CONSTITUTIVE CHARACTERISATION OF RUBBER BLENDS BY MEANS OF CAPILLARY-VISCOMETRY

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Summary: This presentation deals with the development of a new parameter identification procedure for the material characterisation of rubber blends based on the Newton-Raphson iteration-scheme. Essential features of the suggested method are the consideration of the effect of wall slippage on the viscous properties as well as of the nonlinear coupling between the viscosity and the shear rate.

As basis serves an experimental investigation of the viscous properties of rubber blends by means of a capillary-viscometer with different capillary lengths, capillary radii and extrudate temperatures. For a possible extension of the material characterisation, the die swell of all experiments has been determined, too. For the description of the viscoelastic material behaviour the power law published in [3] is used. Its application on the investigated rubber blends is possible for a common interval of the shear rate. By means of the Newton-Raphson procedure the parameters of the power law will be determined without using various correction methods. The most important correction methods are:

The measurement of the pressure is performed before the capillary entry. Therefore, entrance and out-let pressure losses are not considered by such a measurement. To overcome this problem Bagley proposed to use an effective capillary length instead of the existing one [1].

In order to determine the true viscosity curve the calculation of the true shear rate is necessary. For this task, the empiric correction method by Rabinowitsch [4] is used.

The most important condition for using correction methods is the condition of adhesion of the flow on the wall of the capillary viscometer. However, wall adhesion did not occur in case of the investigated rubber blends. Therefore, the development of a new material characterisation method which considers wall slippage is required.

Because of the consideration of wall slippage, of the temperature, and of the die swell, the resulting parameter identification is represented by a coupled system of nonlinear equations. Describing their solution requires a numerical integration algorithm. For this purpose the Newton-Raphson procedure has been adopted [2]. It requires for a certain number of unknown variables the same number of conditional equations. The variables are the coupled state variables, as the material parameters of the power law, the pressure loss according to viscoelastic properties, the shear stress and shear rate at the wall of the capillary, and the wall slippage velocity along the capillary.

A disadvantage of the proposed method is the fact that the derivatives of the conditional equations are required. The verification of the developed parameter identification is given by means of comparison with the classical material characterisation.

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