

Investigation of the flow characteristics of PET at different temperatures

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Abstract

Polyethyleneterephthalate, a thermoplastic polymer and part of the Polyester group, is produced by polycondensation.

PET is processed in different ways and has a wide range of application. One of the most common application is the production of all kinds of plastic bottles (production process injection blow molding) and the converting into textile fibers. PET is also used to produce film footage like it is used for the movies in cinemas. Already since the fifties PET is used in production of very thin cast films, known under the name Mylar. PET has its own resin identification code, which helps to simplify the recycling of PET packages. As textile fiber (Polyester) PET is also popular because of its additional useful properties. PET is crease-resistant, tear-proof, weather-proof and hydrophobic. Therefore PET is predestinated as material for sportswear, which has to dry fast. Even in the food industry PET is used as preferred material. It can be processed in an amorphous state and is in this form absolutely achromatic and highly translucent. It's used for food grade packaging and bottles like e.g. the PET - bottle. Because of its good texture compatibility PET is also used as basic material for blood vessel implants. The glass transition temperature is about 80°C. At about 140°C PET passes into the crystalline state. The melting point is at around 235°C-260°C.

Introduction

Polyethyleneterephthalate (PET) is processed by melt extruding and then stretching the material up to 6 times

the original length to form an endless high-yield point thread. To produce a product of constant quality, it is of great interest for the processor to know how the flow characteristics of the molten polymer change as a function of the temperature and the shearing rate.

The PolyLab System offers a fast and reliable method to investigate these flow characteristics. Unlike for traditional capillary rheometers, the test samples are measured with a laboratory sensor extruder under conditions similar to those encountered during processing.

Materials and Methods

Test Set-Up

PolyLab OS consisting of:

- Rheodrive 4 drive unit with 4 kW
- Rheomex 19/25 single screw extruder 19 mm with L:D = 25:1
- Screw 2:1
- Rod capillary die with rod capillary $d = 1.5\text{mm}$ and L:D = 20:1
- Die ring heater

Temperatures

Extruder:	Zone 1 = 280°C
	Zone 2 = 280°C
	Zone 3 = 280°C
Die ring heater:	280°C
Die:	1. test = 275°C
	2. test = 285°C
	3. test = 295°C

Results and Discussion

The test data is evaluated with the PolySoft Capillary Software. Diagram 1 shows the flow curves (shear stress against shear rate) and diagram 2 shows the viscosity curves (viscosity against shear rate).



PolyLab OS

The curves show the typical shear thinning effect for polymers. The curves demonstrate that for this product the influence of the temperature decreases for increasing shear rates. This means that the viscosity is independent of temperature fluctuations at higher shear rates.

Summary

Recapitulating we can say that the flow characteristics of polymer melts can vary at different processing temperatures. This becomes apparent especially at low shear rates. With increasing shear rates this influence becomes less and less. At very high shear rates one can almost neglect the temperature effect. With the PolyLab OS system Thermo Fisher Scientific offers a platform which allows the customers to evaluate these effects and influences under conditions close to the production process.

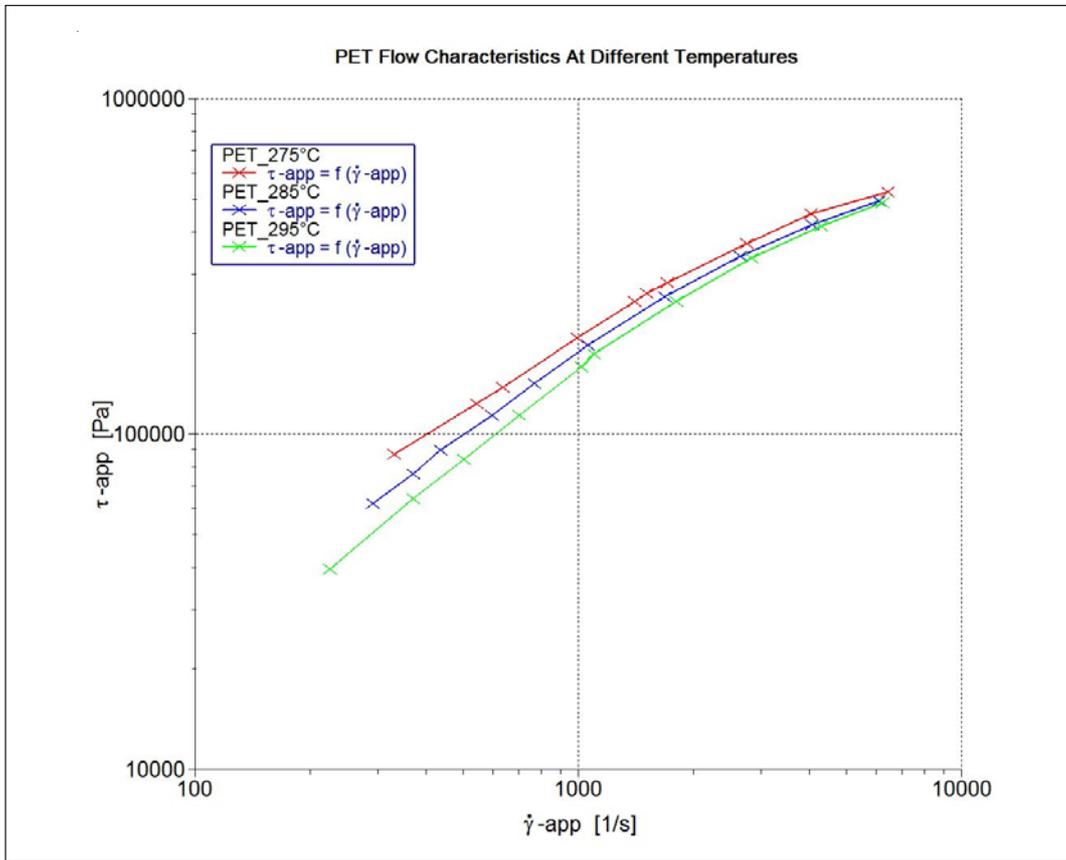


Diagram 1: Shear stress against shear rate

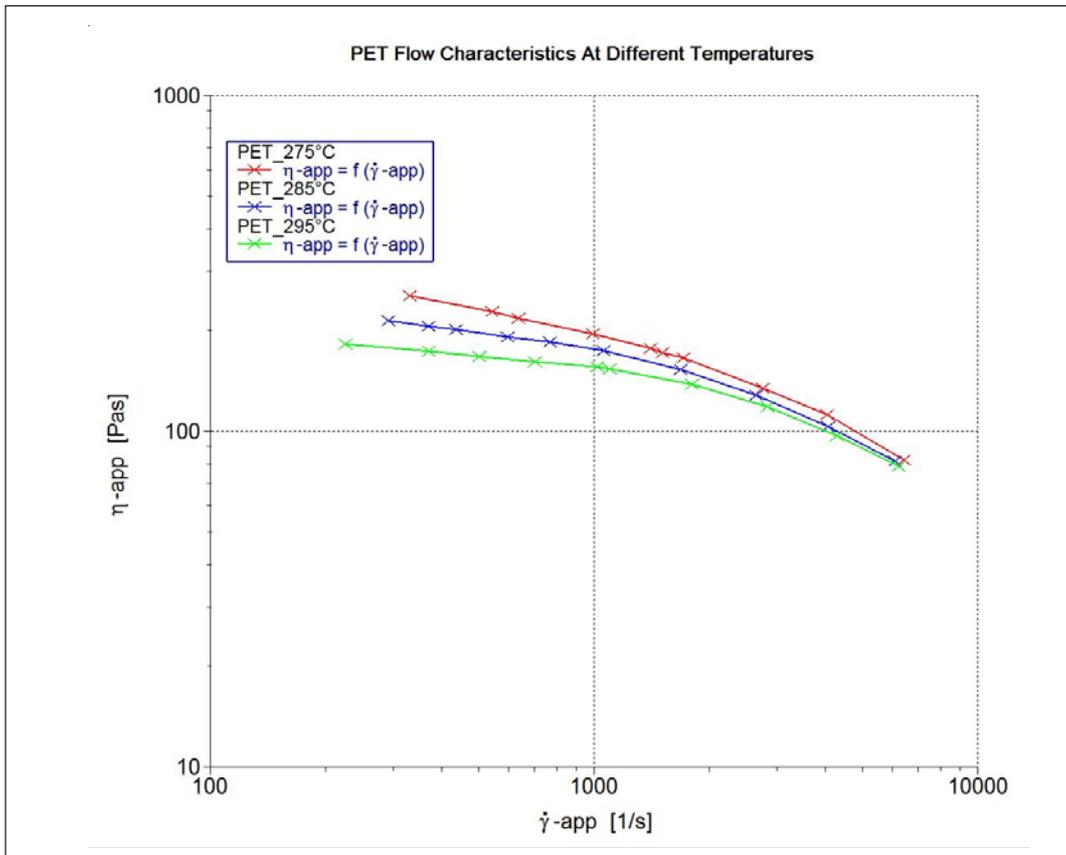


Diagram 2: Viscosity against shear rate

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LR-06_18.01.07

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