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FLOW DYNAMICS AND STRUCTURE OF SOLID PELLETS ALONG THE CHANNEL OF A SINGLE SCREW EXTRUDER

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Plasticating single screw extrusion is a central unit operation in polymer processing. It encompasses a sequence of steps along the helical screw channel involving the conveying of solid pellets that become progressively more compacted, melting of this material and its melt conveying towards the die. Traditional plasticating models assume that the solids behave as an elastic solid plug from the moment they enter the channel to the location where they melt. Unfortunately, this assumption usually leads to significant prediction inaccuracies, namely in terms of the mass flow rate. Moyssey and Thompson [1] pioneered the study of the flow of the individual pellets in the initial screw turns, using the Discrete Element Method (DEM). They showed that normal and tangential forces resulting from inelastic collisions with neighboring pellets and surfaces dictate how each pellet flows. They imposed two exit conditions: a) an open-discharge boundary condition, when no compaction of the solids occurs and a b) close-discharge condition, leading to a pressure increase, by inserting a virtual physical barrier to the flow at the end of the extruder (7 L/D). The present work adopts the same general methodology developed by those authors, but the closed-discharge condition is now implemented via the application of a force/pressure in the initial stage of the screw, which has greater physical meaning and facilitates coupling this processing stage to the subsequent one. The dynamics and the structure of the flow of the granular matter were studied computing the cross- and down channel velocity profiles, the coordination number distribution, the output rate, the residence time distribution and the density profiles. The model seems to be able to capture the process of plug formatin.

[1] P. A. Moysey, M. R. Thompson, Powder Technology. 152 (2005) p95.