

Society of

RHEOLOGY

A Report on the 1964 Meeting in Pittsburgh

By Stephen Prager

Over the past five years the membership of the Society of Rheology has held reasonably steady at around 650, and the attendance at the annual fall meeting has also remained approximately constant at about one-third of that number. In contrast to these figures, the number of papers presented has almost doubled. At the 35th Annual Meeting of the Society, which was held October 26-28, 1964, at the Mellon Institute in Pittsburgh, Pa., there were 62 papers on the program, necessitating double and evening sessions. As much as possible, the sessions were organized along topical lines: melt flow, thermodynamics and constitutive relations, dynamic viscosity, network polymers, viscosity-structure relations, hydrodynamics of viscoelastic flow, and experimental nonlinear viscoelastic flow. In addition, there were three sessions of general papers, plus a special one-day session on the physics and mechanics of random media.

While considerations of invariance under rotation of the coordinate frame do somewhat limit the nature of constitutive relations, such limitations still leave a great variety of relations which cannot be ruled out on grounds of symmetry alone. To narrow the field further, one promising approach has been the use of thermodynamic restrictions. The sessions on thermodynamics and constitutive relations dealt with a number of aspects of this problem, including the formulation of history-dependent thermodynamic functions in materials with memory (B. Bernstein, B. D. Coleman), as well as an experimental paper by L. J. Zapas in which Bernstein's theory was used to predict, for example, observed non-Newtonian behavior in simple shear from dynamic measurements at small deformations.

In the session on dynamic viscosity, A. V. Tobolsky reported on the viscoelastic properties of polystyrene fractions with very narrow molecular-weight distributions. Contrary to theoretical predictions,

he found that the ratio of maximum relaxation time to melt viscosity is independent of molecular weight, and suggested that chain entanglements might be responsible for the discrepancy. Entanglements came up again in the sessions on network polymers and on viscosity-structure relations: in the former, they were suggested as a possible source of the very slow relaxation processes observed by J. D. Ferry and coworkers in cross-linked rubbers, while in the latter the Bueche entanglement network concept received support from T. G. Fox's work on viscosity-molecular weight relations in a wide variety of polymer systems. Also of interest in the network-polymers session was a paper presented by R. F. Landel, who discussed the prediction of ultimate tensile elongation in rubbers from small strain-loss compliance data. In the session on hydrodynamics of viscoelastic flow, F. W. Boggs showed that the viscoelastic properties imparted to a fluid by the addition of a small amount of polymeric solute have important effects on the stability of boundary layers around submerged objects, which may explain why such solutes act to reduce fluid drag. W. R. Schowalter discussed the response of a linear viscoelastic fluid to time-dependent pressure gradients. A number of papers on the determination of normal stresses were presented at the session on experimental nonlinear viscoelastic flow, including one by K. Walters suggesting that the streamline patterns observed by injection of dye into the fluid about a rotating sphere should be useful for this purpose.

The session on random media presented six papers on the calculation of bulk properties in homogeneous media about whose detailed geometry one has only partial information of a statistical nature. Problems of this type arise in a great variety of fields, and this was reflected in the departmental affiliations of the speakers: mechanical engineering, petrophysics, electrical engineering, and physical chemistry. From a mathematical viewpoint, the basic question is how to deal with partial differential equations involving stochastic coef-

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J. M. Burgers of the University of Maryland, the 1964 Bingham medallist of the Society of Rheology, is shown at right as he addressed the members of the Society at its 35th annual meeting last October.



ficients or boundary conditions applied over random surfaces. Examples are Laplace's equation in the calculation of the dielectric constant for a random two-phase medium (W. E. Brown), the Navier-Stokes equation in the calculation of the viscosity increment produced by solid particles in a suspension (S. Prager), or the force-balance equation in the calculation of elastic coefficients for an inhomogeneous solid (Z. Hashin). Many, though by no means all, of these problems are of a rheological nature.

The opening paper by H. L. Frisch discussed the characterization of random geometries by correlation functions. The information contained in such statistical characterizations can be surprisingly detailed: for example, the number of interparticle contacts in a suspension of spheres may be obtained from a two-point correlation. The three papers by Brown, Hashin, and Prager all used variational methods to set bounds upon bulk properties of random media. This seems to be one of the more promising approaches when the point-to-point fluctuation in local properties is appreciable; the inequalities which result are rigorous, in spite of the fact that the geometry of the inhomogeneities has been only incompletely specified. When the fluctuations are small, they may be treated as perturbations, and this approach was presented by M. Beran. A rather different viewpoint was taken by A. E. Scheidegger in his discussion of viscous flow through porous media: instead of dealing with the geometry of the actual material, Scheidegger treats a fluid element moving through the pore system as a particle undergoing a random walk characterized by a certain mean-free-path length. Although one can in this way account for the lateral spread of a dye injected at some point into the entering fluid, the relation of the mean free path to the pore geometry remains obscure.

A social hour and a business meeting complemented the scientific part of the program. The high point of the former was the presentation of the Bingham Award to J. M. Burgers of the Uni-

versity of Maryland for his contributions to the theory of dislocations in connection with the plastic deformation of crystals. In his acceptance address, Professor Burgers suggested that the future of rheology may well lie in the direction of increased application to biological problems.

The main topic of the business meeting was the issue raised by the statistics cited at the beginning of this report: namely, should some attempt be made to cut the number of papers accepted for presentation at meetings of the Society, with a view to eliminating, or at least reducing, the need for parallel sessions? This cannot be done merely by employing more stringent quality criteria; over eighty percent of the papers submitted to the Program Committee for the Pittsburgh meeting were accepted for presentation. R. S. Marvin presented a proposal by the Executive Committee to limit the number of papers to about forty by organizing future programs around a set of four to six topical sessions of six papers each. The topics would vary from meeting to meeting, and would, of course, be announced well beforehand to allow time for prospective speakers to submit abstracts. A small number of papers falling outside the topical sessions would also be accepted. There was considerable opposition to this proposal from the floor, and a show of hands revealed that a majority of the approximately one-hundred members favored retention of duplicate sessions if required to accommodate all papers of acceptable quality.