

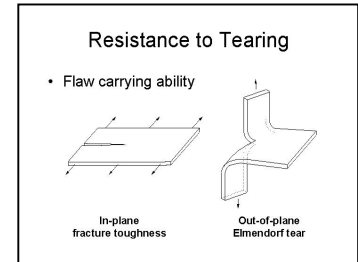
Deriving Maximum Strength from Reinforcing Pulps

by Dr. Raj Seth

Canada is one of the world's largest suppliers of paper-grade market pulps – nearly two thirds of which is bleached softwood kraft used primarily to reinforce weaker furnishes containing hardwood, mechanical pulp, recycled and non-wood fibres. Canfor is the major Canadian supplier of these pulps.

Reinforcement enhances the strength of the wet web and the dry sheet, as well as the strength of the dry sheet when rewetted (e.g., during sizing, coating and printing). Reinforcement fibres can also improve the drainage of the furnish.

The reinforcing potential of these pulps (or “pulp strength”), however, may not be fully utilised. The reason for this stems from standard testing procedures. Pulp strength is commonly measured by the Elendorf or Brecht-Imset tearing (out-of-plane) resistance at a given tensile (in-plane) strength, following beating or refining of the pulp. But, because out-of-plane tearing resistance decreases with increased bonding in the sheet, the goal of obtaining high tearing resistance defeats increasing the other desirable properties of the sheet that improve with bonding. What's more, during manufacturing, printing, and converting operations, when paper fails by crack propagation, it is usually caused by in-plane forces applied to the sheet (Figure 1), not out-of-plane. Therefore, in-plane fracture toughness should be more relevant for evaluating the reinforcing potential instead of the out-of-plane tearing resistance.

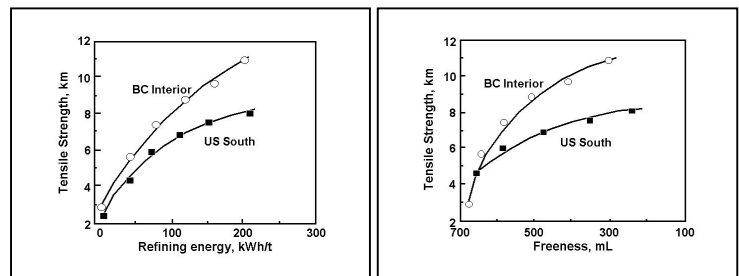


At the Pulp and Paper Research Institute of Canada (Paprican) researchers measured the in-plane fracture toughness and other properties of various chemical pulps following beating and refining, and showed that fracture toughness depended strongly on the sheet's tensile strength and extensibility.

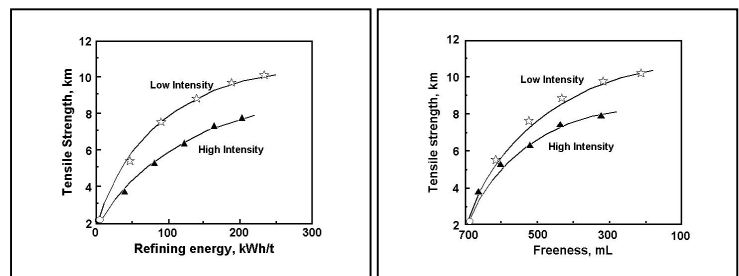
This research shows that fibre properties and papermaking treatments that enhance sheet tensile strength and extensibility also tend to enhance the strength of the wet web and that of the rewetted dry sheet. This leads to a simple strategy to best utilise the reinforcing potential of bleached softwood chemical pulps – refine them to a high tensile strength while maintaining the fibre length and acceptable drainage. Refining to a high tensile strength generally results in high sheet extensibility as well. This strategy also suggests that instead of relying on (out-of-plane) Elendorf or Brecht-Imset tearing resistance at a given (in-plane) tensile strength to determine pulp strength, papermakers should examine the pulp's tensile strength at a given refining energy and its drainage. These should prove more relevant for reinforcement and runnability because, in addition to having the desired strength in the furnish, expending minimal energy in refining and obtaining optimum drainage on the wire are equally important concerns of a papermaker using reinforcement pulps.

It should be noted that high tensile strength and extensibility of the reinforcement fibres translates into the high tensile strength and extensibility of the reinforced furnish.

How can we obtain high sheet tensile strength? Strong, long, fine and thin-walled Canadian softwood fibres make strong sheets (see right). The sheets are stronger if the fibres are never dried and conformable, straight and kink-free and hemicellulose rich. One of the objectives of refining dried pulps is to restore and enhance their fibre conformability lost during drying to maximise fibre-to-fibre bonding.



Treating fibres homogeneously and gently at low refining intensities preserves fibre length, makes fibres more conformable and straighter, and thus better enhances their reinforcing potential (see right). The challenge is to achieve these conditions in commercial settings.



Resources

1. Seth, R.S., “Optimising reinforcement pulps by fracture toughness”, Tappi Journal 79 (1): 170-178 (1996).
2. Seth, R.S., “Beating and refining response of some reinforcement pulps”, Preprints, 84th Annual Meeting, CPPA Technical Section, Montreal, 1998.

Dr. Seth was formerly a Principal scientist at Pulp and Paper Research Institute of Canada.