How dense is your polymer?

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Introduction

Specific volume of polymers is one of the main properties affecting the final dimensions and shape of products. A custom made dilatometer [1] with high cooling rates and shear rates was designed to investigate PVT behavior of polymers. The aim of this work was to develop a new frame and software control to create a table sized machine.

First try

A prototype dilatometer for rapid cooling [1] (100 [C/s]), shear rates (80 [s^{-1}]) and elevated pressures (100 [MPa]) was developed. It consists of a pressure cell in combination with a tensile testing machine with rotation capability (Fig.1).

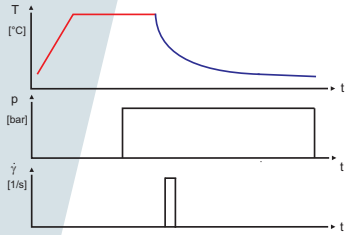
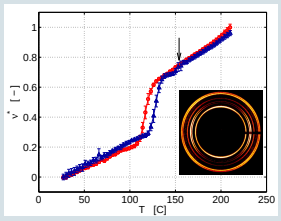


Figure 1 *The prototype (left). The experimental procedure (right)*

Tests were done on two iPP grades [2] (Fig.2).
iPP-1: Mw = 365 kg/mol, Mw/Mn = 5.2; iPP-2: Mw = 500 kg/mol, Mw/Mn = 6.0. Experimental conditions: $\dot{\gamma} = 38s^{-1}$ during 3.0s, shear temperature= 153°C, pressure= 40MPa, characteristic cooling rate= 1.4°C/s.



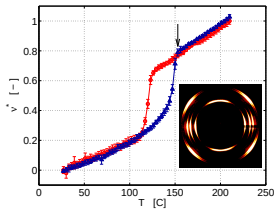


Figure 2 *Effect of shear on specific volume.iPP-1 (left) and iPP-2 (right)[2].*

The next step

The new design represents a table sized machine (LxWxH=60x45x60cm) with additional control devices and computer facilities (Fig.3).

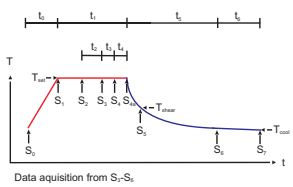
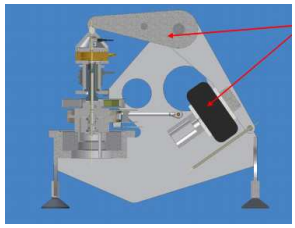


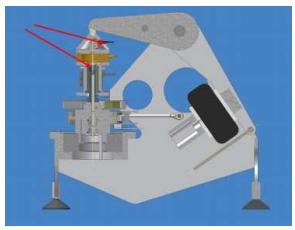
Figure 3 *New apparatus (left). Control sequence (right)*

/department of mechanical engineering

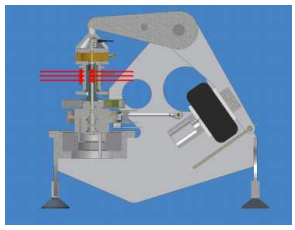
The experimental procedures of the shear experiments improved (time- to temperature controlled) and the specifications extended.



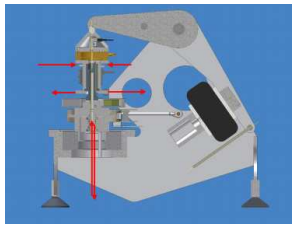
P-V-T-$\dot{T}$-$\dot{\gamma}$
Air cushion



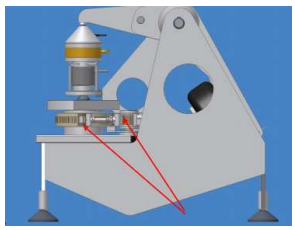
P-V-T-$\dot{T}$-$\dot{\gamma}$
Glass pin



P-V-T-$\dot{T}$-$\dot{\gamma}$
IR-Temperature reading



P-V-T-$\dot{T}$-$\dot{\gamma}$
Cooling channels



P-V-T-$\dot{T}$-$\dot{\gamma}$
Electric motor

Figure 3 *Features of the setup*

Conclusions

A dilatometer for high cooling rates and shear flow with fully automated control was developed and built. The new features of the present design are: temperature controlled and isothermal measurements and no limitation in total shear.

References:

[1] VAN DER BEEK, M.H.E., PETERS, G.W.M., MEIJER, H.E.H. : *International Polymer Processing, XX(2), p.111-120,* (2005)

[2] VAN DER BEEK, M.H.E.: *PhD Thesis,*(2005)

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