SUCCESS STORY

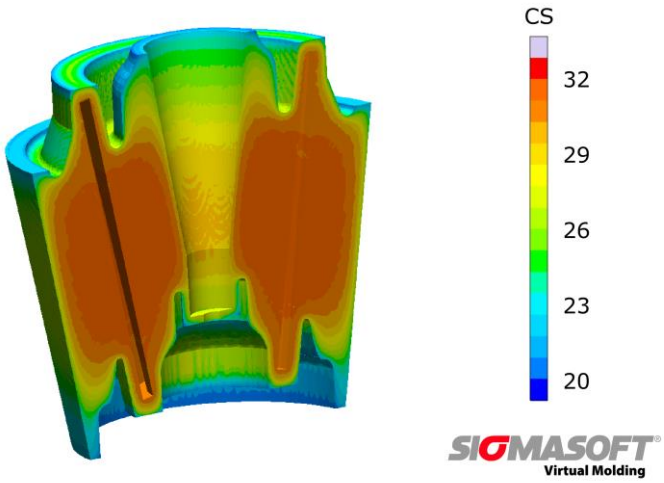
PCCL-K1
K1-Center in Polymer Engineering and Science

Programme: COMET – Competence Centers for Excellent Technologies

Programme line: COMET-Centre

Type of project: Virtual Rubber Injection Molding Machine II (VRIM II), 01/2021 – 12/2024, multi-firm

Virtual part performance in terms of compression set (CS)



PROCESS OPTIMIZATION VIA VIRTUAL PART PERFORMANCE

A NEW MODEL DEVELOPED AS PART OF THIS RESEARCH PROJECT HAS ALREADY BEEN INTEGRATED IN THE SIGMASOFT® SIMULATION ROUTINE. FOR THE FIRST TIME, IT ALLOWS THE CALCULATION OF PART PERFORMANCE CONSIDERING THE PROCESSING HISTORY. AS A RESULT, THIS ENABLES THE VIRTUAL OPTIMIZATION OF THE RUBBER PROCESS CONSIDERING A DEFINED QUALITY CRITERION. REAL PRODUCTION PROCESSES CAN BE OPERATED NOW IN A RESOURCE-SAVING MANNER.

Rubbers belong to the group of reactive materials, and obtain their typical elastic properties during the production process, where energy transfer in the form of heat enables the manufacture of, e.g., car tires, engine mounts, or seals. Properties of elastomers such as damping behavior, tear resistance, and sealing behavior correlate directly with the state of cure, the decisive factor in the rubber processing industry. Process control, i.e., the required or selected mold temperature for the crosslinking reaction, is decisive how fast the reaction takes place, and how this reaction influences the component quality. In reality, however, it does not guarantee that components with an identical state of cure will exhibit the same properties.

Up to now, this deficiency has rarely been considered in simulation routines. It has been sufficient to assume that a simulated state of cure always corresponds to an identical property, e.g., the

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compression set of a manufactured component. In cooperation with the project partners, this problem was solved by developing a new model, the so-called "Average Curing Speed (ACS)" model. This model is based on the relationship between a certain temperature-dependent rate of the crosslinking reaction and the associated component performance that is obtained after processing. Depending on the requirements on the end product, this can be damping behavior, tear resistance or any quality criterion specified by the customer. To calibrate the ACS model, only a one-time information from quality inspection is necessary. In this sense, this model will provide the rubber processing industry with the possibility of optimizing real production processes on a virtual basis according to the specifications set by the customer. Both economic and environmental aspects are addressed.

Impact and effects

The already fully implemented ACS model in SIGMASOFT® opens up a wide range of possibilities for the rubber industry. It is no longer necessary to correlate the parameter of the simulated state of cure with a known part quality. This is now accomplished by the simulation routine, and makes a time-consuming and resource-intense procedure during the real process obsolete. Complex processing steps, such as the injection molding of reactive rubber materials, can thus be optimized virtually to achieve a defined performance. Another important feature of this new model is that, for the first time, it is possible to include the entire processing history in the prediction of the properties of elastomer parts. This leads to a manufacturing process that is adapted to the product requirements in the best possible way, minimizing the consumption of energy and the use of raw materials while concomitantly meeting the sustainability goals in all respects.

Project coordination (Story)
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- Semperit Technische Produkte Gesellschaft m.b.H., Austria
- SIGMA Engineering GmbH, Germany
- MAGMA Gießereitechnologie GmbH, Germany
- Montanuniversitaet Leoben, Department Polymer Engineering and Science, Polymer Processing, Austria

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