Development Of An Integrated Simulation Method For The Prediction Of Transmission Errors Of Injection Molded Spur Gears

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Abstract. Due to the cost-efficient injection molding process and its high degree of freedom in design injection molded gears are widely used in actuating drives. One important functional requirement is the positioning precision of these systems. In gear applications, this precision is mostly dependent on the transmission error. Therefore, a lot of effort in mold design and construction is spent on ensuring acceptable transmission errors of injection molded plastic spur gears.

To predict the transmission error of injection molded spur gears, an integrative simulation method is developed in this work. First, the injection molding process is simulated. The resulting gear geometry is transferred to the mechanical model of a flank rolling test to evaluate the transmission error. The transmission error is mainly dependent on the local shrinkage and warpage caused in the solidification processes during injection molding, which in turn are influenced primary by tool design and process parameters. It is shown, that accurate simulation results concerning gear geometry, require a precise modeling of the process, tool and material. This includes accurate modelling of injection and temperature parameters, gate and cooling design, and behavior of the material. The simulation of the flank rolling test has to take the specified reference torque and testing speed into account to ensure a realistic prediction of the resulting transmission errors.

The research is done on gears with module 1 mm and 39 teeth. According to the model, the gate design and backing pressure have the highest influence on the transmission error. An increase in transmission error of 15% is predicted for gears with three symmetric pin-point gates compared to a central sprue gate, and a decrease of 5% for an increase in packing preasure from 200 to 400 bar. Therefore, if sufficiently modeled, a realistic prediction of transmission errors is possible.