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Refining rheological response of chemical pulp fibre suspensions

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The purpose of this work was to study the influence of the refining operating variables on the rheological response of chemical pulp fibre suspensions using a Valley beater. Pinus sylvestris, Eucalyptus globulus and Betula verrucosa bleached pulps were used. The normal and tangential average forces exerted on the pulp suspension in the gap clearance were evaluated, the gap between rotor and stator was measured and the apparent viscosity evolution during refining was obtained. The refining essays took place in a laboratory Valley beater, and the studied variables were the load on the roll, the rotor speed of rotation and the specific applied energy [1]. Relationships between apparent viscosity and shear rate were tested for the three species fibre suspensions, which showed shear-thinning behaviour (Fig.1). The results were analysed in terms of fiber and flock properties. The computed crowding factors, N_c, (Kerekes and Schell [2]) decrease from pine to eucalypt to birch. Thus, flock dimensions and resistance are significantly higher for pine. Pine had significantly wider gap, due to its greater and more resistant flocks. This produced smaller shear rate and thus higher apparent viscosity. The smaller and weaker eucalyptus and birch flocks induced smaller gaps, higher shear rates and smaller apparent viscosity. For each pulp suspension, the apparent viscosity diminished with refining time due to increased fibre flexibility and shortening, which promoted smaller flocks and reduced gap clearance (producing higher shear rates). The different rheological behaviours under the same operating conditions for different pulps lead to the inference that from the hydrodynamical point of view one should treat pulps with different morphological characteristics separately, considering the optimisation of the energy transfer efficiency in pulp refining.

Fig. 1 – Pulp apparent viscosity (Pa.s) versus shear rate (s^{-1}) in the gap clearance.

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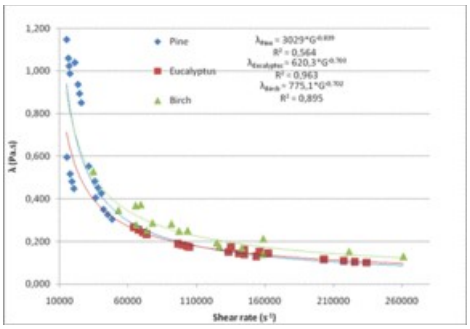
2. Kerekes, R. and Schell, C., Characterization of fibre flocculation regimes by a crowding factor, 1992. Journal of Pulp and Paper Science, 18(1): p. J32-J38.