Simulation of Processing reactive Non-Post Cure Epoxy Resin Systems with Pressure Gelation and Conventional Casting

Abstract of the PhD Thesis of Dipl.-Ing. Josef Grindling

When producing parts of epoxy resin systems the first step of molding is to cast into heated tools. At the time of demolding the curing reaction is with 75-85 % incomplete and the demolded components are put into a second costly post curing step. New non-post cure (NPC) epoxy resin systems allow to abandon post curing.

This investigation offers first detailed insights into the accelerated processes of curing and temperature development, which occur in NPC systems within the molds during conventional casting and automatic pressure gelation.

A modified two-stage parallel reaction with diffusion control in the second step was proposed as an optimized curing kinetics for a NPC epoxy resin system. A concept suitable for the industry to develop the rheokinetics parameters is presented.

Finally the computational fluid dynamics (CFD) code Flow-3D® was chosen to be appropriate for the simulation and adapted by programming subroutines according to the specific requirements. The implemented curing kinetics enables the calculation and illustration of glass transition temperatures, which are used in the industry to estimate conversion rates achieved in parts.

To validate the simulation a purpose-built experimental set-up was used, which allowed to measure not only temperatures but for the first time also to trace the curing progress on-line at different points in a pressure gelation mold using dielectric analysis (DEA). The simulated and measured curing and temperature developments match well to each other.