DR. P. W. BRIDGMAN

1951 Bingham Medalist

Although Professor Bridgman's elegant experimental techniques are well known to all scientists, he is held in special regard by rheologists for his studies of the deformation of solids under extremely high stresses while surrounded by an environment of extremely high pressures. His work on the viscosity of liquids under very high pressure is likewise most notable.

Dr. Bridgman has been Hollis Professor of Mathematics and Natural Philosophy at Harvard since 1926. He was born in Cambridge, Mass. and received his A.B., A.M. and Ph.D. at Harvard where he has taught since 1904. He holds also honorary degrees from Stevens Institute and the Polytechnic Institute of Brooklyn. Dr. Bridgman is a member of many domestic and foreign scientific societies including the National Academy of Sciences. In 1942 he was president of the American Physical Society.

TO FORMER MEMBERS

A little over 21 years ago the Society of Rheology was formed as the result of the concerted interest by a group of scientists in the specialized field of plasticity and viscosity. Largely through the efforts of the late Professor E. C. Bingham, the Society developed rapidly and has enjoyed a healthy rate of growth. As with any organization of this type members of long standing and experience in the field have provided the guidance which has made this possible. It is evident that continued progress will be proportional to the quality of this guidance. The conclusion that a stable membership must be maintained is inescapable. For this reason it is regrettable that some of the Society's highly valued members have been lost. Whether this loss is greater or less than might normally be expected does not change its effect on the organization and activities of the Society. There is little doubt that the re-affiliation of these members would be of great value to the Society.

It seems that this might be a good time to re-examine just what is included with membership in the Society of Rheology. The tangible items are:

1. Membership in the American Institute of Physics.
    (The Society of Rheology is a founder member of A.I.P.)

PROGRAM — OCTOBER 24, 26, 27

Hotel Sherman—Chicago

9:00 A.M. WEDNESDAY, OCT. 24
JOINT SESSION WITH DIVISION OF SOLIDS, DIVISION OF HIGH POLYMER PHYSICS AND AMERICAN CRYSTALLOGRAPHIC ASSOCIATION

"Survey of the Theory of Lattice Imperfections," by J. S. Koehler, University of Illinois.

"X-ray Diffraction for Distorted Lattices," by B. E. Warren, Massachusetts Institute of Technology.

"Effects of Cold Work on the Residual Resistance of Metals," by R. R. Eggleston, D. B. Bowen and R. Kropschot, North American Aviation, Inc.

"Crystallographic Factors in Lattice Deformations," by R. Smoluchowski, Carnegie Institute of Technology.

"Role of Vacancies in Atomic Mobility," by A. S. Nowick, Yale University.

2:00 P.M. WEDNESDAY, OCT. 24
SYMPOSIUM ON INDUSTRIAL APPLICATIONS OF RHEOLOGY

APPLICATIONS OF RHEOLOGY TO THE DESIGN OF EXTRUSION EQUIPMENT: by R. M. Wiley, The Dow Chemical Company.

DR. E. K. FISCHER

The Society received sorrowful news in August when it learned of the death of Dr. E. K. Fischer. Dr. Fischer was one of our most loyal and enthusiastic members, and had just been nominated for the office of first vice-president of SR. He was an outstandingly capable secretary-treasurer from 1947 to 1949.

Dr. Fischer was mainly interested in colloidal dispersions and just last year had published an excellent book on the subject. He had also done excellent work in the textile field and at one time was Head of the Division of Physical Chemistry at the Institute of Textile Technology. He had also been employed by the United Color and Pigment Company and the Interchemical Corporation. He received his bachelor's degree at Southern California and his doctorate at Wisconsin. Dr. Fischer was a member of many scientific societies including the New York Academy of Scenices.

AIP BOARD MEETING
March 17, 1951

The Institute had a rather favorable balance sheet for the year 1950 ending with an excess of income over expense of some $19,000 as against an expected budget excess of about $2,000.

Dr. Hardy, Secretary of the Optical Society, criticized some Institute operating procedures. One of his criticisms concerns the Institute's accounting procedures and attendant costs. The Board decided to have a committee investigate Institute practices, said committee particularly to check into the cost of subscriptions to journals, etc. and said committee to be composed of the treasurers of the founding societies. Since our society does not have a publication, we are not concerned with this; therefore, Dr. Dienes will not be asked to serve on this subcommittee. However, it was further moved and carried that if this investigating committee saw fit, it could expand its investigation into other departments of the Institute, and if that is so decided, I presume that Dr. Dienes should also be called in to serve on the committee for such expanded investigation. This should give Dr. Dienes a chance to fly East at Institute expense sometime during the remainder of this year.

There was considerable discussion about the manpower—student—mobilization plans. It was thought that recent announcements indicated that a more liberal view would be taken by Washington in this important matter.

In discussing the status of "Physics Today," it was pointed out that its deficit was less than had been budgeted and further economies were hoped for in 1951. There was definite indication by Board members that the Institute of Physics should have one unifying informative publication of some kind and that if the present publication did not suit this purpose, then possibly it should be modified further. Many of the new members of the Board were going back over suggestions that had been discussed and sometimes tried in the past, so the writer suggested that the proper thing to do was to have a committee appointed to review the whole situation and make recommendations later. It was moved and carried that such a committee be appointed by the Executive Committee.

As you know, the Society's contribution was lowered from 15% to 13% of membership dues for 1950. It was hoped that a further reduction might be made for 1951. It is thought that a balanced budget may be met even with a lowering of 2% or 3% for 1951. However, some uncertainty comes into the financial status of the Institute for this year because of the 20th anniversary meeting.

Considerable expense will be incurred at this meeting, and of course, at this time it is not known how large the income may be. As you know, there will be exhibits at this meeting which should come close to meeting the expenses or perhaps even afford a surplus. It is thought that by September it will be known what the expense and income of the annual meeting will be approximately, and at that time it can be decided what the Society's contribution to AIP per member can be. Therefore, the Board approved a resolution empowering the Executive Committee to fix the Society's contribution at between 10% and 15% of membership dues at the required time, which if I remember correctly, is around September 1st.

W. F. Fair, Jr.

PROGRAM
Continued from page 1

The scientific study of the process extrusion of plastics has been almost completely neglected, due to the formidable difficulties of analyzing their complex behavior flowing through the various channels of an extruder. As a result, scientific literature on the subject is practically nonexistent, and extruders are frequently designed and operated without benefit of even elementary principles of rheology and heat transfer.

The purpose of the present discussion is to call attention to certain possible applications of known principles of rheology and heat transfer to the design of extrusion equipment. Following a general discussion of the nature of the problems, a few simple formulae are developed as a basis for determining the required dimensions of an extruder for a specified output.

THE FLOW BEHAVIOR OF SYNTHETIC LATTICES: by Samuel H. Maron, Case Institute of Technology

The purpose of this paper is to review the work done in this laboratory on the definition of the flow behavior of rubber lattices over wide range of concentration, and on the interpretation of the results obtained. In this connection will be discussed the question of "yield point," the use of several flow laws to interpret and correlate the observables, as well as the use of a new method for obtaining direcly the rate of shear-shearing stress curves of non-Newtonian systems from concentric cylinder data.

THE RHEOLOGY OF THIN POLYMERIC FILMS: by Rolf Buchdahl, Monsanto Chemical Company.

The importance of the rheological properties of polymeric systems used in the manufacturing of thin films is considered first with respect to the actual film formation during casting, extrusion or calendering. It is shown

TO FORMER MEMBERS

2. The "Rheology Issue" of the Journal of Colloid Science.
3. Subcription to the "Rheology Bulletin."
4. Reduced subscription rates to:
   a. Journal of Applied Physics
   b. Review of Scientific Instruments
   c. Journal of Colloid Science
   d. Physics To-day

If the value of the Society membership is placed on a monetary basis it doesn't take much arithmetic to show that the $4.00 annual dues are returned rather easily. Like the value of research activities, however, the greater benefits of Society affiliation are at any given moment difficult to measure. Much of the value is long range and as such has a way of becoming cumulative. Thus, members who stay with the Society not only are a greater asset to it but have more to gain from their membership.

As is the case for many organizations the responsibility for the administration and policies of the Society of Rheology is borne by a relatively small group. Since contact with the general membership is unfortunately nebulous—the annual business meeting has never been noted for its large attendance—the necessary decisions represent the best judgment of this small group. Under these conditions it would be indeed unusual if the administration met with popular acclaim from all the members. However, in many cases it is felt that dissatisfaction arises from misunderstanding or misinterpretation, usually because of incomplete information, of some of the actions taken. One of the primary purposes of this Rheology Bulletin is to explain, in as much detail as space permits, the decisions made at the annual meeting. This bulletin, which was reactivated two years ago, is sent to all members of the Society.

Basically there are three factors which determine the effectiveness and growth of a technical society.
1. An active and selectively expanding membership.
2. A publication.
3. A solid nucleus of experienced members.

Largely as a result of the efforts of the membership committee the strength of the Society is being gradually increased. Through the "Rheology Issue" of the Journal of Colloid Science and the Rheology Bulletin both the technical and general activities of the Society are brought to the membership; publication activities will be kept commensurate with the size and needs of the Society. The importance of a solid nucleus of experienced members cannot be over-emphasized for it is from these that the Society will draw its officers and policy making members. It is this phase of the growth program which will most measurably determine the future stature of the Society. The reaffiliation of former members will do much to improve the position of the organization in this respect.

PROGRAM

that the thickness uniformity and surface smoothness of a film depend to a large extent on flow characteristics. Secondly, the significance of the rheological properties in producing orientation, above the second order transition point, is discussed. The theory of photoelasticity of a rubberlike, amorphous polymer network is reviewed and it is shown that birefringence is the logical quantity to characterize the degree of orientation. The effect of stress, strain, temperature and molecular weight on birefringence is considered in detail for polystyrene and it is shown to what extent changes in orientation affect the resulting properties of thin films.

APPLYING RHEOLOGY TO THE STUDY OF LUBRICATING GREASES: by N. Marusow, Gulf Research and Development Company.

A discussion of the "behind the scenes" activity in the grease industry to improve methods for applying lubricating greases by using the principles developed through rheology.

A brief discussion of the instrument used for obtaining the necessary rheological constants and illustrations of results obtained is included. The effort made to correlate grease flow properties with practical applications is also discussed.

INDUSTRIAL RHEOLOGY IN THE PLASTICS INDUSTRY: by F. A. Carlson, Jr., and F. E. Reese, Plastics Division, Monsanto Chemical Company.

In general, viscosity and plasticity measurements made in the control laboratory are insufficient for plant process control. Laboratory viscometers and plastometers cannot be installed on process equipment without considerable modification. There has been a paucity of industrial viscometers and plastometers for use in plant process control. Experience in the design and application of such instruments has shown the more important considerations are: (1) speed of measurement; (2) easy cleaning; (3) reliability; (4) ease of operation.

Three examples drawn from plant experience will illustrate the problems of applying viscometers and plastometers to plant processes for control: (1) Plasticity measurement of a dough-like material containing volatile solvent. (2) End point control of a thermosetting resin in a kettle. (3) Process control of a thermoplastic resin.

5:05 P.M. WEDNESDAY, OCT. 24
BUSINESS MEETING
8:00 P.M. WEDNESDAY, OCT. 24
PRESENTATION OF BINGHAM MEDAL AND
SOCIAL EVENING
9:00 A.M. FRIDAY, OCT. 26
GENERAL SESSION

THE BAND VISCOMETER: by Harry H. Hull, R. R. Donnelly and Sons.

PROGRAM

A band viscometer has been constructed which is essentially a flexible band pulled between two parallel surfaces. The sample is between the band and the parallel surfaces and is sheared by the same force per unit area throughout.

With this instrument it is possible to study the consistency of substances at rates of shear from 100 to 10,000 reciprocal seconds. Materials in the range of 5 to 1,000 poises are most suitable for study.

Consistency curves of several inks and other materials will be shown.

A HIGH SHEAR METHOD OF RATING BRUSH-ABILITY OF PAINTS: by W. K. Asbeck, D. D. Laiderman and M. Van Loo, The Sherwin-Williams Company.

A simple rotational viscometer is described which operates in the range of high shear velocities encountered in the normal brushing of paints. Clearances in the order of 100 microns are maintained easily for paints. Considerably smaller clearances are feasible for materials in which all the particles are in the colloidal range. Where the annular space clearance is 100 microns, maximum shear velocities are in the order of 20,000 reciprocal seconds, while for smaller clearances substantially higher values are obtainable without excessive temperature rise. The instrument permits maintenance of accurate temperature control of the paint in the viscometer.

Good correlation of brushability of paints was found between qualified painter opinion and ratings based on viscosity characteristics. The viscosities of paints and their brushability are compared in the range from approximately 15,000 to 20,000 reciprocal seconds. Through measurement in the shear velocity range of brush application, a one point method of rating the brushability of paints is feasible.

RESIDUAL STRESSES AND STRAINS IN MOLDED PLASTICS: by W. H. Markwood, Jr. and H. M. Spurlin, Hercules Powder Company.

This discussion is primarily aimed at illustrations of the molding behavior of eithyl cellulose, for which little fundamental information has been reported. The purpose is to present some of the reasons why this tough, resilient polymer behaves as it does and why some difficulties have arisen when it has been injection molded. The flow of cellulosics can be described rather simply by a phenomenologically observable superposition principle. Ethyl cellulose and cellulose acetate differ markedly in their response to molding temperatures, ethyl cellulose tending to be more rubber-like in the influence of temperature on elastic response. Their flow is influenced by internal chemical structure and when molded they exhibit local frozen in stresses that, on reheating, produce different degrees of relaxation in different parts of the moldings.

DUE YOU?

FLOW CHARACTERISTICS OF DILUTE SOLUTIONS OF RIGID ROD-LIKE MOLECULES: by J. H. Wakelin, Textile Research Institute.

The fluid mechanical forces acting upon an assembly of rigid rod-like molecules in dilute solution have been examined for the case of flow in a cylindrical tube. The force per unit volume resulting from the drag of these molecules on the solution has been calculated in terms of the average length of the molecules, their concentration, and the driving pressure, assuming that the flow profile for the unperturbed Newtonian solution may be used as an initial condition. At a given concentration the volume rate of flow of the solution of rod-like molecules is found to behave as a Newtonian system at low and at very high driving pressures. At intermediate pressures the solution exhibits non-Newtonian flow characteristics, the extent of which depends upon the cube of the length of the solute molecules and on their concentration.

IMPLICATIONS OF PHILIPOFF FLOW CURVES FOR THE DETERMINATION OF INTRINSIC VISCOSITY OF HIGH POLYMER NITROCELLULOSE: by Carl M. Conrad and Hilda M. Ziifle, Southern Regional Research Laboratory.

In an attempt to account for differences observed in different laboratories in the behavior relating the slopes of logarithmic flow curves to concentration and of reduced viscosity counterport to concentration, the rather extensive range of measurements published by Philippoff and Hess on solutions of cellulose nitrate in butyl acetate were studied. It was found that the slopes of the flow curves increase from 1 at low shearing stresses to a maximum and then recede to approximately 1 again at high shearing stresses. It was shown that the displacement of modes gives rise to a wide variety of curvilinear configurations for functions which depend on the values of the slopes of the flow curves.

It was found that the intrinsic viscosities varied, depending on the rate of shear existing during measurement, as well as for the conditions where the shearing stress is held constant for different concentrations.

2:00 P.M. FRIDAY, OCT. 26
GENERAL SESSION

THE FLOW OF POLYSTYRENE THROUGH RECTANGULAR CHANNELS: by C. E. Beyer, F. E. Towsley, The Dow Chemical Company.

The non-Newtonian flow of polystyrene through channels of constant rectangular cross-section having various

MINUTES
BUSINESS MEETING OF
THE SOCIETY OF RHEOLOGY
November 3, 1950

The meeting was called to order by President Traxler at 4:15 P.M.

Minutes of the 1949 business meeting were read and approved by vote.

The Secretary-Treasurer submitted his interim report. The financial condition of the Society was reported as of October 15, 1950, and the tentative budget for 1951 submitted. A brief summary is given below.

(Ed. Note: Interim report deleted. See final report elsewhere.)

The Society operated well within its income and budget. Income and expenses for the rest of 1950 are expected to be approximately equal. Full financial report will be made at the end of the year.

Tentative Budget for 1951

Estimated cash at end of 1950		$1,320
Estimated income in 1951		1,550
Total cash		$2,870
Estimated expenses:		
AIP assessments	$290	
Academic Press	770	
Meeting expenses	50	
Printing, mailing and Sec'y's expenses..	200	
Rheology Bulletin	180	
Total	$1,490	$1,490
Balance		$1,380
Expected surplus		$ 60

It was moved and carried that the Secretary-Treasurer's interim report be accepted and filed.

Important items considered at the Executive Committee Meeting were reviewed at the business meeting (full details are given in the minutes of the Executive Committee meeting.) A brief summary is given here.

The Secretary outlines the plans for the 1951 AIP Anniversary Meeting in Chicago. The activities of the West Coast Section were briefly reviewed and attention was called to the fine program assembed by Dr. Bondi for the December 1, 1950, meeting in Berkeley, California.

The Editor reported on the Rheology Bulletin and general publication policy. Some discussion resulted as to the desirability of publishing rheological abstracts. It was generally felt that the members are in favor of the present Bulletin and that an abstract journal is financially prohibitive as well as perhaps unnecessary because of adequate coverage by existing journals.

Dr. Barton outlined the status of Physics Today and expressed AIP's appreciation to the Society for its past support given to this journal during its formative years. In 1951 Physics Today will be handled on an individual subscription basis at a charge of $3.50 per year to members.

Mr. Dexter reported on the activities of the Membership Committee and its plans for the coming year. The Committee and its Chairman were commended for a successful campaign.

Dr. Fischer reviewed briefly the general publicity activities. Further progress is expected in this field during the coming year.

Total registration at the 1950 Meeting was 78. Nine new members joined the Society during the registration.

It was suggested from the floor (Dr. Buchdahl) that the Society's meetings have become too specialized and that papers on the program should cover a wider field of materials and industries. Dr. Traxler answered that this is precisely the feeling of the Executive Committee and that the Chairmen of the 1951 Program Committee have been asked to plan their program accordingly. Further, it is hoped that the 1951 meeting will afford valuable contacts with men in fields and industries not adequately represented at the present time (see also minutes of the Ex. Com.)

It was moved and carried that the above reports be accepted and filed.

The meeting adjourned at 5:05 P.M.

G. J. DIENES, Secretary-Treasurer

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1951 COMMITTEES
REPRESENTATIVES

AAAS—REPRESENTATIVE: Earl K. Fischer

REPRESENTATIVE ON GOVERNING BOARD OF AMERICAN INSTITUTE OF PHYSICS: W. F. Fair, Jr.

NATIONAL ASSOCIATION OF CORROSION ENGINEERS—INTER-SOCIETY COMMITTEE ON CORROSION: W. F. Fair, Jr.

AMERICAN INSTITUTE OF PHYSICS COMMITTEE FOR 1951 MEETING IN CHICAGO: W. R. Willets, Harry H. Hull (Chicago representative)

PROXIES TO REPRESENT THE SOCIETY OF RHEOLOGY AT ANNUAL MEETING OF THE INSTITUTE OF PHYSICS: H. F. Wakefield, W. R. Willets

REPRESENTATIVE AT 75th ANNIVERSARY OF THE AMERICAN CHEMICAL SOCIETY. SEPTEMBER, 1951: W. F. Fair, Jr.

COMMITTEES

NOMINATING: J. H. Elliott, Chairman; J. D. Ferry, R. N. Weltman

BINGHAM MEDAL AWARD COMMITTEE: Paul Doty, Chairman; Charles Mack, Bruce B. Farrington, M. A. Lauffer, W. H. Markwood, Jr.

PROGRAM COMMITTEE: General Sessions—J. H. Elliott, Chairman; H. H. Hull, Earl K. Fischer. Symposium on Industrial Applications of Rheology—R. S. Spencer, Chairman. Joint Meeting with Solid State Group of the Physical Society—T. Alfrey, Jr., Chairman.

MEMBERSHIP: F. D. Dexter, Chairman

PUBLICITY: Earl K. Fischer

FINANCIAL STATEMENT FOR 1950

GENERAL FUNDS

Cash on hand, January 1, 1950 . . . .$1,727.75
1949 appropriations disbursed in 1950:
18 extra pages for 1950 Rheology Issue of
  J. Coll. Science . . . . $ 180.00
Group subscription to Physics Today 438.00

    Total . . . . $ 618.00
Balance on Jan. 1, 1950 . . . . 1,109.75
Income in 1950
Dues (including 4th quarter of 1949
  and excluding 4th quarter of 1950) . 1,494.50
Bulletin, back number sales 16.19

    Total $1,510.69 1,510.69

    Total cash resources $2,620.44

Disbursements
AIP Assessments for 1950 (15%) 210.32
AIP member service charge (at 20¢) . . 60.00
Academic Press, Rheology Issue 688.35
Printing and Mimeographing 203.95
Mailing Services 17.96
Secretary's expenses (misc.) 36.38
Rheology Bulletin, 2 issues, printing
  and mailing 144.85
Meeting expenses, New York 3.51
Meeting expenses, West Coast
  (1949 and 1950) 33.66
Bingham Medal engraving 6.00

    Total Disbursements $1,404.98 1,404.98

    Balance $1,215.46
Operating Surplus for 1950: $105.71

SPECIAL FUNDS

Bingham Fund
  U. S. Govt. Series G. Bonds . . . .$ 700.00
  Interest on bonds (deposited in savings acct.) 17.50
  Balance on savings account 47.00
  Interest on savings account 1.13

    Total in fund . . . .$ 765.63
Rheological Memoirs Fund
  Balance on hand, Jan. 1, 1950 . . . .$ 59.00
  Sale of surplus copies 36.75

    Total . . . .$ 95.75
Disbursements:
  Advertising expenses . . . .$ 20.80
  Express charges for
    transferring stock 15.76

    Total disbursements . . . .$ 36.56 36.56

    Total in Fund . . . .$ 59.19

REMARKS:

The Society operated well within its income and budget.

The Bingham Fund showed its normal growth and requires no further comment.

With respect to the Rheological Memoirs Fund, advertising in Chemical and Engineering News and Special Libraries has been tried as sales were very slow. This had considerable effect. Notices in the Rheology Bulletin are very helpful.

G. J. DIENES, Secretary-Treasurer

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PROGRAM

breadth-to-width ratios is described in terms of the apparent fluidity function $\frac{R(kS)}{V_0}$ of Spencer and Dillon. V_0 is the zero-shear stress viscosity, k is a material constant, and S is the shear stress at the channel wall. R is the ratio of actual flow rate to Newtonian flow rate. The data and analysis indicate that flow rates in simple shear; between parallel infinite planes; and in dies of circular and rectangular cross-section may all be represented closely by a single apparent fluidity function, if the argument kS is replaced by an argument K_2 k Sw, where K_2 is a dimensionless form factor depending on the channel shape, and Sw is the average shear stress at the wall.

HIGH SHEAR RATE ROTATIONAL VISCOMETER: by E. M. Barber, J. R. Muenger and F. J. Villforth, Jr.; The Texas Company

The object of this work was to design and construct a rotational type of viscometer employing a sleeve type bearing as the test element.

Heating of the oil film leads to one of the major uncertainties in determining viscosity at high shear rates. Temperature gradient in the lubricant film at a given shear rate is proportionated to the square of the film thickness. Advantage of obtaining high shear rates by thin films discussed. Reduction of film temperature gradient by heat removal from the film in both directions discussed.

Calibration runs with Newtonian fluids with film thicknesses of 0.0005, 0.0002, and 0.0001 inches radial clearance. Typical evaluations of non-Newtonian fluid viscosity with shear rate and temperature.

ON THE KINETICS OF ANOMALOUS FLOW: by Charles Mack, Research Department, Imperial Oil Limited.

Anomalous viscosity is determined by the tangent to a point of the stress-shear rate curve. The tangent intersects the stress co-ordinate dividing it into two parts.

Multiplying the stress applied and its parts by a volume, such as the volume of flow, leads to a relationship obeying the second law of thermodynamics, i.e., the change in energy of the system brought about by the applied stress is equal to the sum of the work done under the influence of the effective stress and the product of absolute temperature and entropy change.

Based on this kinetic concept, equations are given expressing anomalous viscosity as a function of the energies involved. For systems where the shear-rate is a power function of the stress, the anomalous viscosity is an entropy effect. For systems where the shear rate is an exponential function of the stress, the anomalous viscosity is a function of the energy change under the influence of stress. Experimental data are presented for two asphalts which conform to the systems described above.

THE RHEOLOGY OF BLOOD: by Alfred Lewin Copley, New York University College of Medicine.

Rheologically, the most interesting feature of blood is one of its important physiologic functions which is circulating through an intricate system of extremely different blood vessels. Whole blood does not conform to the Newtonian equation, while plasma and plasma proteins have been observed to, under certain conditions. Poiseuille made observations of blood circulation in capillary beds which led him to investigate the underlying properties of flow through rigid capillaries. He did not appear to realize that the formulation of new concepts would be needed to explain the anomalous flow properties of blood. As a result, numerous studies on blood viscosity, which appeared subsequently in the literature, are no longer adequate in view of the development of modern rheology.

This review of the rheology of blood must also deal with the rheological and other physical properties of the vessels through which blood flows. A wide range of different vessel wall changes, both active and passive, contributes to the complexity of blood rheology. This complexity is augmented by the physiologic functions of various organs which alter the composition of blood constituents, hemodynamic pressures, caliber of blood vessels, permeability and other physical properties of the vessel wall.

A GENERALIZED FLUIDITY POWER LAW AND LAWS OF EXTRUSION: by M. Mooney and S. A. Black, United States Rubber Co.

Raw rubbers are assumed to obey the fluidity power law. On these assumptions laws of extrusion are derived for circular and slit tubes and orifices. Also by dimensional analysis a general theorem is established concerning the effects of stress (or pressure) and apparatus dimension on deformation and flow rates. Experimental data, obtained with circular tubes of various lengths and diameters, verify the power form of the derived extrusion laws, but do not give the expected values of the exponent n in some cases. Surface slip, included in the theory, was too small to measure in the present experiments.

9:00 A.M. SATURDAY, OCT. 27

GENERAL SESSION

VISCOSITY OF GLASS: by Webster Capps, National Bureau of Standards.

A literature survey of the viscosity of glass is presented. Methods are briefly discussed for measuring the viscosity from about 10^2 to 10^{15} poises at temperatures up to 1400°C. Viscosity data of some of the authors are related to the structure of glass and to the size of the flow units. Some attempts which were made to extend the kinetic theory of gases and solid state theories to the liquid state are outlined.

A more specific discussion of binary alkali silicates follows. If they are compared on a mol-per cent basis, the viscosity at high temperatures increases with increasing size of the alkali ion. At low temperatures, for certain concentrations the viscosity decreases with increasing alkali ion size or decreases as the alkal-oxygen binding forces decrease. If concentration is expressed in terms of mols of alkali per unit volume of glass, the high temperature viscosity is independent of the kind of alkali ion.

VISCOSITY BREAKDOWN AS A FUNCTION OF SHEAR TEMPERATURE IN A ROTATIONAL VISCOMETER: by R. N. Weltmann and P. W. Kuhns, N.A.-C.A. Lewis Flight Propulsion Laboratory.

A method is described which permits determination of the approximate temperature distribution over the cross-sectional area of a Newtonian material which is subjected to shearing forces in a rotational viscometer. By correlating the change of viscosity to temperature increases, and by determining the actual viscosity value as found in the rotational viscometer, the effect of thixotropy can be studied.

Temperature calculations with regard to an Oronite polybutylene oil and a silicone fluid have been made. It appears that in some instances where previously the presence of thixotropy was suspected, temperature increases might be largely responsible for viscosity breakdown. In other instances thixotropic behavior must still be postulated to explain the experimental results.

THE RHEOLOGY OF A LUBRICATING OIL AT TEMPERATURES BELOW THE POUR POINT: by S. P. Jones and J. K. Tyson, Armour Research Foundation, Illinois Institute of Technology.

A rotational viscometer has been applied to the study of a lubricating oil, Pennsylvania 150 neutral, at —25°C.

PROGRAM

and —30°C., temperatures well below the pour point, —15°C. Thixotropy was studied by measuring, at various constant rates of shear, the change in shearing stress with time, which is represented approximately by an equation of two exponential terms.

The relaxation times decrease with increasing rates of shear, the latter becoming very small at high rates of shear and thus not measurable experimentally. The character of flow is Newtonian for times short compared to relaxation time, with a characteristic equilibrium viscosity for a given rate of shear. This behavior, a combination of a reversible and an irreversible process such that a part of the decrease in viscosity is temporary and a part permanent within the time scale of the experiment, is attributed to temperature effects and breakdown of the wax structure, respectively.

These views are supported by calculations of the form and magnitude of temperature effects due to generated heat and by comparisons with the behavior of wax-oil suspensions at room temperature.

CONSTANT-STRESS ELONGATION OF SOFT POLYMERS—TIME AND TEMPERATURE STUDIES: by C. A. Dahlquist and M. R. Hatfield, Minnesota Mining and Manufacturing Company.

The constant-stress method recently described by Dahlquist, et al., is well-suited for the study of the time and temperature dependence of viscoelastic properties. Creep data are given for polyisobutylene and GR-S in the time range of 0.01 to 10 minutes and the temperature range of 40° to —50°C. The data were transferred into master curves of log reduced modulus vs. log reduced time.

The polyisobutylene data superposed satisfactorily using either (1) a time reduction method based on a constant apparent activation energy for elastic deformation, or (2) a time reduction method based on melt viscosities. In contrast to polyisobutylene, GR-S showed a considerable variation in activation energy with modulus. As yet the concept of a modulus dependent activation energy must be considered of doubtful theoretical significance.

SIZE DETERMINATIONS OF CLAY PARTICLES IN WATER SUSPENSIONS BY USE OF LOW ANGLE X-RAY DIFFRACTION: by William J. West, California Research Corporation.

Low angle X-ray diffraction permits studies of sizes of clay particles as they exist in clay-water suspensions. Change in the state of the suspension can be made and sizes of the particles can be determined again as they exist in the new state. Particle size determinations by other methods do not share this advantage. Particle size determinations on clays used as drilling luids in the petroleum industry showed: (1) the size of hydrated clay particles in water suspension was larger than the size of the particles in the original dry powdered clay. This observation contradicts the common belief that highly swelling clays are more finely divided in a water suspension than are poorly swelling clays; (2) sizes of the hydrated particles in water suspensions were independent of dilution for concentrations less than 8%. (3) Viscosity lowering by agents such as tetrasodium pyrophosphate involved size reduction of hydrated particles.

POISEUILLE'S MEMOIRS

A stock of copies of "Poiseuille's Memoirs" which formed the first and only issue of "Rheological Memoirs" was found in storage at Lafayette College after Dr. Bingham's death and was shipped to the Secretary by Dr. J. H. Wilson, head of the Lafayette Chemistry Department. This volume is a translation of the classic Experimental Investigations Upon the Flow of Liquids in Tubes of Very Small Diameter. The translation, by Winslow H. Herschel, has been annotated with critical notes by Professor Bingham. This book of 101 pages is a collector's item and is available to members of the Society at the following prices:

cloth bound $2.00
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Those who wish to purchase copies are requested to send orders with remittance to the Secretary,

> Dr. G. J. Dienes
> North American Aviation, Inc.
> P. O. Box 309
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Proceeds from the sale will be retained in a separate fund for publication of other classic papers; possibly Couette's article on the rotational viscometer would be an appropriate successor (Ann. d. chimie, 21 No. 6, pp. 433-510, 1890).