THE
RHEOLOGY
LEAFLET

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SOCIETY OF RHEOLOGY

No. 13   May, 1940

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The October 1940 Meeting

The next Annual Meeting of The Society of Rheology will be held in the lecture room of the New York Academy of Science, New York, New York, October 18 and 19. Professor Richard B. Dow, Chairman of the Program Committee reports that a full program of unusual interest has been arranged. A large attendance is expected. It is not too early to start to plan your work so that you can be sure to attend. The details of the program will be included in our next issue.

REPORT OF THE RHEOLOGY PROGRESS COMMITTEE
High Pressure Work

The measurement of high hydrostatic pressures is the subject of two recent papers by Vereshagin and Alexandrov (1) of the Physico-Technical Institute of Charuov, Ukraine, U.S.S.R. Their technique is similar to Bridgman's (2) and little original is to be found in the papers. The first paper discusses a free-piston type of manometer for a pressure range of 10,000 Kg/cm^2. The clever use of an optical system to measure the deflection of a steel beam under the force exerted by the piston of a hydraulic ram is their chief contribution to the measurement of pressure. Bending of the beam is produced at its center with both ends supported, and the dimensions of the apparatus are so chosen that the deformation is elastic. The method of Secksmith (3) for measuring small deflections optically consists of mounting a steel ring vertically so that as it is compressed, the distortion can be measured by the angular displacement of a ray of light that is reflected from two mirrors so placed within the inner circumference of the ring that the angular deflection will be a maximum for a given radial displacement of the ring. Using this method the authors state that they can measure to ±0.01 mm. a deflection of 0.158 mm. per 1000 Kg/cm^2. The manometer is not an absolute one, the calibration being obtained by observing the melting pressure of mercury at 0° C (7640 Kg/cm^2). The second paper is on the use of an electrical manometer for the same pressure range. The change of resistance of manganin with pressure is known to be linear, and the authors have adopted this standard method of measuring pressure. The details of design, and precision obtained are comparable with those of other investigators. There is nothing new to report from this second paper.

R. B. Dow, The Pa. State College

(1) L. F. Vereshagin and B. S. Alexandrov, J. tech. Physics U. S. S. R. 9, 348, 1939; 9, 843, 1939 (in Russian)

(2) P. W. Bridgman, The Physics of High Pressure, MacMillan, New York, 1931.

(3) W. Secksmith, Phil. Mag. 8, 158, 1929.

RUBBER

Tensile Properties of Rubber Compounds at High Rates of Stretch. F. L. Roth and W. L. Holt, Bureau of Standards, J. of Research, 23, 603 (1939). A falling weight apparatus with a tuning fork recording device was used to measure the modulus and tensile strength at rupture with ring specimens. Stretching rates as high as 1700 per cent elongation per second were obtained. The high speed stress-strain curves obtained with four compounds were compared with those obtained at normal testing speeds of 8 to 10 per cent per second. In all cases, the high speed curves were found nearly to coincide with the low speed curves at the higher elongations. At lower elongations, the high speed curves lay slightly above the low speed curves.

Application of the Interferometer to the Measurement of Dimensional Changes in Rubber. L. A. Wood, N. Bekkedahl and C. G. Peters, Bureau of Standards, J. of Research, 23, 571 (1939). The change in linear dimensions of a small rubber sample was measured as a function of temperature by means of an interferometer. Very accurate measurements made possible by this method revealed that a second order change in slope of the thermal expansion curve for a sample of frozen rubber exists at about -68°C.

Composite Nature of the Stress-Strain Curve of Rubber. Ira Williams and B. M. Sturgis, Ind. Eng. Chem., 31, 1303 (1939), Rubber Chem. and Tech., 13, 74 (1940). The stress-strain data discussed in this paper were obtained with an ingenious tensile machine of the "Controlled loading rate" type. The driving motor formed part of the balanced loading arm. If the authors apparatus sketch is taken literally, the loading rate was not constant over the whole range of elongations but was the same for all tests.

The stress-strain data apparently were all obtained after 4 or 5 cycles of high elongation, thus approaching quasi-equilibrium conditions, i. e. with negligible permanent elongation after subsequent cycles. A "pure gum" compound was used in all experiments discussed. The form of the extension-retraction cycle was studied as a function of elongation. It was found that the curve was essentially reversible for elongations less than 350 per cent at 25°C. The second section of the curve (350 to 510 per cent) was found to be irreversible. However, the region of rapidly increasing stress (510-590 per cent) was found to be accurately reversible. This latter fact has not been generally recognized by rubber technologists. Curves obtained at 100°C. showed the first transition point to have increased to 600 per cent as against 350 per cent at 25°C.

It is stated that "rubber offers increasing resistance to flow as the temperature is increased" which is hardly in accord with experiment. This careless statement, combined with a rather indefinite description of apparatus and testing conditions, is unfortunate but only slightly mars a very excellent piece of work which should result in further valuable studies of this type over wide ranges of loading rates, temperatures, etc.

The Physics of Rubber I. Its Observed Elastic and Thermoelastic Behavior. E. Guth, J. App. Phys. 10, 161 (1939). This is a review of some of the physical properties of rubber. The nature of the stress-strain curve, values of Poisson's ratio, and themoelastic effects are discussed. The author concludes that the stress decreases linearly with increasing temperature for raw or vulcanized high gum rubber under isothermal conditions.

A Mechanical Oscillograph for Routine Tests of Rubber and Rubber-Like Materials., F. L. Yertzley, Rubber Chem. and Tech. 13, 149 (1940). Results with this instrument have been described in previous papers. It is essentially a compound pendulum which compresses a small rubber sample. The transient oscillations are recorded on a moving chart. The various properties measureable with the instrument are discussed and its constants are computed. The instrument appears to be very well designed for testing both vibration damper and tire compounds. It suffers from the same disadvantage possessed by all transient vibration instruments in that it does not operate with the rubber in equilibrium. This disadvantage is probably not serious in most cases.

Tentative Procedures for Testing the Variability of Normal and Concentrated Latex. Crude Rubber Committee, Division of Rubber Chemistry, American Chemical Society. Ind. Eng. Chem., 11, 593 (1939), Rubber Chem. and Tech., 13, 136 (1930). Various measurements with latex are discussed in this report. In regard to the measurement of viscosity, the coni-cylindrical viscometer of Mooney and Ewart is recommended. However, the capillary flow method is dealt with in more detail. It is recommended that both the limiting coefficient of viscosity and yield value be determined.

Relations between Vulcanization and Reinforcement. C. R. Park, Ind. Eng. Chem., 31, 1402 (1939), Rubber Chem. and Tech., 13, 103 (1940). The work described in this paper was chiefly concerned with investigations of the theory that, during the course of vulcanization rubber-sulfur complexes are formed uniformly throughout the rubber

mix and that these units give the same effects in the rubber as result from fine powders. Rubber stocks were mixed with various loadings of channel gas black but no other pigments for comparison with a rubber-sulfur mix with various degrees of cure. Tensile strength, modulus, elongation, plastic flow, and rebound curves were obtained for this comparison. The role of zinc oxide in vulcanization was also investigated. From these data, it was concluded that the rubber-sulfur complex theory is not correct but that the changes which result from the introduction of finely divided powder may be due to oxidation of the rubber hydrocarbon.

Rubber Stretched by Forces in Two Directions Perpendicular to One Another. R. Ariano, Gomma, 3, 31 (1939). Rubber Chem. and Tech., 13, 92 (1940). Cured cross-shaped rubber strips were stretched in mutually perpendicular coplanar directions with various elongations by means of dead weight loads. Stress-strain curves were obtained by two methods, namely, (1) variation of one load T_2 with its coplanar perpendicular load T_1 held constant, and (2) simultaneous variation of the coplanar perpendicular loads. Curves obtained by method (1) were found to be essentially parallel with the exception of the curve where $T_1 = 0$. This parallelism was found to be consistent with Ariano's well known empirical equation for the stress-strain curve. On the other hand, the analysis became very complex when applied to curves obtained by method (2). Since this analysis involved a combination of the empirical equation for large deformation with classical expressions assuming small linear deformations, its fundamental value is questionable even for the simpler cases.

The Resistance of Rubber to Dynamic Forces. R. Ariano. Gomma, 3, 97 (1939). Rubber Chem. and Tech. 13, 81 (1940). The difference between the energy of elongation for impact loads and that for statically applied loads was measured with both ring and dumbell samples by means of a falling weight apparatus. It was found that the energy of elongation was always greater for impact loads than for static loads. The author's statement that this result is at variance with results obtained by certain other authors appears questionable.

Colloidal Structure of Rubber in Solution. S. D. Gehman and J. E. Field, Ind. Eng. Chem., 32, 282 (1940). Colloidal changes in solutions of purified rubber were followed by means of measurements of the depolarization intensity of the transversely scattered light and by viscosity measurements. A study was made of the time required for vulcanization of benzene solutions of rubber. The light scattering results were interpreted as showing that, upon the addition of the

5.

vulcanizing agents to the solutions, the colloidal units became larger. The decrease in viscosity was explained as being due to a diminished "interlocking" of the units.

<div align="right">J. H. Dillon</div>

BITUMINOUS MATERIALS

In a recent article (1), comment was made upon the work of Thelen (2), Rhodes and Volkmann (3), and Traxler and Moffet (4), on the proposed use of the penetrometer to estimate the viscosities and yield values of bituminous materials. Another interesting contribution to this method of investigation has been made by Mack (5) who uses the successive penetration procedure to obtain data from which a constant "c" may be evaluated. Mack reports that this constant seems to be about .54 for viscous asphalts, and to vary for different plastic asphalts, the variation in "c" being indicative of the degree of plasticity; also it is claimed that from values of "c" information concerning thixotropy, elasticity, and temperature susceptibility may be estimated. The author also states that most paving asphalts, even if plastic in nature, have no yield values irrespective of their flow properties, which may be questioned by some asphalt technologists.

The suggestions made in this paper should be of considerable interest to investigators in this field and efforts taken to study further these relations should be well worthwhile, although the writer feels that many more types of bituminous materials, the properties of which have been established by other methods, should be examined to substantiate or modify the proposed relations and conclusions.

Of importance to research workers in this field is a recent article by Broome (6), who describes and discusses various methods and instruments used to study the flow properties of bituminous materials. He points out that customary routine consistency tests are inadequate in that they give little or no information as to the properties of road bitumens at service temperatures. Furthermore, since few bitumens are true fluids, it is difficult to compare results in absolute units or to extrapolate consistency-temperature curves to obtain information at lower (service) temperatures. Therefore, this author claims, attempts should be made to determine the deviations from true fluid flow so as to be able to estimate the "degree of plasticity" of the bitumen.

In addition to discussion of methods mentioned previously (1), Broome also points out that the Frankland Taylor twisting point apparatus may be adapted for use as an absolute viscometer, and there-

fore furnishes a means of estimating the degree of plasticity from the equation:

$$\text{Degree of Plasticity} \quad \frac{(V\text{obs.} - V\text{calc.})}{V\text{obs.}} \times 100$$

Where Vobs is the viscosity observed by means of the modified twisting point viscometer, and V calc. is the viscosity estimated from penetration data by the Saal-Koens relation; which Broome gives as:

$$V = \frac{5.13 \times 10^{6}}{(\text{penetration})\ 1.93}$$

which presumably is a misprint since the denominator in this equation was given by Saal and Koens (7) as the (penetration) raised to the power 1.93, rather than as written above. The writer also feels that at low penetrations the estimation of viscosity by this method may not have the accuracy desired, and may result in misleading observations concerning the "degree of plasticity" of the material under investigation at relatively low temperatures. A more serious criticism is that V obs. will not be the true "viscosity" if the material really is plastic, but merely an apparent viscosity, the value of which will depend upon the shearing stress used in the determination; and thus the proposed criterion becomes valueless. Complete rheological data obtained by some of the other better methods which Broome describes would be of far greater value. The other methods described are the falling sphere viscometer, suitable only for relatively low viscosities, and presenting difficulties with opaque materials, unless electrical or X-ray devices are used for timing, rather than visual observation; the rotating cylinder viscometer, which may be used over a wide range of consistencies and stresses; and the falling co-axial cylinder viscometer, previously discussed (1). By means of the last two instruments the determination of viscosities under different applied stresses at different service temperatures could be studied, and the writer believes that the resulting information should be of great interest and importance to all concerned with the production and utilization of bituminous materials.

Broome also presents typical shearing stress-rate of shear curves to show the different kinds of flow diagrams which may be encountered in bitumen research, and he also critically discusses various viscosity-temperature indices which have been previously suggested.

In this connection it would seem that the use of any index might be misleading if the bituminous material in question exhibited non-

viscous flow at the lower temperature; the resulting calculated index, dependent upon some function of two viscosities at two different temperatures, could have a wide range of values depending upon the apparent viscosity observed. If, however, the viscosities be determined at different stresses, and found to be constant, independent of the stress applied, a susceptibility index concept may be used to advantage, but should only be applied over the temperature range where viscous flow is known to be exhibited. Below this range only complete rheological diagrams can give an adequate basis of comparison of the bituminous materials being studied.

In connection with the suggested use of the falling sphere above, the comments of Williams and Fulmer (8) are pertinent. They review and discuss various methods and equations for determining yield values, and conclude that yield values may be found by means of the falling sphere viscometer. Experimentally this is done by measuring the velocity of fall (V) of spheres of identical radii, but of different densities in cylinders of identical radius. The values of V so determined are then plotted against the corresponding values of (d_2-d), and the resulting graph is then extrapolated to zero velocity. The value of the intercept thus determined may be converted into yield value by means of the equation given. This method, if applied to bituminous materials at successively lowered temperatures, might be of aid in learning at what temperatures incipient yield values might be found, and in establishing differences between materials exhibiting non-viscous flow.

W. F. Fair, Jr.

REFERENCES

(1) Rheology Leaflet No. 11, 19 (Nov. 1939).
(2) J. App. Phys. 8, 135 (1937)
(3) J. App. Phys. 8, 492 (1937)
(4) Ind. Eng. Chem., Anal. Ed. 10, 188 (1938)
(5) J. Soc. Chem. Ind. 58, No. 10, 306 (1939)
(6) J. Inst. Petroleum 25, 509-30 (1939).
(7) J. Inst. Petroleum Tech. 33, 176 (1933).
(8) J. App. Phys. 9, 760 (1938)

PLASTICS

Investigations of the Strength of "Organic Glasses". I. Ernst Rexer. Z. tech. Physik 20, 97-102 (1939). Polyesters and "plexiglas" were broken under tension and a study was made of the characteristic ruptures.

Viscometric and Osmometric Measurements on Nitrocelluloses. Kurt H. Meyer and E. Wolff. Kolloid-Z. 89, 194-201 (1939). A study of the relationships between specific viscosity, limiting viscosity and relative viscosity of nitrocellulose in acetone and cyclohexane.

Theory of Viscous Flow Reactions for Chain-like Molecular Substances. F. Eirich and R. Simha. J. Chem. Phys 7, 116-121 (1939). The investigation of Ewell and Eyring on the relation of the coefficient of internal friction as a reciprocal reaction rate is extended to new data covering a homologous series of esters. An attempt is made to correlate the variation of the activation heats of the flow process with temperature, molecular weight and constitution.

Double Refraction and Change in Length of Certain Plastics. H. W. Farwell J. App. Phys. 10, 109-113 (1939). A plasticized Vinylite resin is stretched under constant load and then allowed to recover. The birefringence was noted during stretch and subsequent retraction. The behavior is similar to stretched vulcanized rubber. The Vinylite resin, like rubber, is raised in temperature by stretching and when under constant load shortens when heated.

A note on the Elastic Properties of Vinyl Sheeting. S. Bateson, J. App. Phys. 10, 887-89 (1939). The elastic properties of plasticized vinyl acetal resin are studied. Curves are given for stretch and recovery at constant loading. Pronounced creep is noted but the speciments exhibited complete recovery. There is a lag between elongation and birefringence.

The Plastographic Measurement of Polymeric-Homologous Conditions of Synthetic Resins with a View to Molding Practice. Martin Speitman. Brit. Plastics 10, 447-53 (1939). The Brabender Plastograph is employed to study the plasticity of phenolic, urea and alkyd resins. Several suggestions are made regarding possible uses in the study and control of industrial plastics.

The Science of Rheology and The Plastics Industry. G. W. Scott Blair. Brit. Plastics 10, 566-8 (1939). The materials used in the plas-

tics industry are, at least at some stage in the manufacturing process, subject to a control which must be essentially rheological. There is too little co-operation between those engaged in the difficult task of assessing these complex rheological properties in the different industries. The situation is also complicated by the fact that the investigators are generally chemists, whereas the problems involve highly advanced physics.

Elastic and Plastic Properties of Rennet Casein. C. A. Cooper and P. G. T. Hand. Brit. Plastics 10, 572-7 (1939). The Scott Plastometer (Henry L. Scott Co., Providence, R.I.) is used. The temporary and permanent deformation is obtained for casein both before and after treatment with formaldehyde.

The Plastic State. Measurement of Plasticity. Paul Bary. Rev. gen. Caoutchouc 16, 260-3 (1939). A critical review of the physics and chemistry of the plastic state. The various definitions of plasticity fail in that they are not in accord with the fact that plasticity is a function of temperature. Formulae are given for calculating fluidity, rigidity, and plasticity and a method is suggested for a graphic presentation in which the effect of temperature can be presented.

Properties of High Strength Molded Articles from Synthetic Resins. A. Thum and H. R. Jacobi. Z. Ver deut. Ing. 83, 1044-8 (1939). The cold flow, creep, effect of rate of loading, deviation from Hooke's law and strength under repeated stresses are given for phenolic fabric base plastics used in airplane parts.

The Elastic Properties of Paint Films. W. Konig. Farben-Ztg. 44, 83-4, 107-8, 133-5 (1939). A study of the effect of plasticizers upon the elasticity and residual deformation of nitrocellulose films under varying total deformations.

The Measurement of the Technical Pressing Properties of Hardenable Synthetic Resin Plastic Materials. M. Krahl, Kunstoff-Tech. u. Kunstoff-Anwend. 9, 339-42 (1939). A review of the testing methods with eight references.

A New Method for Determining the Flow Properties and the Rate of Hardening of Heat-Converticle Artificial Plastics. A. Schwittman. Kunstoffe 29, 190-2 (1939). An attempt to develop an apparatus which will measure the change in plasticity during cure. The sample is pressed on to a rotor the speed of which varies as heat softens and then hardens the plastic.

Elasticity and Viscosity of Highly Polymerized Compounds. Werner Kuhn. Agnew. Chem. 52, 289-301 (1939). Theoretical review of modulus of elasticity in solids; effect of temperature on behavior; effect of molecular weight on relaxation time; high elastic materials; relations between viscosity, elasticity and relaxation; viscosity of solutions of high polymers; and various attempts to predict or explain rheological behavior.

Plastics Progress during 1939. Modern Plastics 17, No. 5, 43-58 (1940). Eight authors discuss progress in various lines of plastics. Marked improvement in fully automatic molding operations seem to indicate that the future there will be an insistant demand for very accurate control of the rheological properties of the plastics. Cellulose acetate plastics have been improved in quality and their volume of sales increased. Cellulose ethers have found specialized application in hot melt coatings. The phenolics have been noted in particular for advances in molding techniques rather than from theoretical results. The most spectacular advances were made in the field of the thermoplastic resins such as polystyrene, polyvinyl acetates. In safety glass, textiles, fibres, coated paper and fabrics, films and in substitutes for rubber and leather, these resins are exerting a great influence on many industries and on national economics. The urea resins have been improved through changes in plasticity so that larger pieces may be molded and the field for plastics is correspondingly expanded.

All of these yearly advances in technology and increases in the number of different plastics available means that applications will be more highly specialized and that plastics will be purchased and sold on the basis of specific rheological properties as well as those of color and chemical properties.

Denture Base Material: Acrylic Resins. W. T. Sweeney, Modern Plastics 17, No. 6, 43-48 (1940). Acrylic base resins of the type used for dentures were tested for transverse and tensile strength and hardness.

Elasticity of Phenolic Compounds. A. F. Shepard and L. A. Sontag. Modern Plastics 17, No. 6, 48, 78, 80 (1940). The influence of filler upon elasticity is investigated with particular emphasis upon the molding of plastics around metal inserts.

Vinyl Resins. S. D. Douglas. Ind. Eng. Chem. 32, 315-19 (1940). A review covering the preparation and industrial uses if the vinyl chloride-acetate copolymers with some indications of the influence of molecular weight and chemical structure upon physical properties.

Plastic Deformations of Synthetic Materials. A. V. Blom. Kolloid-Z. **90**, 201-4 (1940). When films of a copolymer of vinyl chloride and an ester of acrylic acid are stretched, slip bands may be observed at elongations between 4.6 and 26.0%. Greater deformation causes disappearance of the slip bands and cracks and ridges develop at right angles to the direction of elongation.

Behavior of Polyvinyl Chloride Plastics under Stress. J. J. Russell, Ind. Eng. Chem. **32**, 509-12 (1940). Data is presented showing the effect of temperature upon tensile stress and "brittle point" of polyvinyl chloride plasticized with various types and mixtures of plasticizers.

H. F. Wakefield

THEORY

The unimolecular reaction rate theory of viscosity of Eyring and his associates (1) has been further treated as a bimolecular process by Frisch, Eyring, and Kincaid (2) in a recent paper to the Journal of Applied Physics. The most probable mechanism of liquid flow is regarded as the rolling past of each other to new equilibrium positions of pairs of molecules in adjoining layers, the frequent occurrence of this process shifts the layers of molecules and constitutes flow. The activation energy required for the passing of the molecules is the energy of activation of viscous flow.

The derivation of the partition function ratio gives a result similar to that obtained previously, the mass of the activated complex being replaced by the reduced mass of bimolecular flow. The free volume, however, is now evaluated in terms of the velocity of sound in gas and in liquid. In the new theory the energy of activation is still some arbitrary fraction of the energy of vaporization, and the constant "n", which it will be recalled depends on the class of liquid (i. e. molecular structure) is found to be somewhat larger than formerly (1). A new constant "n' " is introduced to take account of the change of free space at appreciable pressures.

How well the present theory represents the facts, especially as regards the pressure effect, is a matter of opinion. Former calculations for the effect of pressure on the viscosity of ether gave values lower than those observed; the present ones give values greater than those observed, the discrepancies at the higher pressures being considerably greater for the present computations.

R. B. Dow, The Pa. State College.

(1) R. H. Ewell, J. App. Phys. **9**, 252, 1938.
(2) D. Frisch, H. Eyring, J. F. Kincaid, J. App. Phys. **11**, 75, 1940.

A CORRECTION

In the November 1939 issue, pg. 14, line 8, 10 poises should be corrected to read 10^6 poises. In line 17 of the same page, 10 c. g. s. units should be corrected to read 10^7 c. g. s. units.

RHEOLOGY NEWS

An interesting article

In the Journal of Applied Physics, No. 11, pages 353-7, (1940), there is an article of interest to all lubricating engineers as well as all rheologists. It is entitled, "Computation of Some Physical Properties of Lubricating Oils at High Pressure". The authors are R. B. Dow and C. E. Fink, both of The Pennsylvania State College. In this paper a survey is made of available data on the density of fluid lubricants as a function of pressure and temperature. The following equation is derived:

$$\rho = \rho_0 (1 + ap - bp^2)_t$$

where ρ is the density at a given pressure p and temperature t ; ρ_0 is the corresponding density at atmospheric pressure. The authors evaluate the constants a and b over a temperature range extending from $20°$ to $220°F$. The equation is valid over a pressure range of 50,000 $lb/in.^2$. It holds equally well for mineral, animal, vegetable, and fish oils. The variation of density with pressure is independent of the nature of the oil.

The June Meeting of the A. S. T. M.

A meeting of the American Society for Testing Materials would not be complete if the program did not include papers of rheological content. The May 1940 issue of the A. S. T. M. Bulletin lists the abstracts of twelve such papers.

Committee D-20, (W. C. Emley, Chairman), presents a new method of test for determining flow temperatures of thermal plastics, and Robert Burns describes a device which constitutes a relatively simple and inexpensive supplement to the more precise methods for measuring the plasticity of molding compounds. Burns also discusses the effect of moisture content, temperature, and pressure on the plasticity of molding compounds.

M. Manjoine and A. Nadai report on high speed tests at elevated temperatures. They have developed a machine for stress-

strain tests on small metal samples at temperatures up to 1200°C. The stress-strain curves are automatically recorded on the screen of a cathode-ray oscillograph. P. G. McVetty reports that at high temperatures a part of the plastic deformation known as "creep" is not permanent. He gives evidence to show that the removal of externally applied stress at the end of a creep test leaves an internal stress with a component approximately equal to the applied stress but in the opposite direction. Creep recovery is considered to be related to the relaxation of this stress. E. L. Robinson finds little correlation between creep and high temperature rupture. R. F. Miller, W. G. Bing and W. E. Unversagt give data on creep for several commercial steels. J. Marin and L. E. Zwissler report on an experimental study of an aluminum alloy subjected to pure bending accompanied by creep. They give a theoretical differential equation which correlates their data on creep deflection on aluminum beams. W. R. Lorman explains creep in concrete in terms of colloid theory. For constant sustained load, the creep-time relation is expressed by a hyperbolic type of equation, and the creep-time equations have been derived for variable sustained load. Correlation of experimental creep data has made possible the establishment of the fundamental principles governing the values of the creep constants in these equations.

C. W. McGregor presents a fundamental treatment of strain and reduction in area in tension tests. Newer concepts of strain and ductility values are discussed in the light of recent tests, and the relationships between the various strain definitions are described. True stress-strain curves for various materials are given, followed by a discussion of several methods for their construction. The physical significance of these curves is discussed.

Committee D-2, (T. A. Boyd, Chairman), gives a procedure for calculating viscosity index, and new methods for test for dropping point of lubricating greases. T. F. Ford and K. G. Arabian criticize the current emperical methods for measuring the deformation properties of asphalts, and advocate the Couette type of viscometer. They describe a simple instrument of this type which requires small samples, permits rapid measurements, and gives results comparable in accuracy to those obtained in more complicated instruments. Fundamental deformation constants can be calculated from the measurements. R. N. Traxler, H. E. Schweyer, and J. W. Romberg give rheological diagrams for various types of flow of asphalts, and give a brief review of the dependence of the rheological properties of asphalts upon their colloidal structure.

14.

THE AMERICAN INSTITUTE OF PHYSICS.

The five founder societies of the A. I. P. are The American Physical Society, The Optical Society of America, The Acoustical Society of America, The Society of Rheology, and The American Association of Physics Teachers. The A. I. P. is the agency by which these societies cooperate in such activities as they have in common. For instance, by having all the publications of the founder societies handled by the office of the A. I. P., substantial savings are effected. Besides publishing the various journals which belong to individual founder societies, the Institute publishes the Review of Scientific Instruments, The Journal of Chemical Physics, and the Journal of Applied Physics, which belong jointly to all five founder societies. The Institute also aids in promoting public interest in the various branches of physics and in their practical applications. During 1939, the Institute engaged in seven such promotional activities; (1) survey of industrial research, with the National Resources Planning Board; (2) cooperation with the National Association of Manufacturers in bringing to industrial managements a better understanding of the opportunities and requirements of successful industrial research; (3) research advisory service to banks which need scientific advice in connection with industries in which they are directly or indirectly interested; (4) encouragement in the publication of "Atoms in Action", (a book promoting applied physics); (5) sponsorship of a Temperature Symposium, with a registered attendance of 612 and a total attendance of at least 800; (6) cooperation with the Scientific Apparatus Makers of America in improving relations between users and makers of scientific instruments; (7) operation of a placement service.

A conservative estimate indicates that the members of the five founder societies enjoy salaried income of over $10,000,000. They pay about $75,000 a year in dues, subscriptions, etc. A total of over $130,000 was received in 1939 from physicists and from institutions supporting their work, in the form of library subscriptions, reprint purchases, publication charges, supporting memberships, etc. All of this money was used for the publication of physical journals, and the holding of regular meetings of the founder societies except about $10,000. This small fraction of the resources of the profession provides for the only national representation which the profession has as a whole, and the only secretarial headquarters for general coordination of its interests.

The A. I. P. obtains its income from publication charges to the founder societies, publication ($3.00 per page) charges to institutions whose research is published, dues from industrial and other as-

sociates, and advertising charges. In spite of depressions and wars and rumors of wars, the A. I. P. is gradually getting into the black financially. At the beginning, the inevitable promotional expense was underwritten by the Chemical Foundation. After the Chemical Foundation had gotten the A. I. P. safely launched and had ceased to underwrite further promotional expense, the A. I. P. had to operate for a while on an unbalanced budget. By December 31, 1937 the accumulated deficit was $21,845.29. As of December 31, 1939 this had been reduced to $12,840.00. The Governing Board has set as its goal a surplus of $10,000.00 as working capital in order to have a little margin of safety against fluctuating prosperity cycles.

The Society of Rheology is represented on the Governing Board of the A. I. P. by its President, Secretary, and Editor. The officers of the A. I. P. for 1940 are P. E. Klopsteg, Chairman; G. B. Pegram, Secretary-Treasurer; H. A. Barton, Director; J. T. Tate, Publications Adviser; Miss M. M. Mitchell, Publications Manager.

APPLICATION

Mr. H. R. Lillie, Secretary
Research Division
Corning Glass Works
Corning, N. Y.

I hereby apply for membership in the Society of Rheology for the year _____ as follows:

[ ] Sustaining membership (including subscriptions to both **Journal of Applied Physics** and **R. S. I.** $25.00 or more

[ ] Regular membership (including subscription to **Journal of Applied Physics**) $6.00 (foreign, $6.50)

[ ] Associate membership $2.00 (foreign, $2.50)

All members receive a subscription to the Rheology Leaflet.

Please also enter my subscription for the following additional periodicals published by the American Institute of Physics:

_____ at $_____

_____ at $_____

_____ at $_____

I enclose $_____ to cover the above.

(Name) _____
                (Please Print)

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                (Title)

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         (Corporation or School)

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    (No.)   (Street)

_____
        (City and State)