Experimental Identification of Viscoelastic Properties of Rubber Blends by means of a Torsional Rheometer
Herbert W. MÜLLNER*, Andreas JÄGER*, Josef EBERHARDSTEINER*
* Institute for Mechanics of Materials and Structures, Vienna University of Technology, Austria
in co-operation with Semperit Technische Produkte Ges.m.b.H. & Co KG, Wimpassing, Austria

Overview

The dimensioning of injection heads for the extrusion of rubber profiles is exclusively based on empiric knowledge of the non-linear flow behaviour of elastomers. The swirling of the melt when emerging from a capillary is typical for viscoelastic fluids, such as polymers and rubber blends, respectively. Therefore, the experimental investigation and numerical treatment of the injection moulding process is of high interest. This was one of the motivations for starting a research project in the field of rubber blend technology.

The knowledge of die swell phenomenon is important for manufacturing rubber profiles. Thus, the final goal of the project is the numerical prognosis concerning injection heads and tools for the extrusion of rubber. So far, several rubber blends, containing mainly EPDM and carbon black in different compositions, have been investigated. These are used for theatra window sealings, pipeline constructions and various parts of cars.

Literature:

Mathematical Structure of Viscoelasticity

For numerical simulations of injection heads the determination of the viscoelastic properties of the rubber blends is required. Therefore experiments with a rubber process analyzer were carried out. For the comparison of the experimental data and the rheological model governing equations for both, storage modulus and loss modulus, subjected to the corresponding material parameters are required. These equations are based on a relation between creep and stress relaxation which can be found by means of Laplace and Fourier transformation according to Findley et al. [2].

Application to Viscoelastic Material Models

1.) Maxwell model

The Maxwell model is not applicable for the investigated rubber blends. This model leads to a semi-circle in the Cole-Cole diagram, in the Black diagram a phase angle of 80 ° is obtained.

2.) Wiechert model

The Wiechert model can be described as a generalised Maxwell model. It achieves a better agreement as the Maxwell model. Disadvantage of this model is the large number of parameters.

3.) Huet model

The Huet model yields the best agreement for all investigated rubber blends. For a small complex modulus values of phase angles < 90 ° are obtained, in spite of using two parameters.