Reprint 2441
ODC 861.14:174.7 Pinus radiata (931)

NEW ZEALAND RADIATA PINE MARKET KRAFT PULP QUALITIES

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Canadian and Scandinavian softwood resources enjoy the perceived advantages of more than one tree species to provide variability in softwood pulp characteristics and hence end-use applicability. In New Zealand, on the other hand, radiata pine represents the only softwood resource available for pulp and papermaking. This radiata pine is, however, fast grown with a natural variation in wood characteristics which have now been recognised to ensure market kraft pulp uniformity and to optimise end-use applicability. Considerable research and commercial attention have thus been directed in New Zealand at the characterisation of the radiata pine wood and fibre resource.

In New Zealand radiata pine is grown in plantations over a wide range of geographical sites and locations. A wide range of silvicultural regimes and management practices are followed. Wood characteristics also differ depending on the original position of chips within the tree. The growing sites, silvicultural practices, age at harvest, and inherent within-tree variability can all result in considerable differences in the characteristics of the wood, the wood fibres, and the pulps produced. This variability within the radiata pine tree and the resource has been recognised in New Zealand, and several classes of market pulp have been developed. These classes of pulp cover a range of fibre qualities and have potential usage in a wide range of product types. The objective of pulp grade differentiation is to maximise the potential of radiata pine fibres for specific end uses through the development of pulp uniformity and the selection of specific fibre qualities.

Pulp fibre qualities can be classified as being from chips of low, medium, or high basic density. This critical parameter of chip basic density is influenced by that part of the tree the chip is obtained from, how old the tree was at time of harvest, and where it was grown. Thus, chip and ultimate pulp fibre quality depend on whether the material originated from the top logs or slabwood (sawmill residues) of mature trees or from whole trees of different ages (Figure 1). Chips from top logs and whole trees which contain less than about 14 to 20 annual growth layers can be considered as giving pulp from chips of low basic density. Slabwood from the outer part of sawlogs gives chips of medium to high basic density, depending on numbers of annual growth layers in the sawlog. Chips of low basic density give shorter and thinner-walled fibres than do chips from slabwood. Chip basic density is correlated with handsheet tear, burst, and tensile strength (Figure 2)*.

Market kraft pulp manufacturers in New Zealand are able to control pulp uniformity and fibre quality through the segregation and monitoring of chips in the wood yard before they enter pulp digesters.

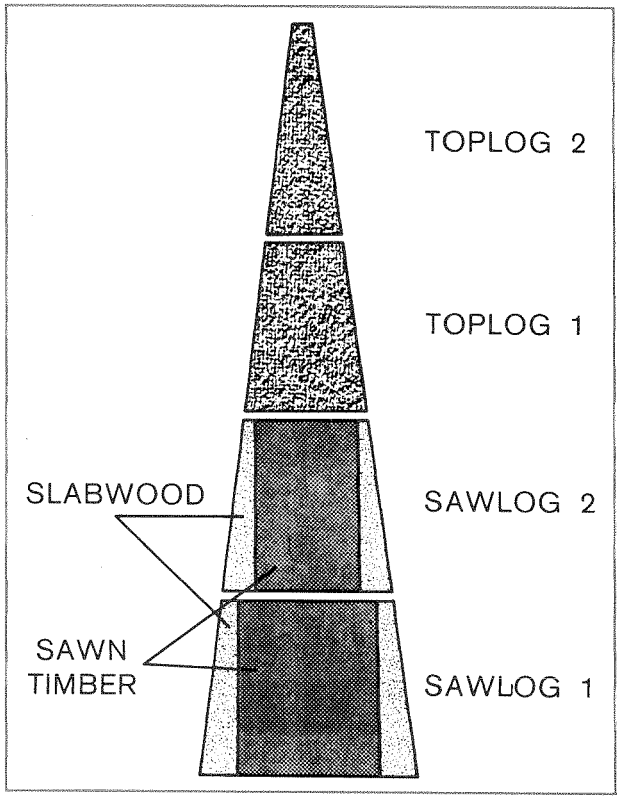


Figure 1–Schematic diagram of tree components

*Source: Kibblewhite, R.P.: Qualities of kraft and thermomechanical radiata pine papermaking fibres. In Puton's "The Raw Materials of Papermaking and Their Effects upon the Papermaking Process and the Properties of Paper", Transactions of the 8th Fundamental Research Symposium, Oxford, England, 1985.

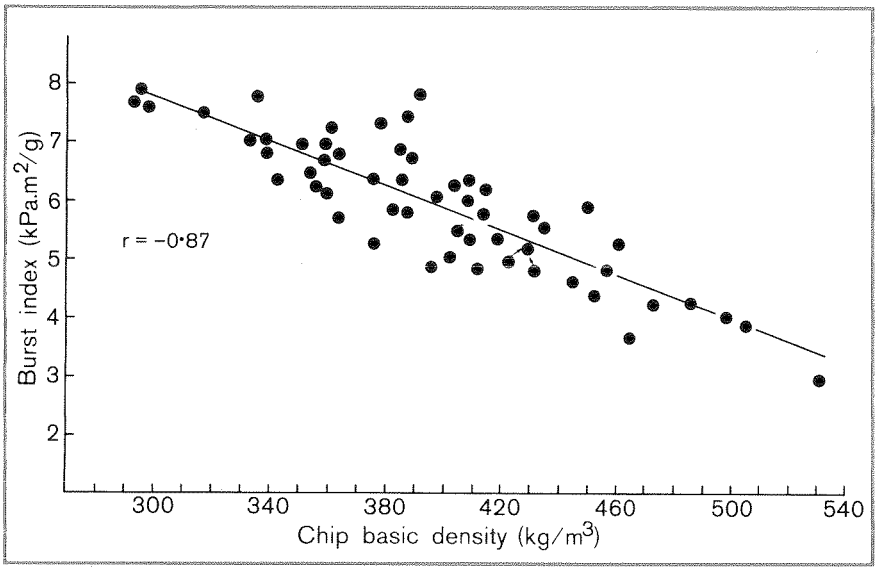


Figure 2–Chip basic density and handsheet burst strength
(Source: Kibblewhite 1985—*see* footnote to previous page)

Kraft Pulp Fibre Characteristics

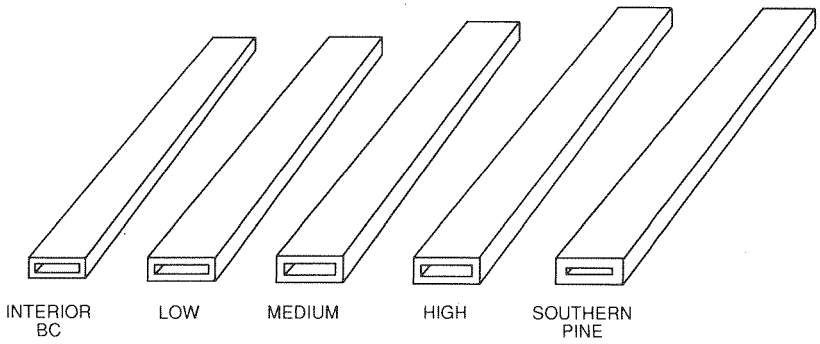
Three categories of New Zealand radiata pine market kraft pulp are recognised: Low, Medium, and High. The terms "Low" to "High" relate originally to the basic density of the wood chips but also refer to fibre wall thickness or coarseness and to pulp fibre length. New Zealand market kraft manufacturers necessarily produce grades of pulp consistent with their wood resource and processing operations. Pulp categories Low, Medium, and High refer to potential radiata pine market kraft grades based on their fibre qualities.

Mean pulp fibre dimensions drawn to scale are represented diagramatically in Figure 3 for a range of commercially manufactured New Zealand radiata pine bleached market kraft pulps. As benchmarks, comparable fibres representative of Interior BC (and Eastern Canada) and Southern pine market pulps are included. Very clear differences are evident for the three classes of New Zealand radiata pine pulp. Fibre widths are similar for each category but actual fibre thickness increases from Low to High as does fibre wall thickness. As fibre thickness and wall thickness increase, the potential for fibre collapse decreases correspondingly. Also evident in the diagram is the increase in mean fibre length which takes place over the range Low to High for the radiata pine pulps. At the low end, the Interior BC fibre is slender and of roughly equivalent length to the radiata pine Low fibre. Relative numbers of fibres, and fibre wall volume and fibre coarseness, are respectively higher and lower for the Interior BC than the radiata pine Low furnish. At the other end of the scale the Southern pine fibres are longer and coarser and contain fewer fibres per unit mass than does the New Zealand radiata pine High furnish.

Furnish homogeneity as measured by fibre wall volume per unit length and fibre length, increase over the range from Southern pine through to the Interior BC furnishes (Figures 4, 5). For the New Zealand radiata pine furnishes, the coarser and longer fibres are concentrated most in the High category whereas the shorter and least coarse fibres are concentrated in the Low furnish. The furnish typified by the Interior BC fibre type contains fibres with the least variable dimensions, whereas the Southern pine furnish is very heterogeneous in terms of both fibre coarseness and fibre length.

Figure 3–Schematic diagram of mean pulp fibre dimensions and related values

Relative mean fibre length	2.9	2.8	3.0	3.2	3.4
Relative mean number fibres per unit mass	100	70	65	57	42
Relative mean fibre wall volume per unit length	100	145	150	159	199
Relative mean fibre coarseness (FS200)	19.7	25.1	27.2	31.1	34.1



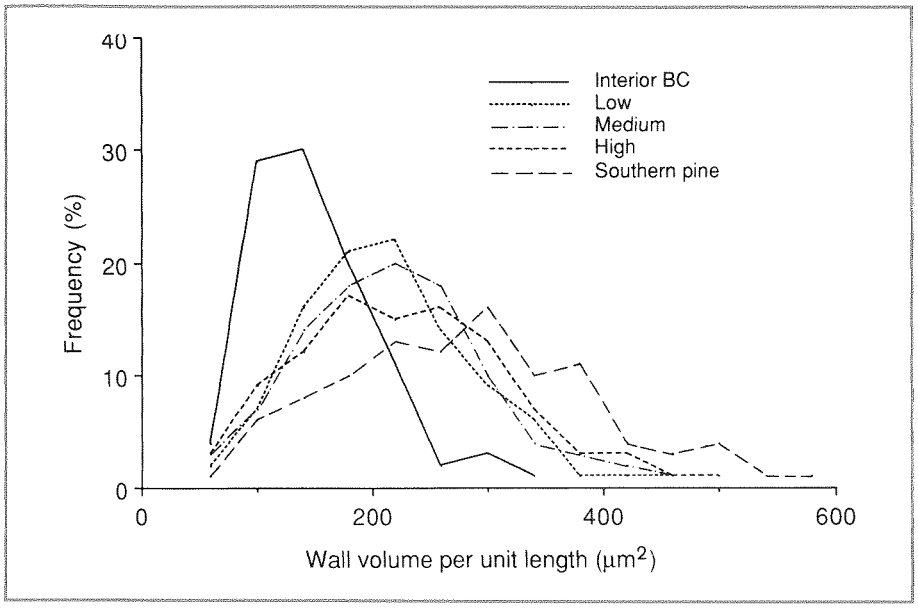


Figure 4–Fibre wall volume per unit length population distributions

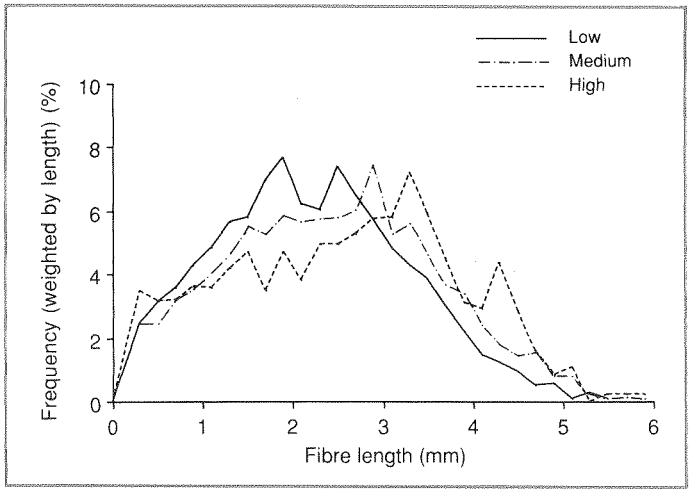


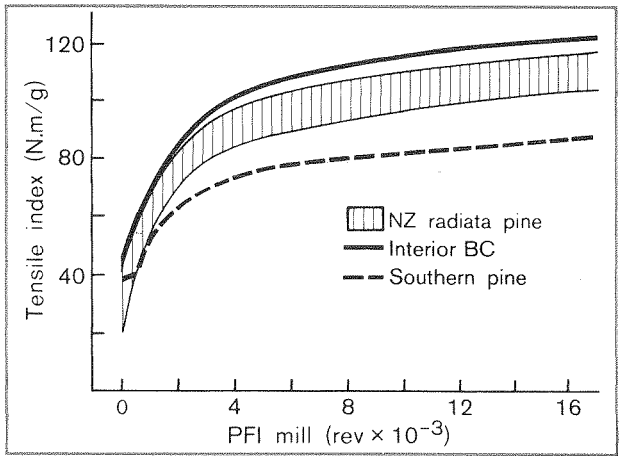
Figure 5–Fibre length population distributions

Pulp category High can be considered as having the coarsest and longest fibres of any radiata pine market pulp which could be expected to be manufactured either now or in the future. It is a very homogeneous and uniform pulp relative to fibre coarseness. At the other end of the scale, market pulps with fibre lengths and coarsenesses considerably lower than those of the Low category furnish can be produced from young and fast-grown radiata pine trees. It is unlikely, however, that such pulps will be available as commercial market kraft pulps.

Pulp and Handsheet Evaluation

The ease of refining, or the development of tensile strength with pulp refining, shows a very clear trend over the range from Southern pine through to the Interior BC pulps (Figure 6). The radiata pine furnishes are very much easier to refine and develop substantially higher tensile strength than do the Southern pine furnishes. Furthermore, there is a trend with the radiata pine furnishes for pulp category "High" to be less easily refined than pulp category "Low". The Interior BC furnish is refined most readily and develops the highest tensile strength. Pulp reinforcing qualities and runnability are generally characterised by tear-tensile strength relationships. The three categories of New Zealand radiata pine pulp cover a very wide range with the Low furnish giving the lowest tear strength and the High furnish the highest (Figure 7). When compared with the Interior BC and the Southern pine furnishes, the radiata pine pulps more than cover the total range possible. On the other hand, the radiata pine High furnish with its relatively long and coarse fibres produces by far the highest tear strength for given tensile properties. Thus, the shorter length and lower coarseness characteristics of the Medium and Low New Zealand radiata pine furnishes will show improved formation and surface properties when compared with the corresponding High and Southern pine

Figure 6–Development of handsheet tensile strength with pulp refining



fibre types. The Interior BC furnish when compared on the basis of tear-tensile strength relationships is very comparable with the New Zealand radiata pine Medium furnish.

Comparison of tensile strength development with handsheet apparent density (or bulk) (Figure 8) shows that the New Zealand radiata pine High furnish produces very strong webs at high bulk or low density. The Southern pine and Interior BC furnishes both have similar tensile strengths and handsheet density (or bulk) properties to those of the New Zealand Medium furnish. The New Zealand Low categories show the lowest bulk and highest sheet density for given tensile strengths.

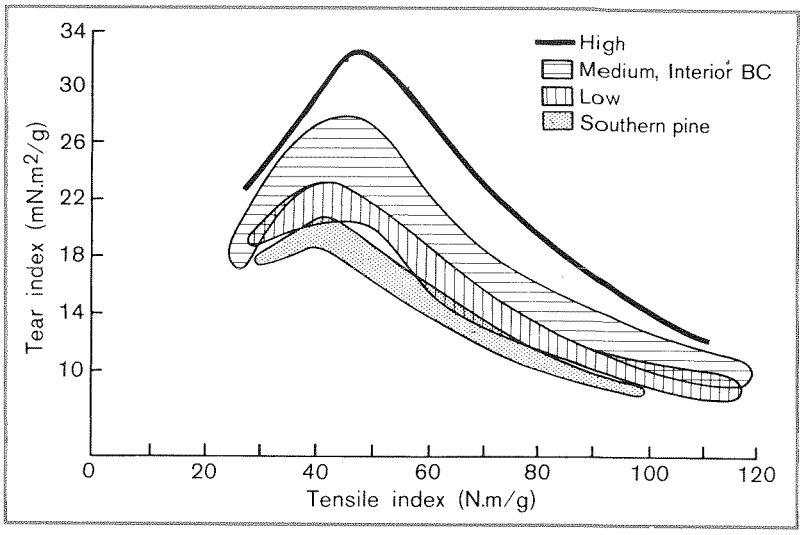
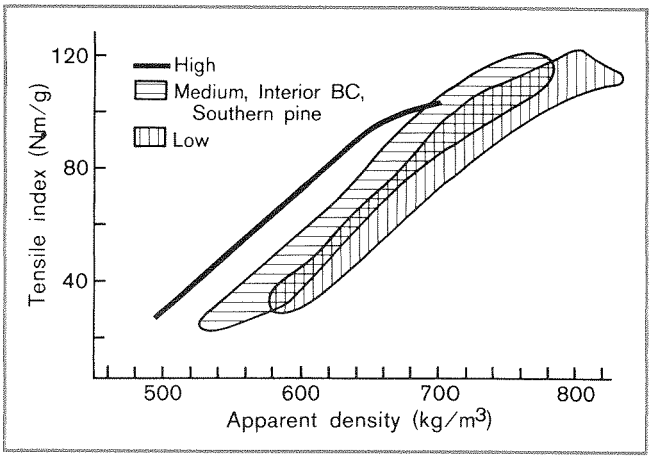


Figure 7–Handsheet tear-tensile strength relationships

Figure 8–Handsheet tensile strength/apparent density



Product Applicability

The three categories of New Zealand radiata pine market kraft pulp, Low, Medium and High, show a wide range of applicability for specific products. These radiata pine market kraft categories are suitable for the manufacture of most high quality products available on world markets. These range through fibre cement, packaging grades such as linerboard and sackkraft as well as tissue and board grades, fluff pulp and the reinforcing component of printing and writing grades, both wood-free and wood-containing.

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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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