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Calculation and Optimization of Maddock and Egan Mixing Elements for Single Screw Plasticising Units

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Completely molten polymer pellets are the prerequisite to achieve the demanded product quality in single screw plasticising technology. When using conventional three-section screws solid particles may occur in the melt. Then dispersive mixing elements are often applied to improve the melt quality. Calculation models are necessary for designing mixing elements in the right way. A new model for the often used fluted mixing sections like Maddock-, Egan- and Z-elements is presented in this paper.
The calculation model can be reduced to one pair of inlet and outlet channel, connected by the shearing gap. The leakage flow through the flight clearance is also considered. Especially in Egan-mixing-sections the longitudinal flow in the flutes is a combined pressure and drag flow, in Maddock-mixing-sections pure pressure flow occurs. In the shearing gap a combined pressure and drag flow can occur.
Geometry functions are introduced for considering the cross sectional shape of the flutes. In the case of circle segments or comparable shapes a subdivision of the cross sections along the channel width is carried out. The viscosity is shear rate and temperature dependent, the channel height as well as the channel width can vary along the mixing element. The model allows the calculation of the pressure profile in the inlet and outlet channels, the pressure drop and the shear stress distribution in the shearing gap.
Mixing sections sometimes show too high pressure drops and insufficient shearing efficiency. Although Egan mixing sections have a lower pressure drop due to the additional drag flow in the flutes, the shearing efficiency can be quite different along the barrier flight gap. Thus a model based optimization strategy of the geometry was carried out to achieve a lower pressure loss and constant shearing conditions.