SHEAR VISCOSITY DATA OF NATURAL FIBRE COMPOUNDS FOR THE MODELLING OF POLYMER PROCESSES THROUGH REVERSE ENGINEERING

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Introduction

Nowadays, more and more interest exists to develop compounds containing different kinds of natural fibre reinforcement. Depending on the required properties, different qualities of the natural fibres are used. If a higher quality is needed, the price of the pure fibres is also higher. For some applications, there is no need to use high quality fibres almost at the end of the value chain.

If less treated material is used, what is applicable in the case of flax, it is possible that some shives are present in the material which has been compounded into a thermoplastic composite. Those shives causes a distorted flow field and in some cases can also block the entrance of the capillaries, especially if they have a small diameter.

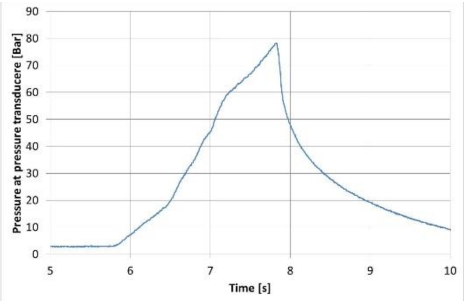
As good tools to predict fibre breakage along the homogenization screw in the injection moulding process are not existing, there is also a need to characterize the process shear viscosity. In this way, the fibre breakage occurring during the homogenization is taken into account, which has an important influence on the shear viscosity data.

Method and Results ([1] to [3])

Using the tensile bar geometry (figure 1) equipped with a pressure sensor and temperature sensors has advantages compared to a standard slit die or spiral die to characterise the shear viscosity data for a 20% flax fibre filled PP compound. Due to a combination of two parallel sections, the pressure as function of time for a constant injection flow rate has two slopes resulting in two flow conditions in one experiment (see figure 2). The temperature sensors allow to check the accurateness of the numerical simulation model used.

To calculate the shear viscosity data in combination with the possible wall slip as function of shear rate and temperature, both commercial available numerical simulation software (Autodesk Simulation Moldflow Insight 2014) has been used and an own development in Matlab®. This allows to fit the flow front position and the accompanying injection pressure as function of injection time for any process setting. A Matlab® routine have been used to be able to calculate for slip along the wall. For the low flow rates, slip along the wall has been neglected. In combination with different cooling water temperatures, the non-slip behaviour first order viscosity model could be fitted on to the data. The combination of this model with the high flow rates, resulted in information about wall slip during the injection moulding for higher flow rates.

Figure 1: *Tensile bar geometry with the locations of the pressure and temperature sensors*



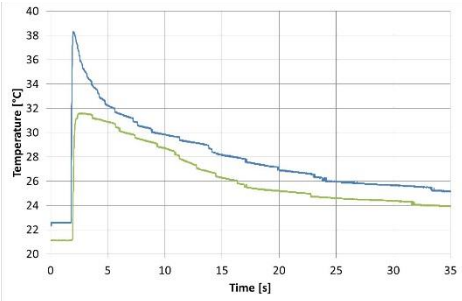


Figure 2: *Pressure and temperature as function of time during injection with constant injection flow rate of a tensile bar geometry*

Conclusions

This study shows a possible approach to calculate for the shear viscosity data for less homogeneous materials. A combination of several experiments with a fitting routine resulted in useful shear viscosity data for natural fiber filled compounds to be used in numerical simulation software. The obtained shear viscosity data has been applied to perform numerical simulations for an industrial part.

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