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Modelling and Simulation of the Extrusion Process Chain

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Since many years simulation programs have been used for the description of technical processes. Procedures can be analysed and solutions will be found for defined problems by assistance of such programs. Even in the fields of the plastics technologies these simulation programs are used for the description of many different processes.
As represented in this detailed report, complete process chains can be analysed and optimised by use of such programs. Three of these simulation programs are used for the process description of an extruder, the slit die and the cooling section. During these processes a defined transmission of certain calculated output parameters takes place. Execution of the simulation is done reversely. Starting with the cooling section, in which the needed output of the extruder is determined by the requested mono film thickness and width in addition to the given haul-off speed, the values for the mass temperature along the cooling section on the basis of the finite differences models are calculated.
The initial temperature of the melt given with the simulation of the cooling sections corresponds to the melt temperature at the discharge of the extrusion tool and serves as a boundary condition for the simulation of the slit die.
By application of special developed models the decrease in pressure and the distribution of the melt volume flow over the extrusion tool width can be calculated. These models base on rheological equations for calculation of flows in channels with rectangular and circular cross sections, which are linked together in a network. The resulting die back pressure at the screw tip serves as a boundary condition for the simulation of the plasticating unit.
The analytical calculation imbedded in the simulation program for the plasticating extruder is based on mathematical-physical models of function zones (e.g. shear elements and mixing elements), which have been developed from the FE- simulations and by theoretical formulation. Profile of pressure and temperature as well as the melting process can be calculated by these models. Feeding problems with fast operating machines which especially may arise with increasing screw speed when the screw diameter is less than 45 mm, can be removed. In addition to this, the function models can be coupled to an integrated model of a plasticating extruder. Due to this a better simulation of systems which are solid dominant is made possible.