On the development of fibre orientation in jet-to-wire impingement

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ABSTRACT

Papermaking is a complex combination of several unit processes. One of the key processes is taking place in the so-called wet-end of the paper machine or more precisely, in a component called the head-box which is used to generate a thin, even jet. Headbox and its design affects notably on the paper properties. Its effect is huge especially on the fibre orientation, which contributes e.g. to the strength properties of the paper. The fibre orientation is largely controlled by the fluid dynamics, i.e. the flow acceleration and turbulence, of the headbox and its slice channel. From the headbox slice channel the process continues as the jet hits the moving fabrics i.e. the wire-section where the water removal is initiated. The fact that the jet enters into the open air and hits the wires cause great changes in the velocity profile and thus, plays important role in the development of the orientation profile. This naturally affects further the orientation of the fibres in the paper sheet. In this work, our focus is in the modelling of the fibre orientation in the jet-to-wire impingement.

As mentioned, the motion of the fibres is determined by the flow profile of the headbox and consists basically of translation and rotation. The orientation of the fibres is defined by the flow configuration in a way that the mean flow aligns the fibres into the flow direction whereas the velocity fluctuations distract the alignment of the fibres. In this work, we use a rather common approach (see e.g. [1-3]) to model the development of the fibre orientation. This approach involves a diffusion-convection equation which with proper definition of boundary conditions and flow properties is used in solving the orientation distribution of the fibres in a given flow conditions. Besides the velocity of the flow, the model accounts for turbulence effects with the diffusion coefficients. The model has been previously validated with experiments performed in a contracting channel geometry [4]. Here we use that model in order to predict the development of the fibre orientation in the jet and further in the jet-to-wire impingement. The results provide an insight how the jet and the jet-to-wire impingement modifies the orientation distribution.

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