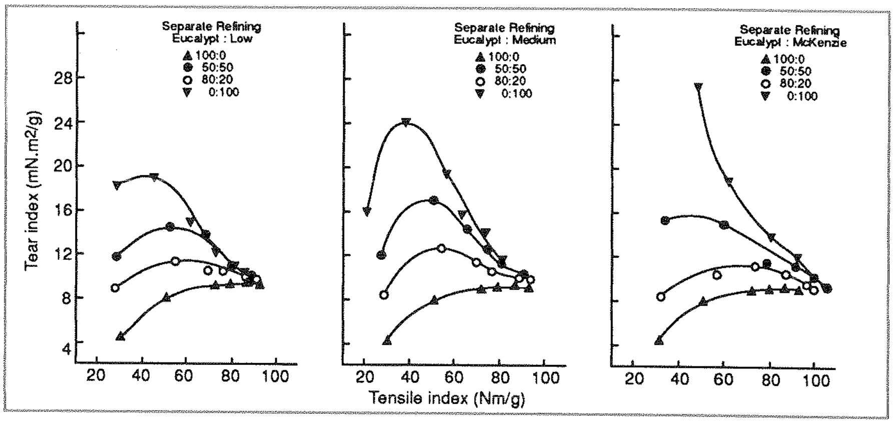


Figure 6: Blend reinforcement strengths—co-refining

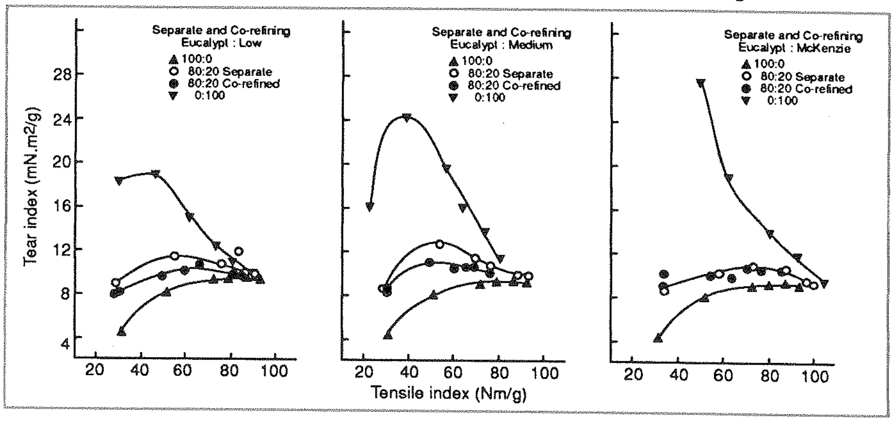


Figure 7: Light scattering coefficient and tensile strength—separate refining

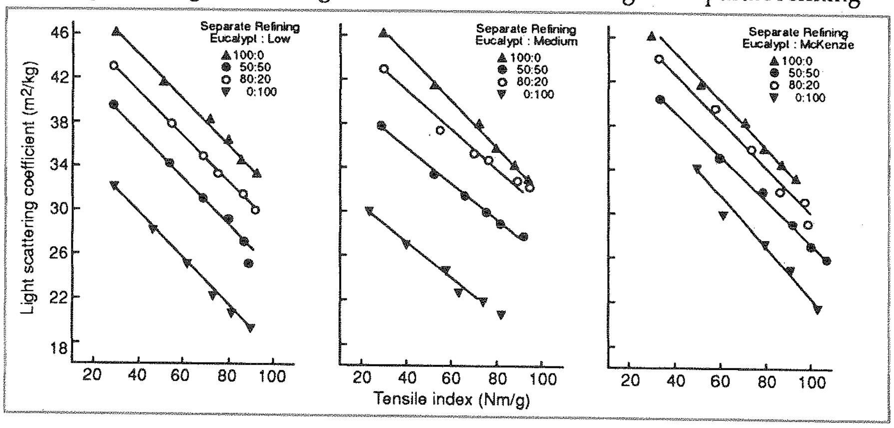
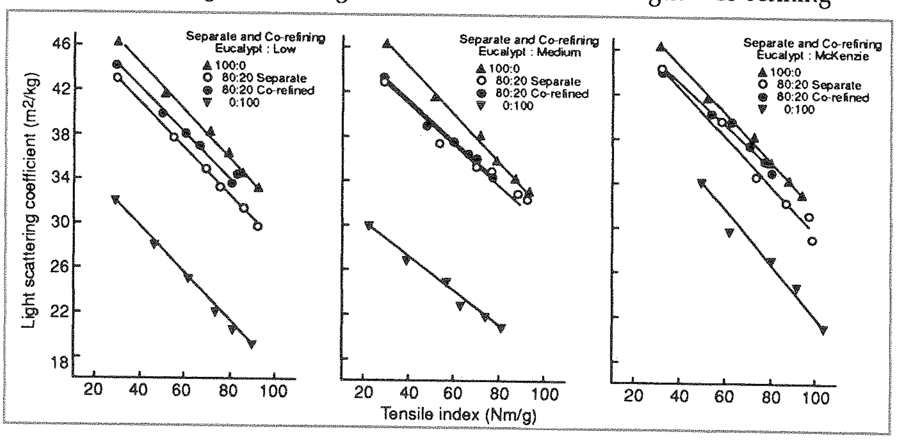


Figure 8: Light scattering coefficient and tensile strength— co-refining



scattering coefficients increase with increasing proportions of eucalypt fibre included in a furnish and can be marginally higher for the McKenzie than for the Low and Medium blends.

For 80:20 eucalypt:softwood blends, light scattering coefficients can be slightly higher with co-refining than with separate refining (Figure 8).

Conclusions

Reinforcement potentials, based on tear/tensile properties, of the refined Medium and McKenzie pulps are roughly equivalent. The Low pulp which is short fibred and of low coarseness compared to the Medium pulp, and short fibred and of intermediate coarseness compared to the McKenzie pulp, has relatively low tear strengths for given tensile indices. Optical properties as measured by light scattering coefficient are highest for the McKenzie pulp and lowest for the Medium pulp, an effect explained primarily by high numbers of fibres per unit mass in the McKenzie furnish.

For 80:20 eucalypt:softwood blends, furnish reinforcement strengths are roughly the same and independent of the origin or type of softwood used. Thus, softwood fibre quality differences have minimal effects on the web reinforcement properties of 80:20 eucalypt:softwood blends. Pulps refined separately have higher reinforcement strengths than those which are co-refined.

For the eucalypt:softwood pulp blends, light scattering coefficients increase with increasing proportions of eucalypt fibre included in a furnish. Furthermore, light scattering coefficients are similar for the three 80:20 eucalypt:softwood blends, although somewhat dependent on whether the basis of comparison is apparent density or tensile index. With apparent density as base, light scattering values of the three blends are roughly the same with both separate and co-refining. With tensile index as base, light scattering values are generally the same with separate refining and can be marginally higher with co-refining. Thus, reinforcement properties can be decreased, and optical properties increased, with co-refining.

References

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DR R. PAUL KIBBLEWHITE is the Leader of the Fibre and Paper Group of PAPRO New Zealand. His specialist research areas are fibre morphology, fibre microscopy, fibre/paper interaction and behaviour, paper properties, and end-use behaviours.

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PULP AND PAPER RESEARCH ORGANISATION OF NEW ZEALAND

NEW ZEALAND FOREST RESEARCH INSTITUTE
PRIVATE BAG 3020
ROTORUA
NEW ZEALAND
PHONE: (07) 347-5899
FAX: (07) 347-5695 *and* (07) 347-9380