Back Calculation of the End Pressure of Circular Capillaries by means of Measurements of Slit Capillaries

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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. Thus, the design of injection heads is carried out with subject to the used rubber blend, whereas the geometry of the appropriate profile is achieved by empiric adaptation of the extrusion die. This was one of the motivations for a research project concerning the experimental and numerical characterisation of the shear rate dependent viscosity of rubber blends.

In that context experiments with a capillary-viscometer were performed. Because of the use of circular capillaries with diameters up to 2 mm only, the measurement of the melt pressure is performed before the capillary entry. Therefore, entrance and outlet pressure losses are not considered by such measurements. To overcome this problem the well-known Bagley correction is used. Because a minimum of two experiments is required, Gleißle introduced one more process parameter, which is unknown for not characterized materials. Furthermore, the Bagley correction leads for some experiments to negative pressure losses, which are physically not possible.

These common corrections methods are well suitable for polymers. The application to rubber blends is not always reasonable. In order to improve the back calculation of the capillary pressure from the measured pressure before capillary entry additional experiments with slit capillaries have been performed. With this type of experiments the determination of the melt pressure within the capillary is possible. The comparison of both experimental data leads to the identification of one scalar parameter which describes the ratio of pressure loss and measured pressure for circular capillaries. The investigations were performed with various rubber blends used in industry, mainly EPDM and carbon black in different compositions. In addition, different temperatures were investigated.