APPLICATION NOTE

Testing the flow characteristics of glass fiber reinforced TPU

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Introduction

In the search for materials to build more fuel-efficient automobiles, lightweight yet robust plastic materials are of great interest. Glass fiber-reinforced thermoplastic polyurethane (TPU) is such a compound material. It can be used for a range of applications where greater structural integrity is required, such as in automotive body side moldings and other automotive components.

Of course, the amount of glass fiber in the processing mixture affects the integrity and quality of the final product. That means variation among batches of raw materials can lead to a high rejection rates of manufactured product, which is especially expensive when injection molding large parts or processing on large extruders. So it's important to understand the quality of batches of raw materials, such as TPU, early in the process.

Test aim

The aim of this report is to differentiate between two glass fiber reinforced TPU samples by characterizing their viscosity with an extruder capillary rheometer.

Test equipment

- Thermo Scientific™ HAAKE™ PolyLab™ Torque Rheometer
- Thermo Scientific™ HAAKE™ Rheomex CTW100 Twin-Screw Extruder
- Venting screws
- Rod capillary die with rod capillary diameter of d=2 mm and length/diameter of l/d=20:1
- Balance with serial report
- Thermo Scientific™ PolySoft Capillary Rheology Software

Test conditions

Extruder temperature:
· 1st zone: 170 °C
· 2nd zone: 190 °C
· 3rd zone: 220 °C
Die temperature: 220 °C

Test material

Glass fiber reinforced TPU (pre-dried):
· Sample 1: TPU_GF_1
· Sample 2: TPU_GF_2

Test procedure

The polymer was molten and homogenized in the extruder, transported to the die and pressed through the rod capillary. Stepwise the extruder speed was changed and the output at each speed step was measured with a balance. From the mass flow data, the melt density and the capillary geometry shear rate was calculated. At each speed step, a pressure transducer measured the pressure in front of the capillary. From that data the shear stress was calculated. The quotient from the shear stress and the shear rate gave the melt viscosity.

Test results

Firgure 1 shows the test results of the two samples superimposed in one graph. The shear stress τ and viscosity η are displayed vs. the shear rate γ in a logarithmic scale. Sample 2 shows a much higher viscosity than sample 1 over the entire range of the shear rate.

At a shear rate value of $\gamma = 200$ 1/s, the viscosity of sample 2 is approximately 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.

The measurements also show that the viscosity of sample 2 drops faster with an increasing shear rate. So the shear-thinning behavior of sample 2 is much more pronounced. In the shear rate range of $\gamma = 200$ - 2000 1/s, the viscosity of sample 2 drops twice as much as sample 1.

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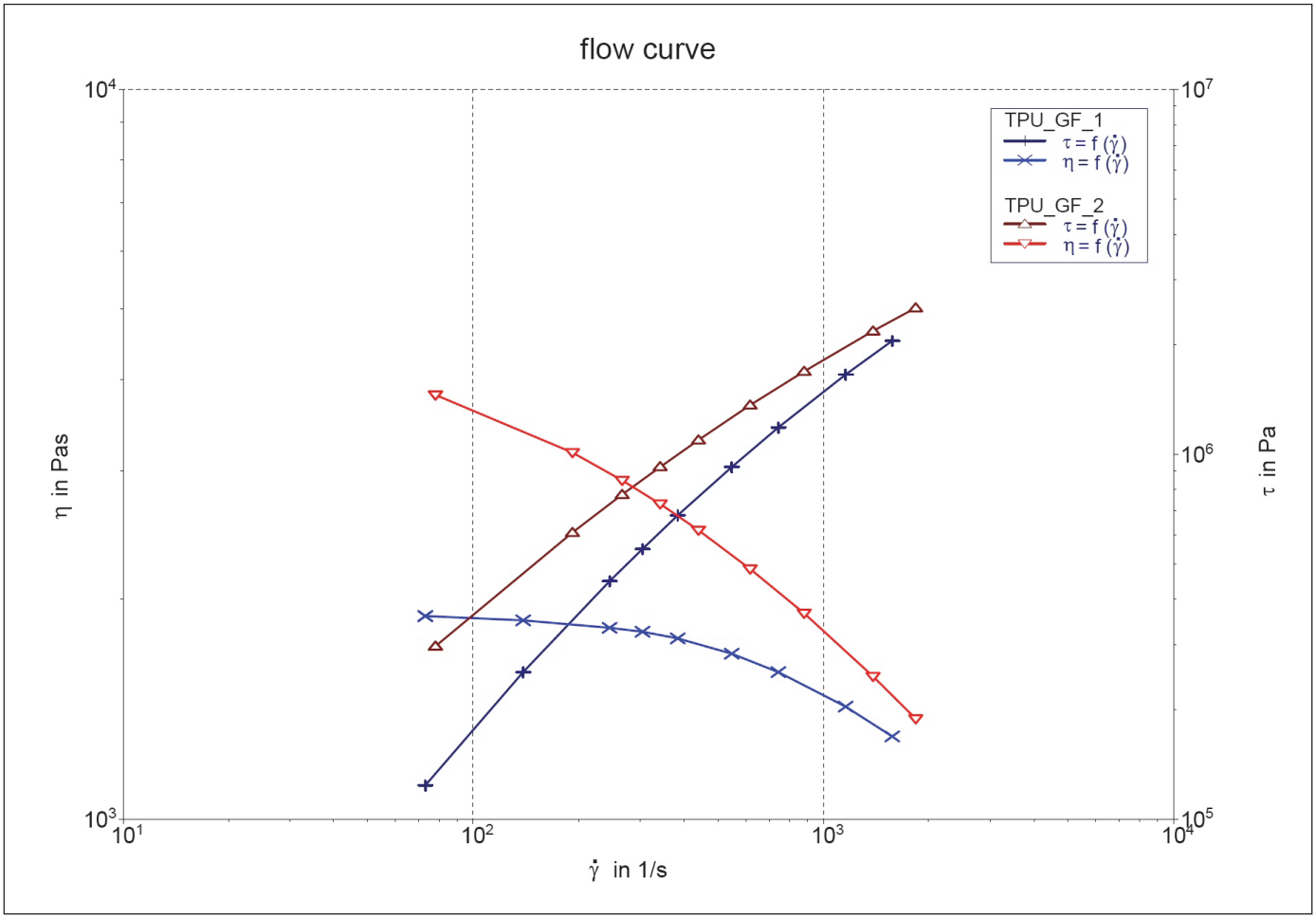

Figure 1: Superimposed test results for two TPU samples.

All measurements were carried out under conditions similar to those during injection molding or extrusion on large scale production machines. That means the data from these tests gives a clear indication of which raw material is suitable for producing goods with the desired material properties.

Summary

The HAAKE PolyLab system - which consists of the PolyLab Torque Rheometer, Rheomex Twin-Screw Extruder and PolySoft OS Software -offers an easy, reliable test method to quickly analyze the flow characteristics of a polymer compound. It can help increase the production yield of finished goods by differentiating raw materials so manufacturers can prevent production of goods that do not meet specifications. The automated PolySoft OS Capillary Rheology Software can be adapted for a range of applications and ensures repeatable testing even with different test operators.

Find out more at thermofisher.com/extruders