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Polymer Mixing in the Cavity Transfer Mixer

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Abstract : In many industrial applications and, in particular in polymer industry, the quality of mixing between different materials is fundamental to guarantee the desired properties of finished products. However, properly modelling and understanding polymer mixing often presents noticeable difficulties, because of the variety and complexity of the physical phenomena involved. This is the case of the Cavity Transfer Mixer (CTM), for which a clear understanding of mixing mechanisms is still missing, as well as clear guidelines for the system optimization. This device, invented and patented by Gale at Rapra Technology Limited, is an add-on to be mounted downstream of existing extruders, in order to improve distributive mixing. It consists of two concentric cylinders, the rotor and stator, both provided with staggered rows of hemispherical cavities. The inner cylinder (rotor) rotates, while the outer (stator) remains still. At the same time, the pressure load imposed upstream, pushes the fluid through the CTM. Mixing processes are driven by the flow field generated by the complex interaction between the moving geometry, the imposed pressure load and the rheology of the fluid. In such a context, the present work proposes a complete and accurate three dimensional modelling of the CTM and results of a broad range of simulations assessing the impact on mixing of several geometrical and functioning parameters. Among them, we find: the number of cavities per row, the number of rows, the size of the mixer, the rheology of the fluid and the ratio between the rotation speed and the fluid throughput. The model is composed of a flow part and a mixing part: a finite element solver computes the transient velocity field, which is used in the mapping method implementation in order to simulate the concentration field evolution. Results of simulations are summarized in guidelines for the device optimization.

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