RHEOTENS 71.97

The New Tensile Tester for Polymer Melts

GÖTTFERT®

certified according to DIN EN ISO 9001

GFT 010.02.0-9-02

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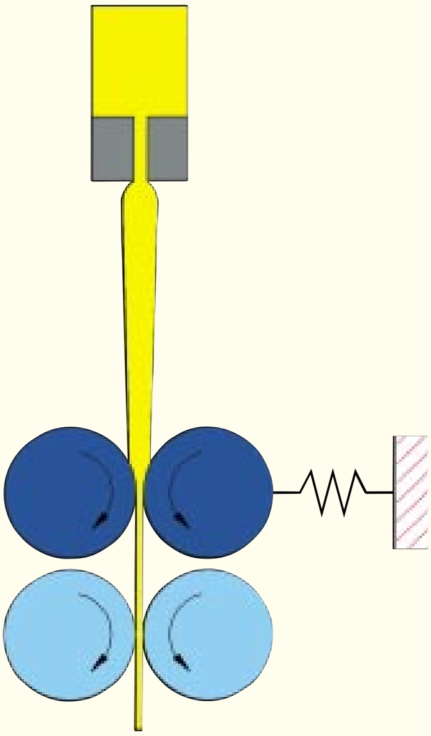
The new tensile tester for polymer melts

It is well known that the elongational flow behavior which dominates many processing techniques can not be determined from shear experiments.
The patented **RHEOTENS** melt tensile testing technique has proven to be highly reproducible and sensitive, and will differentiate even polymer melts showing small differences in molecular structure which can not be detected with analytical methods.

RHEOTENS 71.97 offers the following new features :



- **Tandem pulley system[1] (option):**
An additional pair of pull-off wheels have been integrated to prevent sticking of the elongated polymer strand once it has passed the first pair of pulleys.

- **Extended speed control**
60 % higher pull-off speeds are available now. Infinitely variable speed control up to 1900mm/s

- **New software under WINDOWS**
The new **RHEOTENS** software developed under WINDOWS'95 has an emphasis on user friendliness. The experiment is controlled by a user-programmed set-up. Additionally, the joy stick provides all the freedom required for calibrating, controlling and initiating the experiment.

- **New functions are added:**
In addition to linear constant pull-off speed and constant acceleration, exponential speed control has been added.

[1] patent pending

Shear Followed by Elongational Flow: Constitutive Equations[1] for Melt Spinning based on the RHEOTENS Experiment

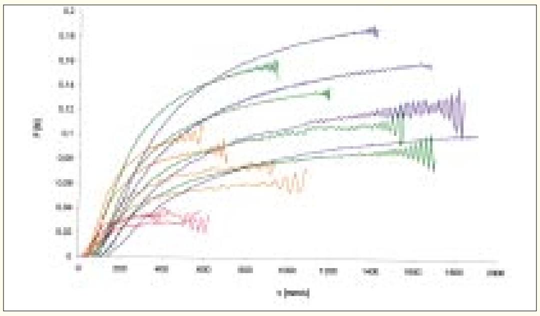


Figure 1: Looking at the **RHEOTENS** diagram, the maximum draw-down speed (v) is a relative measurement for the "elongation" of the melt, while the maximum force (F) is a relative measurement for the melt strength. The **RHEOTENS** test is a rather complicated function of the characteristics of the polymer, dimensions of the capillary, length of the spin line and of the extrusion history:

F=F (Polymer,Geometry,Process Conditions)

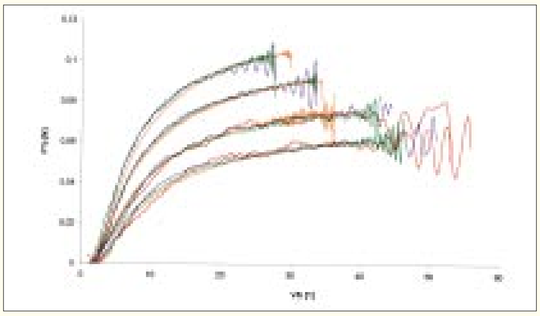


Figure 2: "Super-Master-Curve"
In the first step approach, invariance with respect to different mass flow rates can be found. This reduces the originally 16 **RHEOTENS** curves in our example to 4, whereby the shift factor is solely a function of the extrusion history. With this, the pull-off force (F) is only based on:

F=F (Polymer, Geometry)

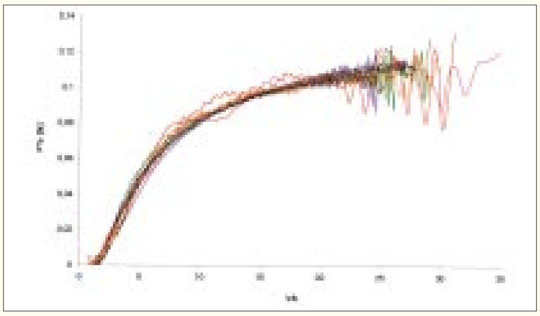


Figure 3: "Grand-Master-Curve"
In a further step towards integration, invariance with respect to capillary dimensions and the spin line length are considered. In the end, all 16 **RHEOTENS** curves are reduced to the **RHEOTENS**-Grand-Master-Curve, which is solely a function of the polymer characteristics.

F=F (Polymer)

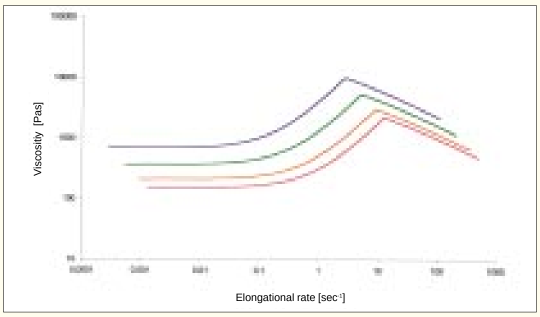
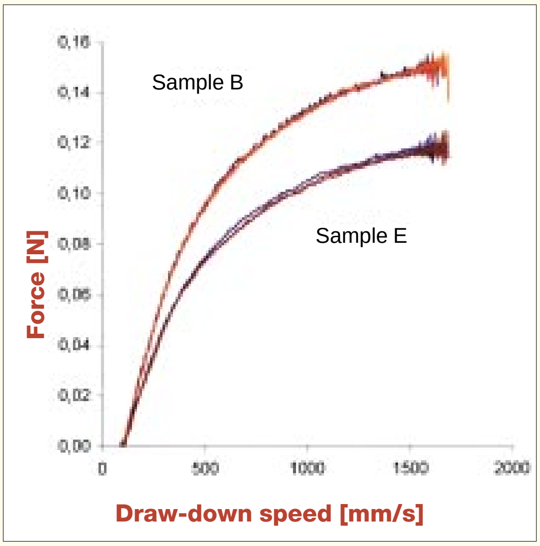
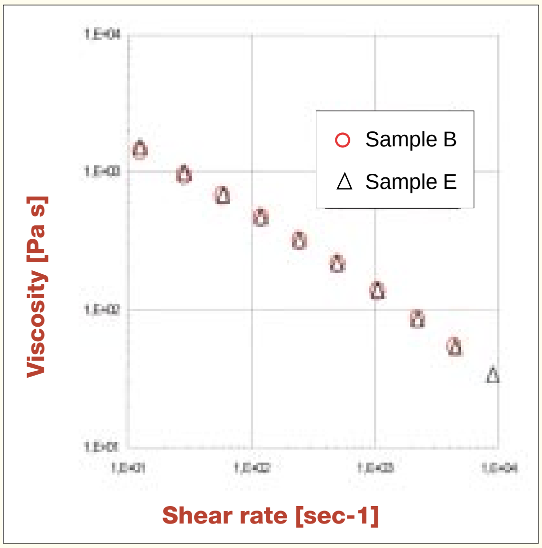


Figure 4: Elongational Viscosity
Now, the effective elongational viscosity can be determined by using a simple analytical model. The elongational viscosity, as a function of the elongational rate, is composed of the "visco-elastic-start-up" with increasing elongational viscosity and the purely viscous elongation with decreasing viscosity, shown here also at different extrusion conditions.

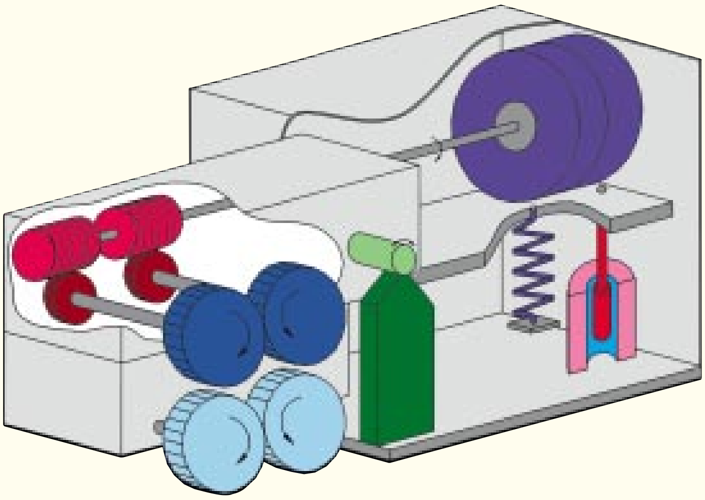
1 : The determination of the elongational viscosity is a software routine of the **RHEOTENS** and is based on the work done by Prof. Wagner and coworkers at the IKT, University of Stuttgart / Germany. Literature references are gladly given on demand.

"RHEOTENS curves allow you to differentiate between the smallest differences in the behavior of your batches, otherwise not detectable with shear experiments."





The material producer has found that sample B has a wider molecular distribution (M_W/M_n = 11.1), versus sample E (M_W/M_n = 10). Sample B and E were run three times (with the respective curves lying on top of each other).
The **RHEOTENS** curves (picture left) show significant changes in the melt strength between the two batches. This information could not have been gathered by looking at the viscosity curves (picture right).



RHEOTENS 71.97 with tandem pulley system

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