Pulp Fractionation via Controlled Flocculation in a Hydrodynamic Fractionation Device

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Recent developments in the pulp and paper industry necessitate more diverse product portfolios, including novelties like microfibrillated cellulose, or fibre-polymer compounds. Also, there is a trend towards even more energy efficient production routes to meet CO_2 emission targets [1,2]. One example is stock preparation, in which the pulp suspension could be potentially separated in streams of different length, opening the door for (i) fractionated refining, or (ii) products with narrow fibre length distribution. Conventionally, pressure screens, hydro cyclones, and froth flotation are applied to separate fibres according to their length. Unfortunately, hydro cyclones fractionate according to the specific fibre surface area and/or fibre coarseness, and flotation processes require the addition of chemicals to achieve a stable froth [3]. Pressure screens are energy intensive as the pulp is constantly agitated to prevent screens from blocking. Thus, there is need for innovation via (i) the improvement of existing processes (e.g., hydro cyclones [4]), or novel processes routes [5].

We present such a novel route, specifically a Hydrodynamic Fractionation Device (HDF): the HDF is based on the principle of channel flow separation, and has been further developed to treat suspensions at higher pulp concentrations. The key process variables are (i) the flow rate and (ii) the pulp consistency to operate the HDF in an inertia-dominated (but non-turbulent) flow regime: the so-called annular plug flow regime. In this flow regime flocculation occurs only in distinct regions of the channel: while long fibres form a network (i.e., flocs) near the channel center, small fibres are still mobile and accumulate in an annular region near the wall . The suspension in the latter region is removed via side channels that are designed to guarantee a blockage free operation.

Our results from an array of experiments using a laboratory scale HDF proof that small fibres can be selectively removed from a pulp suspension, suggesting that a precise separation is feasible. The energy demand, originating from channel friction, is comparably low since the flow is non-turbulent. Based on our laboratory results we will provide an extrapolation towards industrial scale applications, sketching the virtues and potential challenges associated with the implementation of an industrial-scale HDF.

Literature

[1] The Age of Fibre - The pulp and paper indsutry's most innovative products, CEPI confederation of european paper industries, 2015.

[2] A Blueprint for the EU Forest-Based Industry, European Comission, 2013.

[3] M. Karjalainen, Studies on wheat straw pulp fractionation : fractionation tendency of cells in pressure screening, hydrocyclone fractionation and flotation, University of Oulu, 2015.

[4] R. Andersson, Evaluation of two hydrocyclone designs for pulp fractionation, KTH Stockholm, 2010.

[5] A. Madani, Fractionation of Particle Suspensions in a Viscoplastic Fluid : Towards a Novel Process, UBC Vancouver, 2011.