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Non-isothermal Regard of the Pressure-/ Throughput Behaviour of non-Newtonian Materials in Consideration of Wall Slippage Effects (2D)

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The description of the pressure-/ throughput behaviour of wall-slipping materials (e.g. PVCs, high-molecular PEs, elastomers, polymer suspensions, ceramic materials or food products), in a single screw extruder is done with a lot of simplifications in many cases. If real flow processes in a single screw machine are regarded, isothermal boundaries are not valid anymore. Hence a non-isothermal description of the system is necessary. The wall sliding velocity at the barrel and the screw root surface are dependent on the viscosity. The viscosity is a function of the shear rate and the temperature. The amount of heat into the system as the case may be out of the system affects the viscosity and thus the resulting sliding velocities. The appearance of the wall-sliding velocity influences the velocity-profile in the screw channel and thus the pressure-/ throughput behaviour. The pressure-/ throughput is very important, since it effects the profitability of a singe screw unit.
This paper presents numerical results, determined by FE-flow simulations, in case of two-dimensional flow, non-Newtonian material and non-isothermal boundaries. The influence of the in comparison to isothermal-flow simulations additional dimensionless numbers Nah (Nahme-number), Pe (Péclet-number), and heated screw $\pi_{\dot{q}} \neq 0$ (dimensionless heat flux at screw root surface and screw flight) on the pressure-/ throughput behaviour is discussed and explained. Especially the resulting sliding velocities at screw root surface and barrel wall and resulting shear stresses are regarded.