

CHRONICLES

RHEOLOGY SYMPOSIUM

R. G. Gorodkin and A. D. Matsepuro

The IV Rheology Symposium, organized by the Laboratory of Polymer Rheology (Head, Doctor of Sciences Prof. Vinogradov) of the Institute of Petrochemical Synthesis of the Academy of Sciences of the USSR was held in Moscow from May 27 to 30, 1969. More than 200 people representing scientific-research and industrial undertakings took part in the symposium. Scientists from the German Democratic Republic, Poland, and Czechoslovakia also took part in the symposium as speakers and guests.

The main object of rheological research at present is polymer materials and compositions, and therefore a large part of the reports heard at the symposium was devoted to the examination of rheological properties of melts and solutions of polymers and also the deformation properties of solid polymers.

One of the most important methods of investigating viscoelastic bodies is the study of the dynamic conditions of loading, and the influence of vibration loads on polymer materials and compositions. Quantitative research on the reaction of a system to dynamic actions of different frequency enables the main mechanical characteristic, i.e., its relaxation spectrum, of the properties of a polymer system to be obtained. Until recently measurements of this kind were carried out exclusively in the linear region, where the deformation amplitude is small and does not influence the characteristics of the system ("nondestructive experiments"). A number of reports were presented at the symposium (G. V. Vinogradov with his coauthors, L. A. Faitel'son et al.), in which the conventional method of dynamic experiments with polymers was generalized by using large amplitudes or by superposing harmonic vibrations on the viscous flow with a constant shear rate. By this method the nature of the variations of the relaxation properties of the system is successfully studied in the case of changeover from quiescent to flow conditions and also as a result of the action of strong vibrations.

The most general manifestation of the special features of the rheological properties of the polymer materials is their capacity to develop highly elastic deformations. The report by A. Ya. Malkin, M. P. Zabugina, and G. V. Vinogradov examined the mechanisms of highly elastic properties manifested under flow conditions from the point of view of the experimental effects which have been observed, and also in connection with the existing molecular-kinetic and thermodynamic concepts about the deformation mechanism of polymers. The high elasticity of the polymers leads to the occurrence of a plateau on the frequency or temperature relationship of the dynamic modulus. The report by E. A. Dzyuri showed that this effect is common both for thermoplastics and for elastomers, if there is the same number of segments in the chain, and the comparison of the properties of the system of polymers of different class is carried out at the same interval from the temperature of vitrification.

The rheological properties of solid polymer materials with different types of stressed state were examined in a number of reports presented by the Riga Institute of the Mechanics of Polymers of the Academy of Sciences of the Latvian SSR (A. K. Malmeister and A. F. Kregers, S. B. Ainbinder, Yu. S. Urzhumtsev, et al.).

G. L. Slonimskii in his report demonstrated the possibility of a new approach to describing the relaxation properties of polymers using fractional operators. A description of this kind is closely associated with the development of quantitative concepts of the structure of the polymer system, and especially the links which occur between the separate elements of the molecular and super-molecular structure of the material. The report by A. Zyabitskii (Poland) was devoted especially to these problems. This report analyzed the main types of connections in the structural lattice and showed that by using the concept of sliding or fluctuating engagements, it was possible to predict the most important properties of the polymer

Translated from *Inzhenerno-Fizicheskii Zhurnal*, Vol. 17, No. 4, pp. 746-747, October, 1969.

© 1972 Consultants Bureau, a division of Plenum Publishing Corporation, 227 West 17th Street, New York, N. Y. 10011. All rights reserved. This article cannot be reproduced for any purpose whatsoever without permission of the publisher. A copy of this article is available from the publisher for \$15.00.

(the presence of an anomaly of viscosity, the elasticity of the polymer systems, etc.). These concepts unavoidably lead to a conclusion about the existence of a connection between the processes of deformation and destruction of the polymer material. The different aspects of this problem were examined by V. R. Regel', who also dwelt in detail on questions associated with the need to establish a quantitative correspondence between the time relationship of the stability of the polymer and the development of deformation, with respect to time, when loads are applied.

The traditional field of rheological research is solutions of polymers; this field is associated with their value in polymer technology and also with the convenience of using solutions as example systems on which it is convenient to model all the possible properties of different polymers. The general principles according to which the connections between the structural features and the rheological properties of the solutions of polymers are established were examined in detail by S. Ya. Frenkel', who also paid special attention to the influence of thermal history, which occurs frequently in polymer systems, on the measured properties of the material.

Experimental data associated with the influence of the concentration and nature of the solvent and the temperature on the viscosity of solutions of flexible- and rigid-chain polymers, were examined in the report by V. E. Dreval' and A. A. Tager. In a number of reports the influence of the structure and components of the polymer composition on its rheological properties was examined (V. A. Kargin, and G. P. Andrianova, Yu. V. Zelenev, and coauthors V. N. Kuleznev, and B. A. Dogadkin, V. A. Grechanovskii, and others). These reports show a general connection between the structure of the macromolecules and their rheological properties.

One of the most important trends in the application of results of rheological research in practice is the calculation of the flow of abnormally-viscous media in channels of different geometrical form. These problems were examined in greatest detail by V. G. Litvinov, who presented solutions of a number of problems concerning the movement of nonlinearly-viscous and viscoelastic liquids in cylindrical and conical channels. The movement of the abnormally viscous liquids in the working elements of regenerating equipment was examined in reports by S. A. Bostanofzhiyan and his coauthors. In cases which are important in practice the flow becomes complex by the phenomena of heat transfer. The problem of the flow of a non-Newtonian liquid in a round tube in nonisothermal conditions was examined in the report by O. Reger (German Democratic Republic).

Research on the deformation of polymer systems, examined in connection with the mechanism of the simplest molecular processes, requires reliable energy evaluation of the structural processes. An evaluation of this kind enables the thermodynamic features of the behaviour of flowing polymers to be judged. These problems were examined from different points of view in the reports of B. V. Yarlykov and A. Ya. Malkin, who gave an energy treatment of the phenomenon of the anomaly of viscosity, and in the report of Yu. K. Godovskii, G. L. Slonimskii, et al., who carried out microcalorimetric research on the effects accompanying orientation of polymers on drawing.

The extensive report by A. V. Lykov, Z. P. Shul'man, et al., which was devoted to research on the electrorheological effect, its possible mechanisms, and practical application attracted the attention of the participants of the symposium. In addition to discussion of the results of other authors, this report presented new interesting data from the authors' own experiments, in the form of curves of the flow of non-aqueous electroviscous dispersions which carry out a shear movement in static and alternating electrical fields with different concentrations of the solid phase and varying moisture content.

The report by S. G. Regirer on the rheology of blood aroused great interest; this report gave a survey of the present state of research in this field.

Altogether 60 reports were heard, the greater part of which were discussed in detail. The participation of the main group of leading Soviet scientists who took part in various aspects of rheology (G. V. Vinogradov, G. L. Slonimskii, A. A. Tager, S. Ya. Frenkel', and others) contributed greatly to the success of the symposium.

In the resolution adopted attention was paid to the desirability of holding an annual symposium, which would attract a wide circle of specialists participating in research on the rheological properties of polymers and also other abnormally viscous media.