

BRITISH RHEOLOGISTS' CLUB



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CLUB NOTES.

News of Members.

Our congratulations to Dr. A. S. C. Lawrence who has recently received a Sir George Beilby Memorial Award, and to Dr. Barbara S. Neumann (*née* Emödi) on her marriage.

New Members.

A list of members, brought up to date to June 1st, 1949, has recently been circulated to all members of the Club.

Unpaid Subscriptions.

A number of members are now over-due with their subscriptions by two or more years and do not reply to letters from the Hon. Treasurer. If he does not hear from them before the end of September he will assume that they have resigned.

Back Numbers of the Bulletin.

A limited number of copies of some of the earlier Bulletins are available and may be obtained from the Hon. Secretary at 5s. per number. At the time of writing the numbers available include 8 to 22.

Future Meetings of the Club.

Members have already received full particulars of the meeting in Birmingham on July 15th—16th.

Arrangements for the Annual General Meeting and Conference to be held at Wills Hall, Bristol, are proceeding as outlined in the last Bulletin.

Clay Minerals Group, Mineralogical Society.

Members of the Club are invited to attend and to submit papers for the next meeting of the Group which will be held in the apartments of the Geological Society of London, Burlington House, Piccadilly, London (by kind permission) on Friday, 11th November, 1949. The subject for discussion will be:

'The Less Common Clay Minerals.'

which may be taken to include all minerals occurring in clays except the common minerals of the kaolinite, montmorillonite and illite groups. General papers will also be welcomed.

All those desiring to contribute papers should notify the Secretary as soon as possible, and papers together with a summary (preferably about one foolscap-page, double spacing) should be in his hands not later than 20th October, 1949, so that summaries

may be circulated in good time for the meeting. It is hoped it may be possible to arrange a dinner for Members and Guests on the Friday evening after the meeting, and full details will be given later.

The Officers of the Group are as follows :—

A. L. Roberts (Chairman),	R. C. Mackenzie (Hon. Sec.),
Department of Coal Gas and Fuel	Macaulay Institute for Soil
Industries,	Research,
The University,	Craigiebuckler,
Leeds, 2.	Aberdeen.

The Club is most grateful to the Officers of the Group for this kind invitation which also extends to future meetings of the Group.

1st International Rheology Conference.

The proceedings of the first International Rheology Conference, Hague, 1948, are now obtainable through the usual book agencies. Price 63s.

Proceedings of the Joint Meeting with British Glaciological Society and the Institute of Metals.

Mr. George Seligman has placed at the disposal of the Club a number of reprints of the proceedings of the meeting.

Members who would like a copy are asked to apply to the Honorary Secretary.

The Polytechnic, Regent Street, W.1.

A course of twenty-four lectures on "Theoretical Rheology" will be given by I. Berenblut, M.Sc., A.R.C.S., A.Inst.P., on Wednesday evenings from 7.30 to 9.00, commencing September 28th, 1949.

A course of six lectures on "Elasticity, Swelling and Solution Properties of High Polymers" will be given by Dr. L. R. G. Treloar, F.Inst.P., on Tuesday evenings from 7.15 to 8.30, commencing October 4th, 1949.

A further course of six lectures on "Some Aspects of Industrial Rheology" will be given by Dr. G. W. Scott Blair, F.Inst.P., F.R.I.C., on Tuesday evenings from 7.15 to 8.30, commencing November 15th, 1949.

Detailed syllabuses are available. Application to attend these courses should be made as soon as possible to the Head of the Department of Mathematics and Physics.

CORRESPONDENCE

DEAR DR. SCOTT BLAIR,

If the report in Nature for March 5th last, of the B.R.C. Discussion on Fracture, is a true account of my contribution, I think I should try to correct a false impression. I did not intend to assert that the longitudinal tensile fracture of wood was brought about exclusively by breaking of oxygen linkage in the cellulose chains, as I do not think that our knowledge is complete enough to be so dogmatic. The fact that the longitudinal tensile strength is to some extent dependent on moisture content, though not so much as the compressive, would suggest that hydroxyl linkages are also being fractured. I was only wanting to give evidence that a larger *proportion* of oxygen link breakages occurred in tension than in compression.

Yours sincerely,

W. W. BARKAS.

RHEOLOGY ABSTRACTS

NOTE.—The initials following the Abstracts are those of the abstracting member, except for the following abbreviations for abstracts re-produced from other Journals by permission :—

B.C.R.A.	British Ceramics Research Association.
I.D.I.B.	Industrial Diamond Information Bureau.
NICKEL BULL.	Nickel Bulletin.
P.A.T.R.A.	Printing and Allied Trades Research Association.
SCI. ABSTR.	Science Abstracts.
B.S.A.	Building Science Abstracts.

1267. Principles of Penetration of Liquids into Solids.

N. K. ADAM. *Disc. Farad. Soc.*, 3, 5, 1948.

Unless the contact angle of a liquid in a capillary of small radius is exactly 90° , a curved meniscus will result; the contact angle varies however, being a maximum when the liquid advances over a dry surface. A greater pressure is required to expel a liquid from a capillary than to drive it in, and the difference between advancing and receding contact angles can be large, up to 60° on smooth surfaces, and larger values for rough surfaces; the hysteresis appears to be larger for water than for organic liquids. For "receding" angles the minimum contact angle of zero is not uncommon, although less so with "advancing" angles. The maximum advancing angle on a smooth surface is probably between 110° and 120° and it seems unlikely that with organic substances contact angles greater than 120° can exist. Greater apparent contact angles can be obtained with rough surfaces and generally roughness increases the differences between the real contact angle and 90° . In regard to penetration into capillaries of complex shape, penetration pressure will decrease, even to become negative, when the meniscus has to find its way past a constriction in a pore; the constriction need not be sharp, the effect depending on the slopes of the walls. On the question of the mechanism of penetration only qualitative consideration is given, such as when the smallness of the bore allows attraction of the walls to extend across them; liquid in the pores will everywhere be within range of the attraction. Considerations show that the potential energy of a molecule in the surface of a liquid in a narrow tube will be less than in a free liquid surface; diffusion of molecules along the walls of narrow tubes is important. With an appreciable penetration of the liquid, by molecular solution, into the walls of the pores it is likely that a liquid will tend to form a smaller contact angle; in the absence of pores and when penetration is by molecular solution the attraction between solid and liquid molecules must be great enough to separate liquid molecules from each other and to some extent separate the solid molecules from each other as the liquid molecules penetrate between them.

B.C.R.A.

1268. The Determination of the Elastic Constants of Optical Glasses by Heidemann's Method.

L. ALLEGRETTI. *Ric. Sci.*, 18, 995, 1948.

Describes measurements of moduli of elasticity and rigidity and Poisson's ratio for 11 Italian optical glasses (composition not stated) by Heidemann's method. This employs supersonic stationary waves and an optical method for determining the wavelength, and avoids complications due to elastic after-effects which affect static measurements. Details of the electrical and optical systems are given.

SCI. ABSTR.

1269. The Wigmore Concrete Consistometer.

ANON. "Engineering," p. 283. March 25, 1949.

A new apparatus for measuring the "workability" of concrete, suitable for use in the field. $\frac{1}{8}$ cu. ft. of concrete is placed in a cylindrical container, and a ball at the lower end of a rod, which is free to slide vertically in a guide in the lid, is allowed to rest on the surface of the concrete. The container is then dropped repeatedly through a fixed distance on to a rigid platform by rotating a handle. Each bump is recorded on a counter and the number of bumps required to produce a standard penetration is taken as the measure of "workability." This measure—termed the "Wigmore consistency factor"—ranges from about 20 to 800, and suitable values for various classes of work are suggested.

It is claimed that the new method can be performed by one man in less time than the slump test, and also that a better indication of "workability" is obtained. P.M.

1270. Rigidities of Polyisobutylene Solutions in Various Solvents.

J. N. ASHWORTH AND J. D. FERRY. *J. Amer. Chem. Soc.* **71**, 622, 1949.

The rigidity was calculated from the length of transverse waves propagated through the solutions at audio frequencies. The rigidity was found (a) to increase slightly with frequency for range 100 to 1000 cycles/sec., (b) decrease slightly with rising temperature and (c) be proportional to the cube of the concentration. E.W.J.M. (See Abstr. 1214).

1271. Some Theoretical Considerations on the Dynamic Properties of Plastics.

N. F. ASTBURY. *Proc. Roy. Soc. A*, **196**, 92, 1949.

The marked similarity between the mechanical behaviour of plastics and the electric behaviour of certain dielectrics provides a starting-point for the derivation of a mechanical stress-strain relationship for plastic materials, from which expressions are deduced for the velocity of sound in, and the transmission and reflection of sound by, plastic plates. The effect of absorption on departures from Rayleigh's theory is indicated, and limited experimental data are reported. SCI. ABSTR.

1272. Sonic Method for Determining Young's Modulus of Elasticity.

K. A. BAAB AND H. M. KRANER. *J. Amer. Ceram. Soc.*, **31**, 318, 1948; *Industr. Heat.*, **15**, 1580, 1948.

Twenty-one bricks of the same brand taken from various commercial kilns were tested for Young's modulus of elasticity by the sonic method. This method of obtaining the modulus of elasticity does not destroy the sample and is easy to carry out. After obtaining the resonant frequency, each sample was tested for the other physical properties. The values of each property of each brick were plotted against its cone firing temperature which was known. The property of elasticity is more sensitive to differences in firing conditions than most of the other properties commonly used. From the work that has been done, it is apparent that this property shows a more definite correlation with firing temperature than the other properties and that the spread of values is lower. The sonic method of determining the modulus of elasticity might be used as a tool for control work in the manufacture of refractories and by the consumer as a means of checking specifications. This test may be suitable only for the comparison of firing temperatures of a single product, because any given firing temperature or method of manufacture produces various physical properties when different clays or materials are used. Standards might be developed for the various brands and the comparisons made only within the brand. The same holds true for the physical properties now being used. B.C.R.A.

1273. The Measurement of Thixotropy of Bentonite Suspensions.

J. BARRIOL, J. M. BLOCH AND F. KAYSER. *C.R. Acad. Sci. (Paris)*, **226**, 1899, 1948.

The depth of sinking of hollow metal cylinders of various diameters into bentonite gels is measured. The results are claimed to be more quickly obtained than are data from a rotation viscometer with which they are nevertheless in close agreement. G.W.S.B.

1274. High-Elastic Properties of Vulcanised Butadiene Rubbers.

G. M. BARTENEV. *Kolloidnyi Zh.*, **11**, 57, 1949 (See Abstr. 970).

1275. A Simple Micro-Hardness Tester with many Practical Applications.

E. B. BERGMAN. *Schweiz. Arch. angew. Wis. Tech.*, **14**, 294, 1948.

A testing device suitable for mounting on a microscope with top objective is described and illustrated. Measurements are made by means of a Vickers or Knoop diamond loaded by weights of 1-500 g. The appropriate weight is set directly on a weight plate and for making the test the objective of the microscope is replaced by the diamond. An electric signal indicates the start of the test which is completed after 15 sec. in the case of indentation tests. Scratch tests can also be made with the device. Tests can be carried out on very small surfaces, e.g., the point of a gramophone needle, the cross-section of a wire of 0.1 mm dia., on thin metal foils, on thin surface coatings deposited electrolytically, or by a diffusion process, over small regions of a micro-structure. The load is so small that the hardness of brittle material can be determined without the danger of fissures. Small differences in hardness can be measured, e.g. in welding seams and cold-worked metals.

SCI. ABSTR. (See abstr. 423).

1276. Dispersibility of Coal in a Supersonic Field.

N. BERKOWITZ. *Nature*, **163**, 809, 1949.

The increased dispersibility of various coals in organic solvents by supersonic waves is ascribed to an increase in dispersion of coal micelles. Coals simulate thixotropic substances in that their micellar structure can be disturbed by a sufficiently high energy input and largely reconstituted after removal of the disturbance.

E.W.J.M.

1277. Tackiness and Adhesion.

J. J. BIKERMAN, *Trans. N.Y. Acad. Sci.*, **9**, 273, 1947.

The concept of tackiness is discussed and the limitations of Stefan's equation are noted. An apparatus is described for the study of the uniformity of solid and liquid phases. It is shown that tackiness depends primarily upon the viscosity of the adhesive. The strength of the bond between two surfaces joined by an adhesive does not depend simply upon the attractive forces between the molecules.

P.A.T.R.A. (See abstr. 673).

1278. The Influence of the Moisture and Water Content upon the Strength Properties of Spinning Paper.

W. BRECHT. *Melliand Textilber*, **28**, 367, 1947.

The author studied the variations in the individual strength properties which a sulphite spinning paper underwent in the machine and cross-machine directions in the complete range from almost oven-dry through air-dry to the water-saturated condition. The mechanism of moisture and water absorption by paper is outlined briefly. Viewed as a whole, the strength properties of a paper depend to a much larger extent on its moisture and water content than is generally assumed. The differences in all the strength properties in the two main directions are essentially a function of the moisture content, although the changes caused by different moisture contents vary for the indi-

vidual strength properties. No maximum values are obtained in the oven-dry condition; with the exception of tensile strength and burst—which correspond almost to the values obtained in air-dry condition—all strength properties are weak and the differences between machine and cross-machine direction are almost negligible. The maximum for the breaking load was reached at 5%, for burst at 8%, for folding endurance at 16%, for initial tear at 18%, for tear-through at 22%, and for elongation at 24% moisture content. The difference between the two directions was always the greatest at the water content corresponding to the maximum strength value. Although all strength properties decreased after passing through their maximum values, burst and folding endurance had completely disappeared at 50% moisture, whereas elongation and tear-through in the machine direction and initial tear in both directions were not much lower than the corresponding values obtained for the oven-dry papers. The results for the complete range are also illustrated in four diagrams. P.A.T.R.A. (See abstr. 841).

1279. Board Testing—Physical.

W. BRECHT AND A. BAUER. *Das Papier*, 2, 225, 288, 1948.

The authors studied the effects of moisture content, couching pressure, freeness of stock and type of fibrous raw materials on the resistance to ply separation of the finished sheet. In determining ply separation, special use is made of the Schopper tensile strength tester but, in this case, the two layers of a paper test strip are partly separated from each other, the one being fastened by the upper and the other by the lower clamp of a Schopper tensile strength tester. The weight required to separate the plies is a measure of ply separation. The formation of the various test sheets and details of the test are fully described. The effect of moisture content of the paper layers at the time of couching is important. A sheet of high water content (92-93%) in either layer at the time of couching shows the highest ply separation. As the water content decreases, ply separation drops sharply at first, but only rather slowly after the water content has reached 80%. Below 70% the rate of decrease in ply separation is again fairly rapid. At a high water content the higher the degrees Schopper-Reigler, the greater is the ply separation. This relationship no longer holds when the water content (at the time of couching) is lowered. The pressure applied during couching has very little effect on ply separation. In general, ply separation depended on the quality of the pulps used in the paper plies. Thus, papers having mechanical pulp plies showed far lower values for ply separation than did those made from unbleached sulphite or kraft pulps. Detailed tabulated data and graphs are given. P.A.T.R.A.

1280. The Linear Compression of Various Single Crystals to 30,000 kg/cm².

P. W. BRIDGMAN. *Proc. Amer. Acad. Arts Sci.*, 76, 89, 1948.

The linear and volume compressions of large single crystals of 13 compounds and of Mg have been measured up to 30,000 kg/cm². The method of the lever piezometer was used. Comparison of the results for the different materials and for the various axes within a given material produces some interesting results, particularly that the volume decrements at 30,000 kg/cm² only vary by a factor of 2, while the anisotropy varies by a factor of 3. The deviations from linearity are also discussed.

(See Abstr. 1144, 1145).

1281. Problems of Fluid Flow through Swarms of Particles and through Macro-molecules in Solution.

H. C. BRINKMAN. *Research*, 2, 190, 1949. (Paper presented at 1st Rheological Congress, 1948).

An approximate description of flow is given on a basis different from that used by Burgers. Figures are given shewing (a) permeability as a function of porosity,

(b) the velocity profile in a vertical pipe containing a stationary swarm of particles and
(c) the sedimentation velocity and intrinsic viscosity of macromolecules as a function of chain length.
E.W.J.M. (See Abstr. 952, 953).

1282. Tearing of Paper.

P. BROCHARD. *Papeterie*, **70**, 237, 1948.

The tear index of a paper sheet does not necessarily measure the structural intactness of the individual fibres; the effect of the fibrillation and hydration on tearing and tensile strength (breaking length) and the difference in the mechanism of tearing a free and a slow paper are discussed.
P.A.T.R.A.

1283. Elastic-viscous Oleate Systems containing KCl. I. Measurements of the Elastic Properties. Dependence of Period and Damping on the Temperature.

H. G. BUNGENBERG DE JONG AND H. J. V.D. BERG. *Proc. K. Ned. Akad. Wet.*, **51**, 1197, 1948.

Solutions of Na oleate (1.2%) containing KCl are placed in spherical glass vessels and set in vibration. By observing with a telescope a small air bubble in the viscous solution the period of the vibrations and the damping were measured. Several methods of imparting the initial impulse were used and the effect of air bubbles, temperature, etc., on the elastic behaviour was examined.
SCI. ABSTR.

1284. The Photoelastic Properties of Diamond.

E. BURNSTEIN AND P. L. SMITH. Letter in *Phys. Rev.*, **74**, 1880, 1948.

Reference is made to an earlier work by Ramachandran giving values of the photoelastic constants of diamond, which later investigation has proved to be of the correct magnitude in units of cm^2/g^4 but of incorrect sign. The corrected photoelastic constants, atomic anisotropy constants and related quantities are given and their significance discussed. A necessary change and typographical errors in an earlier work by the same authors are mentioned. This leaves MgO as the only crystal known to have a negative $dn/d\rho$.
SCI. ABSTR.

1285. The Incremental Friction Coefficient—a Non-Hydrodynamic Component of Boundary Lubrication.

J. T. BURWELL AND C. D. STRANG. *J. Appl. Phys.*, **20**, 79, 1949.

In investigations of lubricated sliding friction between two crossed cylinders it is found that for hard, smooth surfaces the friction force is a straight-line function of the applied load, although this line does not generally pass through the origin. The slope of this line defines a friction coefficient, designated as the incremental friction $f\Delta$. It is independent of load and of viscous-fluid effects and hence permits investigation of non-fluid friction at reasonable speeds. It is often found to decrease with increasing speed, U , over at least part of the range, and this variation often appears to be a linear function of the log. of the speed. The curve of $f\Delta$ vs. $\ln U$ seems to be characteristic of the chemical structure of the lubricant and of the rubbing surfaces.

SCI. ABSTR. (See Abstr. 35).

1286. The Flow of Adsorbed Molecules.

P. C. CARMAN. *Nature*, **163**, 684, 1949.

The flow of H_2 , air, CO_2 and $\text{C F}_2\text{Cl}_2$ through plugs of "Linde silica" at 22°C were consistent with theory but SO_2 gave higher rates than were expected. Experiments at 0° show a rapid increase in permeability as the saturation v.p. of liquid SO_2 is approached; the mobility observed for the adsorbed layer could not be predicted from the properties of liquid SO_2 .
E.W.J.M. (See Abstr. 685, 1147).

1287. **Macromolecular Physics. Maxwell Effect (Flow Birefringence) in Suspensions of Deformable Particles. I. Generalities. Brownian Movement of Rotation and Deformation of a Spherical Elastic Particle.**

R. CERF. *C.R. Acad. Sci., Paris*, **227**, 1221, 1948.

Reference is made to authors who suggest flow birefringence arises as a result of particle deformation. Following this, the influence of thermal agitation on an elastic sphere (radius 50-500 Å) is considered, whereupon (a) for feeble Brownian movement, the movements of displacement and deformation are independent and (b) $\bar{X}_{ii}^2 = kT/VE$; $\bar{X}_{ii}\bar{X}_{jj} = kT/V \cdot \sigma/E$ where $\bar{X}_{ii}$ and $\bar{X}_{jj}$ are the principal coefficients of deformation, k is Boltzmann's constant, T is the absolute temperature, V is the particle volume, E is Young's modulus and σ is Poisson's ratio. The behaviour of the sphere submitted to both a hydrodynamic field and thermal agitation is mentioned and for a representative point a Gaussian law of distribution holds.

SCI. ABSTR.

1288. **Macromolecular Physics—Maxwell Effect in Suspensions of Deformable Particles. II. Dynamical-optical Properties of a Suspension of Elastic Spheres. Application to Solutions of Chain-like Macromolecules.**

R. CERF. *C.R. Acad. Sci., Paris*, **227**, 1352, 1948.

The author discusses the birefringence of an infinitely dilute suspension of elastic spherical particles initially optically isotropic, but deformed to anisotropy when flowing under a small constant velocity gradient. An expression for the birefringence is derived in the form of the product of a mechanical factor dependent upon thermal agitation and an optical factor. Contrary to the result obtained in the case of solutions of rigid particles, it is the optical factor that is found to depend upon the velocity gradient, the mechanical factor being a constant so far as the first approximation is concerned. The theory is applied briefly to the case of the poly-isobutylenes and poly-styrenes.

SCI. ABSTR.

1289. **Flow of a Compressible Fluid about a Cylinder. II. Flow with Circulation.**

T. M. CHERRY. *Proc. Roy. Soc. A*, **96**, 1, 1949.

The investigation is based on the fact that any solution for compressible flow is associated with a generating function which is the solution for a corresponding case of incompressible flow. This correspondence is used to determine a solution for compressible flow past a cylinder in the case where the circulation round the cylinder is not zero. It is found that the most direct generalization of the formulae for incompressible flow yields multiple-valued formulae for compressible flow. A single-valued solution is obtained for the case of flow round a slightly distorted circular cylinder by a method in which a multiple-valued solution is obtained, containing a set of constants which can be determined by means of a set of linear equations. Numerical values for transonic flow have been worked out from certain formulae obtained in a previous paper, which gives exact solutions for steady 2-dimensional flow of a compressible fluid past a cylinder. Stream-line diagrams are given, and commented upon, for 3 of these solutions.

SCI. ABSTR. (See Abstr. 963).

1290. **The Plasticity of Clay Bodies.**

H. DETAILLE, *Verre Silicates Industr.*, **13**, 207, 1948.

The ionic nature of the lyosphere around clay particles in a slip is discussed; the significance of the double-diffuse layer of Gouy and Freundlich is pointed out. This double ionic layer controls the stability of the clay particle in a system in which water is the continuous phase; the degree of stability is determined by the Helmholtz formula. The conditions that obtain when the continuous phase is water and when this phase

is alkaline are considered. In the plastic state the plasticity of clay arises from the sliding of the particles over one another; they are separated by a film of water and the forces of attraction give the mass some cohesion. The torsion test is considered to be the most promising for studying the plastic properties of clay; the forces involved are analyzed and it is shown that the test-piece should be a thin-walled tube. The apparatus used at the Institut National des Silicates at Mons is illustrated. B.C.R.A.

1291. Two-Species Laminated Beams.

A. G. H. DIETZ. *Trans. A.S.M.E.*, p.401, May 1941.

This paper sets forth the simple theory of two-species wooden beams incorporating high-strength heavy outer laminations or "flanges" together with low-strength lighter cores into glued laminated members having high strength and high stiffness. Expressions for transformed section, ratio of core depth to over-all depth, and shear at the neutral axis are derived. A few beams made of Douglas-fir outer laminations, and No. 1 or No. 2 common eastern-spruce cores were tested and their strength properties determined. Their performance coincided quite well with that predicted by the theory. A "form factor" similar to that for wooden I-beams may be involved.

AUTHOR'S ABSTR. (See Abstr. 448).

1292. On the Dimensions of Physical Magnitudes (Seventh paper : A paradox in Dimensional Theory).

H. DINGLE. *Phil. Mag.*, 40, 94, 1949.

The theme developed in previous papers is applied to the problem of dimensions of the quantity, ψ given in the form, $\psi = S\beta\sigma^{-1}t^k$, by Nutting, where S is the stress, σ the strain of a material which is neither a Hookean solid not a Newtonian fluid; and also to the recent work of Scott-Blair. It is concluded that, with the new outlook developed in previous papers, there is no objection to Scott-Blair's work on dimensional grounds.

SCI. ABSTR. (See Abstr. 1122).

1293. The Steady Non-uniform State for a Liquid.

R. EISENSCHITZ, *Proc. Phys. Soc., Lond., A*, 62, 41, 1949.

The Smoluchowski equation for the distribution of the relative co-ordinates of a representative pair of molecules in a liquid is formulated in such a way that the effect of non-uniform velocity or temperature is taken into account. The equation is reduced to an ordinary linear differential equation of the second order. One of the two constants of integration is readily determined, whereas the determination of the other may lead to inconsistencies. The molecules are assumed to interact with the average potential that is appropriate to thermal equilibrium. If it is assumed that this potential becomes infinite of the first order at distance zero then the problem of viscous flow and the problem of thermal conduction are uniquely soluble. Approximate evaluation of the transport coefficients shows the right kind of temperature effect. The result is in accordance with the previous treatment by means of the cell model.

SCI. ABSTR. (See Abstr. 858).

1294. A New Type of Viscosimeter.

A. A. ELKARIM. *Amer. J. Phys.*, 16, 489, 1948.

A small air index is driven along a horizontal capillary tube, the pressure difference being due to a head of the liquid whose viscosity is being measured. The velocity is measured directly, and the viscosity deduced from the gradient of the graph of head against velocity, using Poiseuille's equation. This graph does not pass through the origin, as there is a constant difference between the head and the effective pressure, due to surface tension. The apparatus gives good results for viscosities between 0.0055 and 0.042 c.g.s. units.

SCI. ABSTR.

1295. A New Form of Viscometer for Transparent Viscous Liquids.

A. A. ELKARIM. *Rev. Sci. Instrum.*, **19**, 833, 1948.

Based on the application of Stokes's Law. The method is to allow air bubbles to rise through a liquid placed in a glass cell. SCI. ABSTR.

1296. Rheological Measurements with the Rotational Viscometer.

E. K. FISCHER AND C. H. LINDSLEY. *Text. Res. J.*, **18**, 325, 1948.

The use of a rotating cylinder viscometer in various forms for the measurement of viscosity and the study of anomalous flow is discussed in some detail. To obtain consistent results, the basic factors to be considered are: (a) a measure of the retarding torque produced by the liquid being sheared in the annular space between the cylinders; (b) determination of the magnitude of end traction of the inner cylinder; and (c) variation in the ratio of shear between the cylinders. Details of the modification of a Stormer viscometer are included. P.A.T.R.A.

1297. Laminar Flow of Newtonian and Maxwellian Liquids.

H. FROMM. *Z. angew. Math. Mech.*, **28**, 43, 1948.

In Maxwellian liquids the rotation of an element in a space of constant stress results in elastic deformation. The flow is investigated by the use of tensors, taking both rotation and translation into account. With stationary laminar flow the shear stress $< \frac{1}{2}$ numerical value of the modulus of shear. The flow of these liquids through pipes or plates may give rise to stable and unstable regions of velocity distribution with discontinuous pressure distribution. Pressure measurements in Maxwell liquids should be carried out by Pitot tubes with 4 transverse perforations. The similarities between Maxwell liquids and macromolecular colloidal "structure-viscous" solutions are discussed. SCI. ABSTR.

1298. The E.V.T. Viscometer.

G. H. FUIDGE, A. L. DEADMAN AND A. L. HUTTON. *Chem. & Industr.*, No. **38**, 601, 1948.

This viscometer is designed to measure the equi-viscous temperature (E.V.T.) of road tar. The principle is that tar should be characterized by the temperature at which it has a standard viscosity rather than by its viscosity at a standard temperature. B.C.R.A.

1299. Investigations on the Viscosity of Solutions of Polyisobutylene in Mineral Oils. II. Dependence of Viscosity on Temperature.

G. I. FUKS AND N. G. PUCHKOV. *Kolloidnyi Zh.*, **11**, 34, 1949.

Ramaiya's equation, which gives linear curves plotting log of square root of either kinematic or dynamic viscosity against reciprocal of absolute temperature, is shown to hold for a limited temperature range for the polyisobutylene solutions studied.

G.W.S.B. (See Abstr. 1154).

1300. Torsional Viscous-Friction Dampers.

J. C. GEORGIAN. *Trans. Amer. Soc. Mech. Eng.*, (May, 1949), 389.

Some silicone oils have suitable rheological properties for use in a liquid-friction damper designed to reduce the stresses in a crankshaft. The variation of viscosity with temperature and with rate of shear is given. A description of the Lanchester damper and some design calculations are included. J.G.O.

1301. Soil Mechanics Studies of a Stiff Fissured Clay. I. Field and Laboratory Technique.

R. GLOSSOP. *Verre Silicates Industr.*, **13**, No. 6, COBEA Suppl., 87; No. 7, COBEA Suppl., 93, 1948.

The first part of the paper deals with the problem of obtaining the undisturbed samples of clay essential for any study of soil mechanics. The results of several grading

tests on the clay are illustrated on a triangular diagram and histograms are given of the moisture contents, liquid limits and plastic limits of some hundreds of samples. Linear relationships exist between the plasticity and the liquid limit and between the liquid limit and the clay content. Experiments carried out in a field laboratory at Chingford are described. The tests included unconfined compression tests, the determination of the angle of failure and the shear-compression ratio; a triaxial compression test was also used. The consolidation characteristics of the London clay are considered. B.C.R.A.

1302. Measurement of the Elasto-Plastic Properties of Gels.

K. GOLDSMITH. *Nature*, **163**, 601, 1949.

A torsion method, using a vane embedded in gels and a form of Cheftel and Mocquard's equation, modified to accommodate the modulus of elasticity, were employed to determine the "firmness intensity factor" and other rheological constants of 1% commercial soap gels. E.W.J.M.

1303. The Measurement of the Rheological Properties of Visco-Plastic Substances.

K. GOLDSMITH AND J. IBALL. *Proc. Phys. Soc. B*, **62**, 251, 1949.

The behaviour of a visco-plastic substance under the action of a small decreasing stress is examined in a specially designed apparatus. The results are interpreted by means of a modified Scott Blair-Nutting equation and a "firmness intensity factor" for the substance is calculated. The apparatus has been used to study the properties of milk curds. W.P.F.

1304. A New Capillary Viscometer.

D. W. GROVER AND R. A. P. WERTHEIM. *Research*, **1**, 618, 1948.

A new method of measuring the flow properties of liquids is described which enables viscosity over a wide range of shearing forces to be ascertained by a single test. Two forms of apparatus utilizing this method are described and simple methods of calculation are developed. Results have been obtained with a newtonian liquid (sucrose solution) and a non-Newtonian liquid (sodium alginate solution). B.C.R.A.

1305. On Highly Compressible Helical Springs and Rubber Rods, and their Application for Vibration-free Mountings, I.

J. A. HARINGX. *Philips Res. Rep.*, **3**, 401, 1948.

The elastic stability is studied of helical springs under compression, or under combined compression and twist. If the problem is simplified by replacing the helical spring by an elastic prismatic rod, its rigidity with respect to shearing must be referred to the transverse force acting in that plane which in the unloaded state is normal to the central line of the rod, but is no longer so in the deflected state. A new relation is deduced between the relative compression at which buckling occurs and the ratio length/dia. of the spring. For this ratio there exists a limiting value below which no buckling occurs, not even under complete compression, and which is dependent only on the method of fixing the spring ends. A more accurate calculation, which takes the helical structure of the spring into account, confirms that the wire dia. and the number of coils are of secondary importance provided that the pitch of the helix is less than say, half its diameter. SCI. ABSTR.

1306. Factorial Analysis of the Rheological Properties of Cheese.

R. HARPER AND M. BARON. *Nature*, **162**, 821, 1948.

Regularities in the matrix of correlation coefficients relating a number of empirical rheological tests are interpreted in terms of three orthogonal factors which are tentatively associated with hardness, springiness and hardening. G.W.S.B.

1307. Organised Structures in Soap Solutions.

G. S. HARTLEY. *Nature*, **163**, 767, 1949.

Soap micelles are probably spherical, of closely constant size in any one solution and vary but little with concentration. They are mutually repulsive so will tend to array themselves at maximum distances in a closely packed tetrahedron assembly.

E.W.J.M.

1308. Comments on the Turbulence Problem.

W. HEISENBERG. *Z. Naturforsch*, **3A**, 434, 1948.

The older point of view according to which turbulence is regarded as an instability induced by friction is contrasted with that of more recent statistical theories according to which the movements of fluids, even of frictionless liquids, is always turbulent while high viscosity tends to reduce vorticity at small Reynolds numbers. The apparent contradiction between these two views is resolved and a survey of the modern statistical theories is given.

SCI. ABSTR. (See Abstr. 1222).

1309. Modern Applications of Photo-Elasticity.

R. B. HEYWOOD. *Proc. Instn. Mech. Engrs.*, **158**, 235, 1948.

It has long been known that polarized light may be employed to analyse the stresses occurring in engineering parts. Recent modifications have simplified the apparatus required, so giving a wider scope to the application of photo-elasticity to engineering. The method of preparing transparent models for stress analysis is discussed and the significant of the photo-elastic fringes is explained. Only the boundary stresses in the model are considered and their importance is demonstrated by means of examples, such as the modification of the design of aero-engine parts so that a substantial increase in strength is attained. The procedure for evolving the best shape of fillet for a particular set of conditions is given. The three-dimensional "freezing" technique is described, a technique which enables the boundary stresses in parts of complicated shape to be determined, and has the further advantage that an assessment of the elastic distortions may be made. Examples of the application of photo-elasticity include a connecting rod, crankshaft, poppet valve, and gear wheel.

B.C.R.A.

1310. Study of the Rheological Properties of Rapidly Thickening Colloidal Systems by means of the Stormer Viscometer.

H. G. HIGGINS AND K. F. PLOMLEY. Letter in *Nature, Lond.*, **163**, 22, 1949.

For a commercial Stormer viscometer it is found that $\eta = KWt$ (η = viscosity, W = actuating weight, t = time for 100 revolutions, K = instrumental constant). With $K = 2.93 \times 10^{-4}$ this equation holds for the ranges : η , 2-75 p; W , 100-500 g, $t > 18$ sec. For η between 1.5cp and 2 p and W between 10 and 100 g an additional term must be added. Newtonian and non-Newtonian liquids were distinguished by plotting W against $1/t$. Such curves were plotted from observations at 25°C on casein—lime—sodium silicate, casein—caustic soda, urea formaldehyde resin—sulphuric acid—urea and resorcinol formaldehyde resin—formaldehyde, and the main conclusions are given. It is suggested that systems which exhibit instantaneous Newtonian flow whilst the viscosity is rapidly increasing may be regarded as a distinct type.

SCI. ABSTR.

1311. An Investigation of the Dynamic Elastic Properties of some High Polymers.

K. W. HILLIER AND H. KOLSKY. *Proc. Phys. Soc. B*, **62**, 111, 1949.

An apparatus for the investigation of the transmission of sound along filaments at frequencies between 1,000 and 6,000 cycles per second is described, both for unstrained specimens and whilst they are being elongated at a constant rate of increase of strain.

Measurements of the dynamic elasticity and damping factors of filaments of polythene neoprene and nylon have been obtained, and the correlation of these results with the molecular re-arrangements which take place during stretching is discussed.

AUTHOR'S ABSTR.

1312. Theory of Elasto-Plastic Deformation and its Application.

A. A. ILYUSHIN. *Bull. Acad. Sci. U.S.S.R.*, No. 6, 769, 1948.

This paper is highly mathematical.

B.C.R.A.

1313. Planar Elasticity as a Potential Theory.

R. ISAACS. *Rev. Univ. Nac. Tucuman*, 6, 263, 1948.

The planar theory is cast into a form where the potential functions are polygenic functions of a complex variable, the derivative of the potential at any point and in any direction being (tensile stress) $+ i$ (shearing stress) at that point and in that direction. The relevant properties of polygenic functions are derived and the theory of elasticity is then developed.

SCI. ABSTR.

1314. Kinetic Theory of the Viscosity of Amorphous Bodies.

A. KOCHENDORFER. *Z. Naturforsch.*, 3A, 329, 1948.

Assuming a rigidity modulus of the same order in viscous as in solid materials, the author derives an expression for the viscosity in terms of temperature, rigidity and molecular constants. The theory is based on the view that the viscous flow of amorphous substances or liquids is of the same nature as the thermally activated gliding of crystals under stress. Results are compared with experiment for glass and molten metals.

SCI. ABSTR.

1315. Dynamic Shear Resistance of Thixotropic Systems.

N. G. KOLTASHEV. *Kolloidnyi Zh.*, 11, 73, 1949.

Thixotropic aluminium hydroxide sols in narrow (diam. 0.3-1.3 cm.) U-tubes are sucked into one arm then allowed to fall under gravity. The rate of fall and the final difference of level are claimed to give a quantitative measure of thixotropy, in view of the re-setting which proceeds during the course of the flow.

G.W.S.B.

1316. On the Theory of Elastic After-working.

D. KUHLMANN. *Z. Phys.*, 124, 468, 1948.

Derives an expression $\alpha = A \log t - B$ for the development with time t of the elastic after-effect α , on the assumption that elementary processes are involved which have activation energies proportional to the instantaneous value of the strain. Amorphous substances are discussed in detail, the after-effects being attributed to the plastic deformation of small domains by the "notch" effect. Experimental values for glass and metals are considered. The electrical after-effects in dielectrics are also discussed.

SCI. ABSTR.

1317. On the Distribution over the Volume of Metal Crystals of Deformation Produced by Slip.

D. G. KURNOSOV, N. M. TRONINA AND M. V. JAKUTOVICH. *J. Tech. Phys., U.S.S.R.*, 18, 197, 1948.

An experimental investigation, by studying the topography of the cuts of deformed mono- and polycrystal specimens by the micro-interference method. It was shown that at low degrees of deformation only the smaller part of the deformations produced is concentrated on the slip packets, whilst the greater part is distributed over the whole crystal volume.

SCI. ABSTR.

1318. On the Specific Viscosity of Solutions with Lamellar Molecules and its Dependence on Temperature.

E. KUSS AND H. A. STUART. *Z. Naturforsch*, **3a**, 204, 1948.

The specific viscosity of solutions of substances with lamellar molecules (benzene derivatives) in various solvents, mostly in nitrobenzene and xylene, has been measured at various temperatures. The most important results are: (1) the unexpectedly high value of $d\eta/dT$, (2) the occurrence of negative η values, (3) sometimes a positive $d\eta/dT$. The results have been used for calculating such constants as the mutual-action energy and mutual-action viscosity, in accordance with a theory by one of the authors.

SCI. ABSTR.

1319. Consistency Meter.

H. W. LAURANCE. *U.S. Pat.* 2,448,533, 7/9/48.

An electrical device is described for determining the consistency of a batch of concrete as it is being prepared in a mixer. The principle appears to depend on the relation between the power requirement of the mixer and the consistency of the concrete being mixed.

B.C.R.A.

1320. Investigations on the Kinematic Flow of Dispersed Systems (Peat, Thick Greases, etc.) through a Conical Channel. I. Experimental Methods.

N. V. LAZOVSKAYA. *Kolloidnyi Zh.*, **11**, 77, 1949.

The streamlines in materials flowing through tubes of diminishing cross-sectional area are followed by means of X-Ray photographs, three different cone angles (10° , 20° , 25°) being used. A formula proposed by N. A. Slezkin (*Matematich. Sbornik* **42**, 1, 43, 1935) is applied to the data for thick greases. Photographs are shown in the article.

G.W.S.B.

1321. Theoretical Aspects of Clay Consolidation.

H. H. MACEY. *Sci. Progr.*, **36**, 633, 1948.

The general theory of soil mechanics first enunciated by Terzaghi, and later modified to some extent by Taylor and Marchant, does not agree precisely with observed data. It is difficult to explain the deviation, as has been attempted, on the basis of plastic deformation, and the author therefore approaches the problem afresh from first principles. An equation is derived free from *a priori* assumptions, but in a form that cannot be solved except by approximation.

B.C.R.A.

1322. Experiments on Plasticity. IV. The Phenomenon of "Backlash."

H. H. MACEY. *Trans. Brit. Cream. Soc.*, **47**, 259, 1948.

Certain clays, under continuously repeated alternating stresses, develop a looseness of structure, or an ability to undergo large deformation at small stress. The term "Backlash" is proposed by analogy for this phenomenon which only appears in those clays or bodies in which the proportion of small particles is low. The phenomenon, and experiments illustrating its effect on stress-strain diagrams under different conditions are described and the relation between backlash and thixotropy, are discussed. Both are considered to be due to the formation of layers in the clay between which most of the shear takes place, but to lie at extreme ends of a scale in the sense that backlash occurs with clays having few small particles, i.e. in which the perfection of packing of the particles is poor, while thixotropy occurs in those clays in which the packing is good.

B.C.R.A.

1323. Experiments on Plasticity. V. The Behaviour of Clays in the Tensional Experiment with Particular Reference to the "Local Elongation" or "Necking."

H. H. MACEY. *Trans. Brit. Ceram. Soc.*, **47**, 291, 1948.

Tensional experiments on clay bars at constant rates of extension are considered both as a whole and with particular reference to the second stage in which the clay pulls out into a "neck." Data on ten widely different clays are reported and discussed. A parallel with the behaviour of cold-worked copper bars under tension is found and part, at least, of the disagreement found between repeat experiments can be explained by the supposition that the clay bars have, originally, different arrangements of the particles or "structures," although made under identical conditions. In bars of the same moisture content, high maximum stress values are associated with low elongations. B.C.R.A.

1324. Frictional Levels.

A. MARCELIN. *C.R. Acad. Sci., Paris*, **226**, 1584, 1948.

Experimental results obtained with an instrument termed a "frictiographe" are interpreted as signifying that a lubricating film comprises an integral number of double layers of molecules; the pile of layers in the film is termed a stratofilm having its own characteristic order determined by the number of double layers comprised in the film, and each layer is characterized by its own special coefficient of friction. Lubricant supplied between a rotating shaft and its bearing comprises a hydrodynamic region, including a minimum film thickness, and succeeded by a series of stratofilms in the region of the bearing. Characteristics of the frictional forces excited in the various regions as the shaft is accelerated are briefly described and illustrated.

SCI. ABSTR. (See Abstr. 790).

1325. Determination of the Viscosity of Glycerine and Various Softening Agents within a Temperature Range of + 60 and - 50°C.

W. MEISSNER. *Z. angew. Phys.*, **1**, 75, 1948.

The viscosity η of glycerine is determined by a method based on Poiseuille's formula. The liquid is moved to and fro by pistons through a Cu tube, internal diameter 5 mm. A null method is used to measure the pressure difference at two points far enough from the ends of the tube for the formula to be applicable. The accuracy of the results is 2.2%. The temperature is measured to within 0.1°C with three manganin-constantan thermocouples. For temperatures T greater than 303°K, this equation holds: $\log_{10} \eta = 3,168/T - 9.657$. For glycerine of sp. gr. 1.26 $\eta = 0.72$ poise at 60°C. A modification of Maxwell's oscillating disc method is used for 19 other organic substances, the instrument being calibrated in terms of the viscosities of glycerine, water, and their mixtures. Tables and graphs present the results, whose maximum error is 5.2%. Diagrams are given for both instruments. SCI. ABSTR.

1326. Note on Stability of Laminar Viscous Flow between Parallel Planes.

D. MEKSYN. *Proc. Roy. Soc. A*, **195**, 174, 1948.

The problem of the stability of laminar flow in two dimensions was first discussed by Heisenberg. Its solution involves the integration of a fourth order differential equation containing a large parameter, and comprising two slowly-varying and two rapidly-varying integrals. Amongst others, Tollmien has discussed the problem (*Z. angew. Math. Mech.*, **25/27**, 34, 70 (1947)). Meksyn has given a rigorous solution of the problem and deduced a transformation of the slowly varying integrals which, at first sight, appears to be quite different from the results of Heisenberg and Tollmien (*Proc. Lond. Math. Soc.*, **49**, 436 (1947)). Here this transformation is presented in a new form, and it is shown that the author's previous conclusion that Tollmien's result

was invalid so far as the hydro-dynamical problem is concerned, cannot be sustained; the terms neglected by Tollmien in his analysis are without effect on the final result.

SCI. ABSTR.

1327. Integration of the Boundary-Layer Equations for a Plane in a Compressible Fluid.

D. MEKSYN. *Proc. Roy. Soc. A*, **195**, 180, 1948.

Analytical integrations of Emmons and Brainerd's equations for arbitrary values of the Prandtl number and the Mach number, using the powerful asymptotic method of integration developed by the author in a previous paper. In the first approximations the asymptotic integration gives ample accuracy and can be determined by simple and elementary methods. The results of this comparatively rapid calculation are in very satisfactory agreement with the results of the lengthy numerical calculations made by Emmons and Brainerd for certain specific values of Prandtl number and Mach number.

SCI. ABSTR. (See Abstr. 1106).

1328. Some "Temperature-Young's Modulus" Relationships for Plastics.

H. W. MOLL AND W. J. LEFEVRE. *Industr. Engng. Chem.*, **40**, 2170, 1948.

The variation of Young's modulus with temperature for any given plastic material is useful in evaluating the suitability of that material for certain applications. A laboratory apparatus is described, which makes possible the accurate and efficient determination of the relationship between temperature and Young's modulus for a wide variety of plastic materials and sample sizes. Data for a number of plastics have been compared with impact and service data and are reported in this paper.

SCI. ABSTR.

1329. Viscosity and Thermal Conductivity of Air and Diffusivity of Water Vapour in Air.

R. B. MONTGOMERY. *J. Met.*, **4**, 193, 1947.

Carefully chosen numerical values for the viscosity and thermal conductivity of air and diffusivity of water vapour in air are tabulated for temperatures from -20°C to $+40^{\circ}\text{C}$ and for a pressure of 1,000 mb. A summary of physical constants relating to air is included.

SCI. ABSTR.

1330. Deformation of Metals in Static and in Sliding Contact.

A. J. W. MOORE. *Proc. Roy. Soc. A*, **195**, 231, 1948.

Examinations of the contours of the depression in a copper surface made by a cylindrical indenter shows that although considerable bulk deformation has occurred the asperities are relatively little deformed. When a similar groove is made by sliding with a hemispherical slider, there is sufficient surface damage to obliterate completely the surface irregularities. In the presence of a lubricant, similar effects are observed, though on a reduced scale. The tops of the asperities are wiped away, showing that there is considerable interaction between the metal surfaces through the lubricant film. A detailed examination of the surface damage produced during sliding shows that metallic junctions are formed and sheared during the sliding process. These junctions are formed even when the sliding speeds are so small that the temperature rise due to frictional heating is negligible, and it is suggested that they are produced by a cold welding of the surfaces as a result of the high localized pressures developed at the points of real contact. These junctions are often strong enough to rupture the stronger of the two sliding metals. Thus when copper slides on steel (unlubricated) there is not only a marked tearing out of copper fragments from the copper surface, but also a plucking of minute particles of steel out of the steel surface. Further, the shearing

of metallic junctions and the smearing of metallic fragments over the surfaces may produce considerable work hardening below the actual points of contact. Although a lubricant reduces the amount of intimate metallic contact, the investigation shows that metallic junctions are formed through the lubricant film by an essentially similar mechanism. These observations provide graphic evidence for the view that the frictional force for both clean and lubricated surfaces is due mainly to the shearing of metallic junctions formed by cold welding at the points of intimate contact. The significance of these conclusions in the burnishing of metals and in the behaviour of bearing alloys is discussed.

SCI. ABSTR.

1331. **Studies on Turbulence.**

G. MORETTI. *Ric. Sci. Ricostruz.*, **17**, 1623, 1947.

Reports results of papers published elsewhere and based on the method developed by Taylor and Karman. The investigation is confined to the problem of the two-dimensional turbulent transport and it therefore is possible to contract the 3 Navier-Stokes equations into a single one, containing one term characterizing turbulence. This term may be represented as the product of two orthogonal components of the turbulent oscillation, or of their r.m.s. values $\times$ a correlation factor. It is shown that this factor $\propto$ mean velocity gradient, so that the turbulence term as such can be expanded into a series in terms of the velocity gradient and its derivatives. This makes Navier-Stokes' equation formally integrable, the integration constants being then determined from experimental data on the usual considerations of affinity. It is claimed that this simplified method furnishes a result incorporating the common features of all the divergent theories. (Prandtl, Taylor, Karman, etc.), and also, that the representation of experimental data so obtained is better than that of any previous theory.

SCI. ABSTR.

1332. **Design in Devices used in the Study of Stress-Strain-Time Properties.**

D. R. MOREY. *Text. Res. J.*, **15**, 267, 1945.

The design of loading devices giving, e.g., constant stress, or constant rate of stress increase, and utilizing chain loads unwrapping from cylinders or cams, is discussed.

SCI. ABSTR.

1333. **Theories of the Mechanical Properties of Metals.**

N. F. MOTT. *Research*, **2**, 162, 1949.

The author discusses (a) diffusion in metals, (b) the concept of dislocation, (c) yield point and resistance to flow, (d) origin of age hardening, (e) the theory of work hardening, (f) theory of transient creep and (g) slip along grain boundary, crystal growth and viscous creep, in terms of the concept of atomic physics. Further experimental work is necessary before the concepts on the motion of dislocation become quantitative.

E.W.J.M.

1334. **Constant Volume Deformations with Finite Strains.**

R. MOUFANG. *Z. angew. Math. Mech.*, **25/27**, 209, 1947.

In the theory of plastic deformation linear and volumetric strains must be differentiated by analogy with Hooke's law of elastic deformation. With infinitesimal linear strains, there is no resultant volumetric strain; but with finite strains the volumetric strain depends on the 3 variants of the strain tensor. A special tensor, called "strain deviator," which does not give rise to volumetric strain, is developed. It is formed by subtracting a suitable spheric tensor from the strain tensor. The spheric tensor is found by multiplying the unit tensor with a function of 3 tensor invariants determined from a cubic equation.

SCI. ABSTR.

1335. Critical Study of Hardness Measurements and of Microhardness.

M. MOUFLARD. *Métaux et Corrosion* **23**, 245, 1948.

Programme was to determine conditions and relations between known hardness tests, to study influence of different factors on precision of hardness number according to chosen scale, with particular regard to Vickers-Brinell, interpretation of tests and conditions for best use of testing apparatus. Hardness scales are discussed, Mohs, Shore, Herbert, Brinell and Vickers, Rockwell, and theoretical hardness Hertz and Honda, experimental relations are shown between scales Rockwell, Brinell, Vickers, Shore. Factors influencing in Vickers-Brinell scale are deformation of material under action of indenter, diameter of ball, load and load application, speed of applying load and duration of load. Second part deals with role of surface finish on interpretation of tests. Influence of specimen preparation, (1) macrogeometric flatness of specimen, (2) degree of surface polish, (3) physical heterogeneity. Electrolytic polishing increases precision by reducing dispersion of test values. Orientation of diamond also of influence. Preparation of specimen particularly important if penetrated layer is very thin. Difference of hardness measured on skin of sample dependent on polish. Macro- and microhardness have different fields of application. Microhardness tests are more sensitive to surface state. Both tests simultaneously applied determine causes of differences of penetration resistance. Investigations carried out in lab. of Centre Nationale de la Recherche Scientifique, Vitry. I.D.I.B.

1336. Fundamental Study of Clay. VIII. A New Theory for the Plasticity of Clay-Water Masses.

F. H. NORTON. *J. Amer. Ceram. Soc.*, **31**, 236, 1948.

In spite of the large amount of work which has been done in the field of plasticity, none of the explanations is entirely fitted to the facts when dealing with clay-water systems of pasty consistency. As there is now a considerable amount of data on carefully fractionated and cleaned kaolinite, it has been possible to substantiate a new mechanism of plasticity which is termed the "stretched-membrane theory." This theory accounts for the plasticity of the clay masses by the compression of the whole due to the surface envelope of water which tends to push the particles together by capillary forces. This theory is shown to be reasonable by both direct and indirect proof; however, it in no way changes the general picture of the forces acting between the particles in a suspension as portrayed by the colloid chemists. B.C.R.A. (See Abstr. 31, 54, 283, 284).

1337. Tensile Strength with a Modified Mullen Tester.

R. M. OWEN. *Paper Trade J.*, **128**, 23, 1949.

The relationship of Mullen burst, tensile strength and % stretch of paper is reviewed. The need of a quick and simple method of determining the relative tensile strength of newsprint in the machine and cross directions resulted some years ago in the development of a slight modification in the ordinary Mullen tester. This modification consists in the use of an oblong aperture to replace the circular aperture in the Mullen tester tripod. The limitations and errors involved in this test are discussed. It is shown that the modified Mullen tester gives results which are in a close relation to the actual tensile strength. This test has been used for some years in several newsprint mills in grading the strength value and uniformity of the paper. P.A.T.R.A.

1338. The Frictional Behaviour of Engineering Materials.

R. C. PARKER. *Engineering*, **193**, March 4th, 1949.

Departures from Amonton's law are often large in engineering applications yet publications and handbooks give frictional coefficients to three decimal places; these measurements are rarely of practical help. μ_k is usually dependent upon the past

history of the mating materials as well as upon the apparent are of contact, normal load, relative velocity, surface finish, the nature of contaminating films, etc.

The authors present data with regard to these effects on the performance of non-metallic brake-lining materials determined on a constant torque machine and a large inertia machine.
E.W.J.M.

1339. Contribution to the Study of Saint-Venants Problem in the Elasto-Plastic Field.

G. PIZZETTI. *Comment. Pont. Acad. Sci.*, **11**, 1, 1947.

Theory of bending of beams, compression of struts and torsion of cylinders is discussed using Saint Venant's hypothesis that plastic flow occurs when a limiting strain is exceeded.
SCI. ABSTR.

1340. Recent Developments in the Mathematical Theory of Plasticity.

W. PRAGER. *J. Appl. Phys.*, **20**, 235, 1949.

A general technique for the discussion of stress-strain laws for inviscid elastic-plastic materials with work hardening is developed and various problems of plastic equilibrium are treated.
W.P.F. (See Abstr. 1174, 1248, etc.).

1341. Irany's Temperature Function of Viscosity.

B. PRASAD. *Phil. Mag.*, **39**, 645, 1948.

It is shown that the function, supposed linear in temp., is not compatible with Andrade's equation, and has only a limited range of validity. A number of similar functions may be developed but it is impossible to develop a function which is linear over a large range of viscosity for all liquids.
SCI. ABSTR.

1342. A Theory of Viscosity and Thermal Conductance of Liquids and Highly Compressed Gases.

B. PRASAD. *Phil. Mag.*, **39**, 884, 1948.

Assuming Andrade's theory, an expression for the viscosity (η) of a liquid is obtained. Modifications of this formula, made by Andrade, are unnecessary on theoretical grounds and also on the basis of experiment. The mechanism of thermal conductance of a liquid is the same as that of viscosity, and this fact leads to an expression for the conductance (K). For a highly compressed gas the mechanism for η and K is the same as for a liquid, as is shown by existing experimental data.
SCI. ABSTR.

1343. Some New Studies in the Strength Properties of Paper.

H. F. RANCE. *World's Paper Trade Rev.*, **131**, Tech. Sup. 1, 1949.

The impact of rheological studies upon the strength testing of paper is discussed, and a survey is given of the relevant literature. Some new experimental results are discussed, including work on a system of empirical strain analysis and the relation between plastic flow and wet expansion. It was found that pre-straining a wet paper strip reduced the wet expansion by an amount more or less proportional to the degree of permanent set which had been put into the specimen.
P.A.T.R.A.

1344. Some New Studies in the Strength Properties of Paper.

H. F. RANCE. *World's Paper Trade Rev.*, **131**, Tech. Sup. 9-13, 1949.

For many purposes a stress/strain curve is sufficient to predict the behaviour of a sheet under predetermined conditions; this is demonstrated in connection with the folding endurance of paper. The folding endurance, as measured by the Schopper

instrument, is controlled by, and relatable to, the elastic flexibility of the paper under consideration. It was concluded that the flow characteristics have little significance for folding endurance. When the elastic flexibility was plotted against the square root of the folding endurance a smooth curve was obtained. It is considered that the ultimate rupture of a paper sample is the logical termination of the straining process and the conditions of rupture are entirely determined by the strain history of the sample, subject to the incidence of any abnormalities in the paper structure. An instrument has been developed which gives rapid and accurate automatic stress/strain records. This instrument, which is akin to the Cambridge textile extensometer, is briefly described.

P.A.T.R.A.

1345. Resistance Strain Gauges for the Measurement of Roll Force, Torque, and Strip Tension.

J. RANKINE, W. H. BAILEY AND F. P. STANTON. *J. Iron Steel Inst.*, **160**, 381, 1948.

Methods of measuring roll separating force, spindle torque and strip tension in a 10×10 in. two-high experimental cold-rolling mill by the use of resistance strain gauges are described and illustrated. The tension meter consists of a combination of a torque-meter and a device which automatically divides the value of the torque by the coil radius. The equipment operates on d.c. at 100 V which can be supplied from dry batteries. Electronic equipment is limited to one single-valve d.c. amplifier which is used only when measuring very low voltages. The value of torques and tension are indicated on 2½ in. pointer meters, the readings of these and similar meters indicating other variables being recorded simultaneously by a 35 mm cinematograph camera equipment.

SCI. ABSTR.

1346. Physics and Chemistry of Hydrocarbon Gels.

E. K. RIDEAL. *Nature*, **163**, 665, 1949.

A summarized report of a Royal Society discussion (24th March, 1949) on thixotropic polymer or soap-thickened hydrocarbon systems.

The mechanism of the swelling of the gel phase and the rigidity of gels were considered. Data suggest that twisting of chains against hindered rotation rather than bond extension or chain entropy is the main factor in rigidity. The point of thixotropic breakdown is considered to be associated with a balance between bond breaking and bond making. To describe the flow properties of the system two physical parameters are required, namely, viscosity and normal stress coefficient. Aluminium soap complexes in hydrocarbon dispersion can be broken down by peptizing agents, such as water, amines, alcohols, etc., which break the aluminium oxygen co-ordinate links by preferential co-ordination with the peptizer.

E.W.J.M.

1347. A General Kinetic Theory of Liquids. VI. The Equation of State.

A. E. RODRIGUEZ. *Proc. Roy. Soc. A.*, **196**, 73, 1949.

The paper studies an approximate equation of state, first derived by Green, which covers both phases, liquid and gas, and can be used for numerical evaluation. It contains explicitly the roots of a certain transcendental equation. The difference between the liquid and the gas corresponds to the existence of non-existence or real roots of this equation. The solution of the transcendent equation has been reduced, by using a suitable expansion, to the solution of an algebraic equation. In this way explicit expressions for the equation of state are obtained which, however, are too involved to be generally discussed. The theory can be applied to A using the Lennard-Jones potential for the interaction between A atoms, and the results are shown in diagrams. The character of the singularity separating liquid and gas can be seen from these diagrams to lie at the lowest point of the isotherm in the unstable region. An estimate of the position of the critical point is made and found in fair agreement with the experimental data.

SCI. ABSTR.

1348. Rheology of Rubber.

F. RÖSSLER. *Zeit. angew. Phys.*, **1**, 50, 1948.

Stress-strain curves, tearing strengths and plastic flow under constant load were measured on test strips of various rubbers at temperatures from -80°C to room temperature. Flow effects were much greater at low temp. and a small elastic after-effect was observed. There was a general similarity between the results for natural and synthetic rubbers. Theoretical explanation of results is suggested. SCI. ABSTR.

1349. New Method for the Measurement of the Viscosity of Metals.

C. SĂLCEANU. *C.R. Acad. Sci., Paris*, **226**, 1798, 1948.

Results are given for the viscosity of 9 metals obtained by a method using determinations of the log. dec. of a pendulum employing the metal as the suspension. Differences from the results of previous workers are discussed. An attempt is made to determine the influence of temperature. SCI. ABSTR.

1350. The Thermal Stresses in a Body.

W. SCHMEIDLER. *Z. angew. Math. Mech.*, **28**, 54, 1948:

The stresses in a body subjected to a stationary field of temperatures are expressed by 3 partial differential equations. The solution is determined by the fact that the normal and shear stresses are zero at the surface. The problem is reduced to 4 linear integral equations for the cubical expansion and the 3 components of the curl of the displacement vector; and the conditions for the existence of a solution are found.

SCI. ABSTR.

1351. The Spreading of a Liquid over a Rough Solid.

R. SHUTTLEWORTH AND G. L. J. BAILEY. *Disc. Farad. Soc.*, No. 3, 16, 1948.

A liquid placed on an ideally smooth solid spreads until the total surface energy is an absolute minimum and the contact angle is uniquely defined. When the solid is rough, the value of the apparent contact angle at the absolute minimum of surface energy is different and is given by Wenzel's expression. In equilibrium, the liquid surface near a rough solid must be ragged in order that it intersect the solid at the true contact angle. On solids, whose roughness is formed by isolated pits, subsidiary minima of total surface energy exist and hysteresis of contact angle arises because the liquid comes to rest at a different minimum after spreading and recession. The inevitable roughness of solids is sufficient to explain hysteresis. B.C.R.A.

1352. Terminology in the Field of Viscometry of Liquid Mixtures of High-Polymeric Materials.

G. L. SLONIMSKIĬ, S. S. VOYUTSKIĬ AND YU L. MARGOLINA. *Kolloidnyi Zh.*, **11**, 116, 1949.

Gives the customary Russian equivalents for the definitions for specific, reduced, intrinsic, etc. viscosity as proposed by Cragg (*J. Colloid Sci.*, **1**, 261, 1946). G.W.S.B.

1353. Theory of the Strength of Metals considering their Structure.

N. K. SNITKO. *ŷ. Tech. Phys., U.S.S.R.*, **18**, 857, 1948.

A method for determining numerically the yield point of a polycrystalline metal in any state of compound stress, applied to the three lattice groups of α -Fe, Cu and Zn, clearly showing the influence of the structure. The result shows that the Huber-Mises theory furnishes yield point values agreeing approximately only with those obtained by the author for the group of quasi-isotropic, coarse-grained α -Fe (neglecting influence

of grain boundaries, and in the range of small plastic deformations). For fine-grained steel and for tempered materials, having different plastic properties, the mechanical application of Huber-Mises' theory is not warranted. SCI. ABSTR.

1354. An Autographic Stress Relaxometer.

R. S. STEIN AND H. SCHAEVITZ. *Rev. Sci. Instrum.*, **19**, 835, 1948.

Designed and constructed for studying the relaxation of the stress of a polymer film elongated to constant length. The force-measuring element is a linear variable differential transformer which measures the distortion of a flexible steel ring and drives a recorder. The sample is elongated to the desired length automatically, and the correct length is maintained by means of a second differential transformer. SCI. ABSTR.

1355. Elastic Behaviour of Quartzite and Fused Quartz.

R. V. G. SUNDARA RAO. *Proc. Indian Acad. Sci. A*, **28**, 185, 1948.

Effective elastic constants of quartzite have been computed from determinations of the velocities of an ultrasonic wave along 3 orthogonal directions. Velocities and elastic constants are the same in the 3 directions. Since the velocity in fused quartz is practically equal to that in quartzite it is concluded that quartz grains are randomly oriented in quartzite. SCI. ABSTR.

1356. The Theory of Cavitation and the Process of Butter Churning.

V. SURKOV. *Molochnaya Prom.*, **9**, 28, 1948.

An account of work on butter-making in progress at the Moscow Chemical and Technological Institute of the Meat Industry.

It is claimed that a gas phase plays an important part in the fusing of fat globules in breaking the *O/W* emulsion and also that peripheral velocities in the "continuous" churn exceed those needed to induce cavitation, i.e. the formation of cavities in the fluid.

In "periodic" butter-making processes, velocities are lower and cavitation therefore plays a less important part. Here especially the presence of a gas phase is significant.

The effect of variations in temperature of churning is discussed. G.W.S.B.

1357. A Falling Sphere Viscometer for Use with Opaque Liquids.

A. M. THOMPSON. *J. Sci. Instr.*, **26**, 75, 1949.

The charge of inductance of a coil is used to signify the passage of the sphere past the reference marks. The auxiliary bridge circuits are described and constructional details of the Viscometer are given. J.E.C.

1358. Some Factors Influencing the Accuracy of Mullen Testers.

N. G. M. TUCK AND S. G. MASON. *Paper Trade J.*, **128**, 22, 1949.

The variation of pressure with time in Mullen burst tests on paper was determined by taking pictures of the motion of the gauge needle at 64 frames per second. It was found that the pressure increases at an increasing rate to a maximum at burst and then decreases suddenly. The expansibility of a number of gauges in use on Mullen testers was measured, and a variation of from 0.6×10^{-3} to 6.4×10^{-3} cc./lb./sq. in. was observed. The gauge expansibility has a marked effect on the rate of straining of the sample during a burst test. This in turn can influence the burst pressure. To eliminate this source of variation, the gauge expansibility should be specified in the standard test method. The effect of air in reducing the burst pressure has been studied. From the data on the rate of loading, a theoretical analysis of the dynamic errors in gauges has

been made. The errors are of three types, and arise from friction, vibration and overshooting of the needle mechanism. The cumulative dynamic error is of the order of 2%, and is due mainly to overshooting. P.A.T.R.A. (abridged). (See Abstr. 1006, 1104).

1359. Relaxation Measurements on Systems having Colloidal Structure.

S. Ya. VEILER, V. I. LIKHTMAN AND P. A. REBINDER. *Kolloidnyi Zh.*, **11**, 8, 1949.

An apparatus is described in which a vane attached to a spring is suspended in the relaxing system, the relaxation being followed by observations on a scale with a cathetometer. Gelatine sols are shown to follow Schwedoff's law, i.e. there is a linear plot for $\log. (P - P_{\infty})$ vs t . G.W.S.B.

1360. The Thermomechanics of Ideal Fluids.

J. E. VERSCHAFFELT. *Bull. Acad. R. Belg. Cl. Sci.*, **34**, 325, 1948.

On the view that a gradient of temperature in a fluid acts as a motive force, a term depending on temperature is introduced into Euler's equations of motion, and a similar extension is made to the theorem of Bernoulli. Various problems of flow arising from initial gradients of temperature are considered and solutions obtained in accordance with the theory given. The process employed extends the theory of fluid motion to include effects of molecular motion as postulated in the kinetic theory of matter; and several problems are considered from this point of view. One result obtained by the application of the laws of thermomechanics is that the flux of heat conduction has, to a moving observer, the same intensity as to a stationary observer. SCI. ABSTR.

1361. Rheology of Typographic Printing Inks.

A. VOET. *Internat. Rheological Congress*, 1948.

Properties required in printing inks at various stages of the printing process are reviewed. The phenomena of thread formation during rolling and ink misting are discussed with reference to the viscosity and yield value of the inks. The property of tack is discussed and related to the viscosity of the ink only. The splitting of an ink film is postulated as due to rupturing of a thin liquid film as if it were a solid, rather than to fluid flow. P.A.T.R.A.

1362. Rheology of Typographic Printing Inks.

A. VOET. *Amer. Ink Maker*, **27**, 27, 41, 1949.

The rheological requirements of the inks at the various stages from the ink container to the paper (viz., the "transport," "distribution" and transfer phases) and the tackiness of inks are discussed. In the transport phase, a low yield value and absence of thixotropy is required. In the distribution phase a maximum viscosity is allowed for each press speed, to secure a proper ink distribution, although, to prevent misting, a high yield value is desirable. Finally, in the ink transfer phase a high viscosity should be combined with a low tackiness. While usually viscous inks are tacky, variation of the press speed and the film thickness applied may modify the viscosity-tack relationship. A new instrument to measure tack in fundamental units is described. P.A.T.R.A.

1363. Influence of External Gas Pressure on the Oiliness of Lubricants.

G. VOLOVICK. *C.R. Acad. Sci., Paris*, **227**, 1354, 1948.

The oiliness of 3 oils used in refrigerators was measured under conditions where the gas pressure could be varied. If the coefficient of friction of dry rubbing surfaces is F and the coefficient when lubricated is f then the oiliness (ϕ) of the lubricant is defined as $\phi = (F - f)/F$. When the gas surrounding the rubbing surfaces is at atmos-

pheric pressure, ϕ increases with time and reaches a steady value. As the pressure is reduced, ϕ increases again in a series of steps. Pressures down to 10 mm Hg were investigated with air, CO_2 , NH_3 and SO_2 . The explanation is that the number of gas molecules in the lubricating layer is reduced as the pressure is reduced, thus increasing the number of oil molecules and hence the oiliness. SCI. ABSTR.

1364. Physical Properties of Poly-1, 2-dimethylethylene Phthalate.

R. W. WATSON AND N. H. GRACE. *Canad. J. Res.*, **26B**, 752, 1948.

The polyester derived from *levo*-2,3-butanediol and *o*-phthalic anhydride is moderately hard at a number average molecular weight of 660 ($DP=3$), and at an average DP of 4 is a brittle glass. Its hardness on the Brinell scale ranges from about 10 at $\bar{M}_n = 880$, to 22-23 at $\bar{M}_n = 2500$, where it equals the hardness of Lucite. Water absorption decreases with increasing molecular weight, and reaches a value of 0.08% in 430 days at 25°C for a DP 36 resin. A 50% solution of a solid DP 4 resin ($\bar{M}_n=840$) in acetone has an absolute viscosity at 25°C of 1.4 centipoises. Apparently molecular solutions are formed in common aromatic hydrocarbons, ketones, alkyl acetates, alcohols, ethers and chlorinated solvents. AUTHORS' ABSTR.

1365. The Viscosity-Molecular Weight Relation for Poly-*levo*-2, 3-butadiyl *o*-Phthalate.

R. W. WATSON AND N. H. GRACE. *Canad. J. Res.*, **26b**, 783, 1948.

The inherent viscosities of dilute solutions of acidic polyesters of high purity have been compared with number average molecular weights accurately determined by end-group titration. For unfractionated resins with a degree of polymerization from 2 to 11 ($\bar{M}_n=480$ to 2410) the viscosity-molecular weight relation is linear in chloroform at 25°C. Where in $\eta_r/c = K\bar{M}_n + \beta$, $K = 1.923 \times 10^{-5}$ and $\beta = 0.0176$. For fractionated polyesters from DP 5 to 8, $K = 1.959 \times 10^{-5}$ and $\beta = 0.0161$. For unfractionated resins with a $DP > 11$, molecular weights increase more rapidly than inherent viscosities. Above $\bar{M}_n=14,000$ for fractionated resins linearity is resumed and the slope increases. Several attempts have been made to explain this complex relation. Apparently the short chains remain linear, and the formation of anisotropic fibers at a DP close to 100 establishes a degree of molecular orientation in the long-chain superpolyesters. Isomerization of *levo*-diol to the diastereoisomer during polycondensation is without effect on the dilute solution viscosity of the resulting resin. Preferential degradation of the longer chains is assumed to be partially responsible for the decreasing slope from DP 11 to 65. As yet it has not been possible to assess the roles played by changes in size distribution, and variation in solvation with increasing chain length, but the data point to a curved viscosity-molecular weight relation in chloroform at 25°C.

AUTHORS' ABSTR.

1366. Some Investigations on Turbulent Friction Layers.

K. WIEGHART. *Z. angew. Math. Mech.*, **25/27**, 146, 1947.

The velocity profiles for arbitrary pressure curves were always found approximately one-parametric, even behind considerable obstacles or along rough surfaces, in accordance with Gruschwitz's results (*Ing. Arch.*, **2**, 231, (1932)). The law valid outside the laminar sub-layer and near the wall is $u/U \sim (y/\theta)^{1/7.7}$ (where u =average veloc. in layer, U =velocity outside layer, y =dist. from wall, θ =density of impulse loss) and this despite the dissimilarity of turbulence characteristics (e.g. curves of shear stresses). On Prandtl's boundary layer theory a relation for the energy of friction layers may be derived in analogy with the impulse law. All these relations taken together enable a differential equation for $\eta(x)$ to be set up, corresponding to Gruschwitz's diff. eqn. which had been

obtained empirically. However, the dynamic terms entering the diff. eqn. such as shear stress τ_0 near the wall, or work of the shear stresses, still evade determination, as their variation shows the most surprising discontinuities. However, these effects are not observed so long as $\theta/U \times dU/dx| < 1 \times 10^{-3}$. SCI. ABSTR.

Industrial Adhesives: Review of Colloidal Properties of Sodium Silicate.

J. H. WILLS AND R. H. SAMS. *Ind. Engng. Chem.*, **41**, 81, 1949.

The general qualities of sodium silicate solutions which has led to their use as industrial adhesives have been reviewed, with reference to recent studies and available data. The effect of the ratio of sodium oxide to silicon dioxide and water content on colloidal, rheological, reactivity and strength properties is emphasized. A study of the viscosity change in drying indicates that an initial set occurs at about 40,000 poises and that this requires the loss of less than half the amount of water which equilibrium conditions would require. The rate at which such adhesives wet paper depends on the ratio of sodium oxide to silicon dioxide as well as on the viscosity or concentration. Wetting agents appear to strengthen the bond only as they increase the spread. The strength of the bond tends to decrease for equivalent spreads. There is a real need for a study of the tack strength of such adhesives and for a study of the colloidal structure by modern techniques. Application of the properties outlined has resulted in the development of new products and mixtures with clay, etc., which meet the needs of modern high-speed machines. P.A.T.R.A. (See Abstr. 867).

BOOK REVIEW

VISCOMETRY. By A. C. MERRINGTON, LONDON. Edward Arnold, 1949, pp. 142, viii., 6s. net.

In VISCOMETRY Dr. Merrington gives a brief description of most viscometers of importance to the research worker. Consequently, the treatment of any one instrument or class is necessarily concerned with the essential characteristics rather than with the details which affect the final accuracy of the method. The task of choosing typical examples of viscometers, though facilitated by Barr's "Monograph," is still very difficult and on the whole Dr. Merrington chose well. The book is well arranged, has very few minor mistakes in printing and can be safely recommended to all those who want an outline of the essentials of viscometry without the necessity of delving into the subject.

The book deals successively with capillary, rotary, oscillatory, falling sphere and technical viscometers. This is followed by chapters discussing particular problems, i.e. viscometry of gases, miscellaneous methods adaptable to special circumstances of pressures, temperature and other conditions, the evaluation of semi-solids and very viscous liquids and finally complex non-Newtonian systems.

Perhaps, the chief criticism is that the book suffers from certain important omissions. The discussion of end-effects in capillary viscometers neglects important additions to our knowledge of these matters which appeared subsequently to Barr's classical book. In discussing rotary viscometers the rather important and useful class of recording viscometers which have been developed in recent years is not mentioned. The complex functions which control the behaviour of rolling sphere viscometers are not given due considerations. And finally, it is perhaps inevitable that the chapters dealing with semi-solids and with complex non-Newtonian systems should be too short to deal with the subjects adequately.

Nevertheless, the book will be found useful and well worth its price; it fills the need for a short book to supplement the few and infrequent books dealing with the subject.

A.H.N.