

GEESTHACHT POLYMER DAYS: “PRACTICAL USE OF RHEOLOGY FOR POLYMER MATERIALS”

GEESTHACHT, GERMANY
NOVEMBER 18–19, 2014

A two-day workshop for rheology users concerned with the production, processing and use of plastics was held for the second time by the Institute of Polymer Research at the Helmholtz-Zentrum Geesthacht in cooperation with Anton Paar GmbH. The aim was to give a comprehensive practical insight into rheological methods of analysis for polymer materials. Experienced professionals from industry and academia provided a broad spectrum of presentations from the basics of polymer rheology to methods for analyzing rheological properties in solid, melt and solution state, as well as database analysis, including relevant examples.

Professor Volker Abetz welcomed the participants and gave a short overview of research at the Institute of Polymer Research, Helmholtz-Zentrum Geesthacht, which is focused on membranes for separation. At the end of the day, all participants took up the invitation to visit the Institute and see the extensive laboratory set up. Following the opening remarks, Michael Schäffler (Anton-Paar Germany GmbH, Ostfildern) introduced the principles of rheology in rotation and oscillation. In addition to rheological phenomena, such as viscoelastic and time-dependent material behavior, rheological models

and basic definitions were explained. In the next lecture, Dr. Andreas Eich (SI Analytics GmbH, Mainz) illustrated his polymer rheology work with the example of polyisobutylene, explaining the time-temperature sweep and the creation of a master curve based on frequency sweeps at different temperatures. The curve shapes of storage and loss moduli depending on frequency from polyisobutylene with different molar mass and molar mass distribution were discussed. Then Michael Härtel M. Sc. (Institute of Polymer Materials, University of Erlangen-Nuremberg) explained in his lecture the practical challenge of characterizing poly(ethylene terephthalate). He demonstrated the influence of sample preparation, surrounding atmosphere, predrying, preheating time and measurement duration.

Topics on the first afternoon included extensional rheology of polymer melts, viscosimetry and extensional rheology of polymer solutions. Professor Manfred Wagner (Institute of Polymer Technology and Polymer Physics, TU Berlin) discussed the true elongational viscosity of LDPE at constant strain-rate extension and elongational flow at constant force conditions. He explained various Rheotens experiments and master



Figure 1: Participants of the Geesthachter Polymertage 2014.

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curves affected by acceleration, crystallization, wall slip at low temperatures, branching structures and branching topology. Dr. Andreas Eich presented in his second talk the viscosimetry of polymer solutions with glass capillary viscosimeters, which are only valid for Newtonian fluids; e.g. oil and diverse aqueous solutions for the pharmaceutical industry. The extensional rheometry of polymer solutions was the subject of the last lecture of the day from Professor Norbert Willenbacher (Institute for Mechanical Process Engineering and Mechanics, KIT Karlsruhe). He gave an overview of extensional rheometers for low viscosity fluids, as well as capillary break-up extensional rheometry and their operating systems, data analysis and applications, which include polymer and surfactant solutions, emulsions and yield-stress fluids.

The focus in the first session on the second day was given to polymeric dispersions. Dr. Meik Ranft (BASF SE, Ludwigshafen) made a presentation about synthesis of polymeric dispersions. He showed how to synthesize stable polymer-dispersion systems and the influence of the electro-viscous effect. The importance of rheological and viscous behavior of the dispersions during synthesis was explained. "Flow Stability Characterization of Dispersions" was the topic of Dr. Dirk J. Dijkstra's presentation (Bayer MaterialScience AG, Leverkusen). The ring-slit device was suggested for the simultaneous formation and detection of aggregates because it allows the flow-induced aggregation of concentrated dispersions. Flow-induced aggregation is strongly influenced by the presence of small impurities, but can be controlled by adjusting colloidal-particle interactions. Dynamic mechanical analysis (DMA) is one of the most important techniques for polymer characterization. Dr. Helmut Steininger (BASF SE, Ludwigshafen) presented

the basics of DMA, explaining the importance of the measurement conditions, the sample preparation, the temperature dependence of storage modulus, and time-dependent viscoelastic properties of polymer materials. Various accessories and possibilities in rheology were presented by Dr. Christine Wurm (Anton Paar Germany GmbH, Ostfildern), including rheo-optical measurements, microscopy, polarized-light imaging, dichroism and small-angle light scattering.

The rheological behavior of magneto-rheological fluids and elastomers based on liquid silicone was presented by Dr. Joachim Kaschta (Institute of Polymer Materials, University of Erlangen-Nuremberg). Dr. Ulrich A. Handge (Helmholtz-Zentrum Geesthacht) discussed solubility and diffusion phenomena due to the thermodynamic and rheological properties of polymer materials under gas loading and pressurization. In the final lecture of the workshop, Dr. Jörg Läuger (Anton Paar Germany GmbH, Ostfildern) introduced the advanced method of large amplitude oscillatory shear rheology. This emerging technique presents new possibilities in comparison to the often-used small amplitude shear rheology. Investigating the non-linear behavior of polymer materials helps to understand complex samples and is often crucial for relating results to practical applications.

In summary the "Practical Use of Rheology for Polymer Materials" was a very successful convergence of industry and research. A highlight was the interesting discussions that complemented the program, as these were a valuable opportunity for exchange between participants and lecturers. The next rheology workshop will take place in 2016, again in Geesthacht.

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