Investigation of the flow characteristics of PET at different temperatures

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Abstract

Polyethylenterephthalate, 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, know under the name Mylar. PET has it's own resin identification code, which helps to simplify the recycling of PET packages. As textile fiber (Polyester) PET is also popular because of it's additional useful properties. PET is crease-resistant, tearproof, 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 bottels like e.g. the PET - bottle. Because of it's 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 fort he processor to know how the flow characteristics of the molten polymer change as a function of the temperature and the shearing rate.

The Thermo Scientific™ HAAKE™ PolyLab™ OS 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.

Thermo Scientific HAAKE PolyLab OS

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Materials and methods

Test set-up

PolyLab OS consisting of:

- RheoDrive 7 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 = 1.5mm 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). The curves show the typical shear thinning effect for polymers. The curves demonstrate that fort his 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 that allows the customers to evaluate these effects and influences under conditions close to the production process.

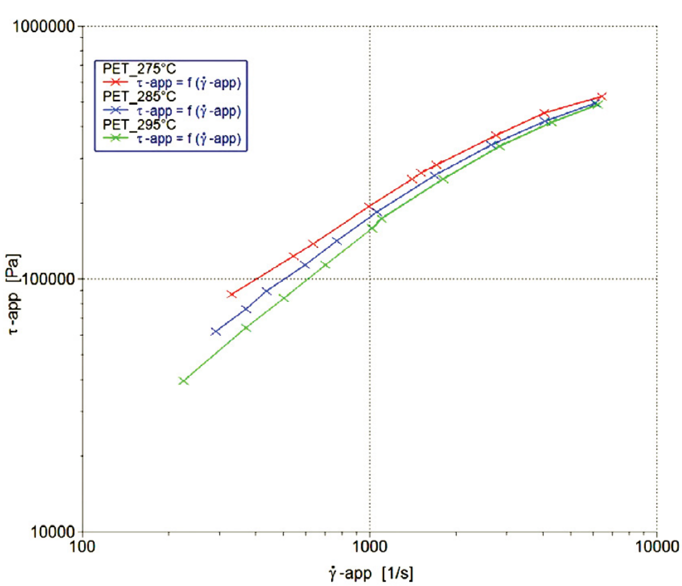

Diagram 1: Shear stress against shear rate

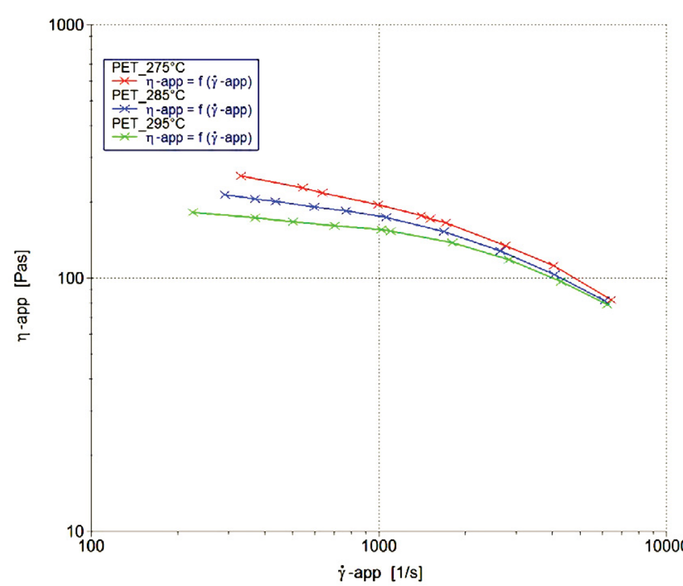

Diagram 2: Viscosity against shear rate

Find out more at **thermofisher.com/polylab**

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ANLR-06_E 09/18M