Testing the Flow Characteristics of Glass Fibre Reinforced TPU

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Introduction

Raw material batch variation can lead to a high reject rate in the plastics processing industry, especially when injection moulding large parts or extruding on large extruders.

Test Aim

Differentiating between two Glass Fibre reinforced TPU (thermoplastic polyurethane) batches by determining their viscosity using an extruder capillary rheometer

Test Equipment

- Torque rheometer Thermo Scientific HAAKE PolyLab System
- Twin screw laboratory extruder Thermo Scientific HAAKE Rheomex CTW100
- Venting screws
- Rod capillary die with rod capillary dia. = 2 mm and L/D = 20:1
- Balance with serial port
- Thermo Scientific HAAKE Software PolySoft OS Capillary Rheometry

Test Conditions

- Mixer temperature:
  - 1st zone: 170 °C
  - 2nd zone: 190 °C
  - 3rd zone: 220 °C
- Die temperature: 220 °C

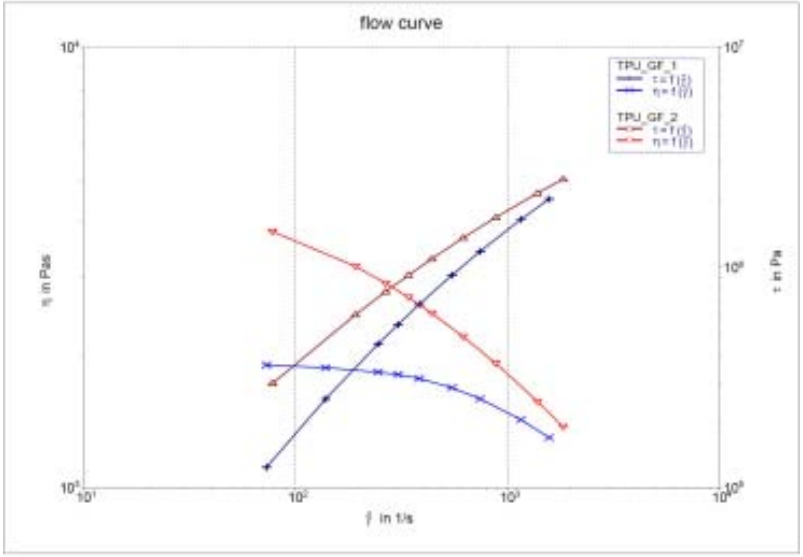
Test Material

Glass fibre reinforced TPU (thermoplastic polyurethane, pre-dried):

- Sample 1: TPU_GF_1
- Sample 2: TPU_GF_2

Test Procedure

The polymer is molten and homogenized in the extruder, transported to the die and pressed through the rod capillary. Stepwise the extruder speed is changed. The output at each speed step is measured with a balance which is connected to the computer via a serial port.



From this mass flow data, the melt density and the capillary geometry the shear rate is calculated.
At each speed step a pressure transducer is measuring the pressure in front of the capillary. From those data the shear stress is calculated. The quotient from the shear stress and the shear rate gives the melt viscosity.

Test Results

The diagram shows the test results of the two samples superimposed in one graph.
The shear stress τ and viscosity η is displayed vs. the shear rate γ in a logarithmic scale.
Sample 2 shows a much higher viscosity than sample 1 over the whole shear rate range.
At a shear rate value γ = 200 1/s the viscosity of sample 2 is approx. 50 % higher than that of sample 1.
The shear stress and viscosity curves of both samples run closer to one another in the high shear rate range. Therefore differentiation between these samples is better accomplished at a lower shear rate range.

From the measurements it can also be seen, that the viscosity of sample 2 drops faster with increasing shear rate. So the pseudo-plastic behaviour of sample 2 is much more pronounced. In the shear rate range of γ = 200 - 2000 1/s, the viscosity of sample 2 drops twice as markedly as sample 1.

Summary

The Thermo Scientific HAAKE PolyLab system offers the possibility of quickly and reliably analyzing the flow characteristics of a polymer compound under conditions which approximate to actual processing.

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