

BRITISH RHEOLOGISTS' CLUB

BULLETIN No. 20



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ROYAL AIRCRAFT ESTABLISHMENT,
FARNBOROUGH, HANTS.

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LONDON, S.W.6.

Bulletin No. 20.

September, 1948

Price to non-members, 5/-

CLUB NOTES.

(As foreshadowed in the last issue, this Bulletin has been delayed on account of the International Congress on Rheology.)

International Rheological Congress.

A big group of our members attended the Scheveningen Congress. It was generally agreed that the Congress was a great success and that the Dutch Organizing Committee and especially Mr. Rotgans were to be warmly commended for their excellent organization of all the arrangements. Nor will British Rheologists forget the many personal kindnesses shown to us by our colleagues in Holland.

Size of the Bulletin.

It has been pointed out to the Hon. Editor that the cost of the printing of the Bulletin has been steadily increasing and is now beyond the financial capacity of the Club. This is due to the ever-increasing number of abstracts and, for the present, the Editor will have to be stricter than hitherto by excluding abstracts of papers not likely to appeal to any appreciable number of members. He is always glad to hear members' views as to what topics are of interest to them.

List of Members.

The cost of printing and circulating lists of members annually has now become prohibitive. In future, replicated lists will be available to members on application to the Hon. Secretary.

*At the A.G.M., Dr. V. G. W. HARRISON, Lyndhurst, Links Way, Little Bookham, Leatherhead, Surrey, was elected Hon. Treasurer.

FUTURE MEETINGS.

Annual General Meeting.

By the time this Bulletin reaches members, the A.G.M. will have been held in London on October 29th. A discussion on "Fracture of Solids" will be introduced by Professor N. F. Mott, F.R.S. (who has been nominated as our President) and other speakers will include Dr. E. Orowan, F.R.S., Dr. C. F. Tipper, Professor H. Moore and Mr. H. W. Hall.

Mathematics in Rheology.

A meeting on this subject will be held at the London Polytechnic, Upper Regent Street, on Tuesday, December 14th, the speakers being Dr. J. Topping and Dr. P. White. If Dr. M. Reiner is still in this country, he will preside.

Rheology of Petroleum Products.

A meeting is planned for July, 1949, to be held in Birmingham. Speakers will include Dr. A. H. Nissan.

Sedimentation and Rheology of Suspensions.

A joint meeting with the local branches of the Chemical Society and the Royal Institute of Chemistry is planned for May 6th-7th, 1949, in Exeter. The meeting will be followed by a visit to the Shiny Ore Mines.

Further Meetings.

It is planned to hold a meeting next Easter in Cambridge and the 1949 Annual Conference will take place in Bristol, September 21st-24th. Further particulars of all these meetings will be sent to members in due course.

Reprints.

Limited numbers of reprints of (1) The Journal of the Textile Institute account of our Leeds meeting; (2) Mr. H. H. Macey's paper in J. Sci. Instrum. are available on application to the Hon. Secretary. It is hoped to be able to send to all members copies of the account of the International Congress as reported in *Nature*.

Other Societies' Meetings.

The Road and Buildings Materials Group of the S.C.I. kindly invites our members to a meeting at 6 p.m. on April 21st, 1948, at which a paper will be read by Mr. R. S. Millard on "Problems in Concrete Road Constitution." Further particulars will be given in the usual journals.

The Institute of the Rubber Industry offers the Proceedings of the Rubber Technology Conference, June 23rd-25th, 1948, to those who apply before December 31st, 1948, at a cost of £2 2s. 0d. The cost to later applicants will be £3 3s. 0d.

The Mond Nickel Co. Ltd. has recently issued a summary of properties and uses of nickel alloy steels. Free copies may be had on application.

News of Members.

We are delighted to know that our two Palestinian members are safe and well. Dr. Markus Reiner is in England for an unspecified period, working at the National Institute for Research in Dairying, University of Reading, and his friend and former pupil, Mr. Qaddura, is now a lecturer in Physics at the Syrian University, Damascus.

Dr. Reiner's book *Ten Lectures on Theoretical Rheology* has not been available for some time. The last remaining seventy copies were flown over from Jerusalem to Holland but unfortunately too late for the Congress. They can now be obtained from Academia, Oude Delft 101, Delft, Holland.

CORRESPONDENCE

Shinfield, 9th October, 1948.

Dear Dr. Scott Blair,

In attempting an agreed standard notation in the mathematical theory of rheology, one meets the problem of how the components of the strain should be expressed. Love, from whom we of the older generation learned elasticity, writes:—

$$e_{xx} = \frac{\partial u}{\partial x}; e_{xy} = \frac{\partial v}{\partial x} + \frac{\partial u}{\partial y} \quad (1)$$

In this case, if γ is the modulus of rigidity, the tangential stress

$$p_{xy} = \gamma e_{xy} \quad (2)$$

Conditions are similar in hydrodynamics where

$$p_{xy} = \eta e_{xy} \quad (3)$$

But in the form of Equ. (1) the e_{xx} and e_{xy} are not components of one tensor and if one keeps e_{xx} for the normal component, the tangential component of the tensor is $e_{xy}/2$. Murnaghan and also Sokolnikoff define

$$\bar{e}_{xy} = \frac{1}{2} \left(\frac{\partial v}{\partial x} + \frac{\partial u}{\partial y} \right) \quad (4)$$

This makes e_{xx} and $\bar{e}_{xy}$ components of one tensor, but necessitates writing (2) and (3) in the form

$$p_{xy} = 2\gamma \bar{e}_{xy}, p_{xy} = 2\eta \bar{e}_{xy} \quad (5)$$

Nobody will attempt to double all moduli of rigidity and all coefficients of elasticity and thereby get rid of the factor 2. There is a way out, used by Trefftz, by defining

$$\bar{e}_{xx} = 2 \frac{\partial u}{\partial x} \quad (6)$$

keeping Love's definition for e_{xy} .

In this case, $\bar{e}_{xx}$ and e_{xy} are components of one tensor and the factor 2 is avoided. But apparently nobody else has followed Trefftz.

Being now occupied with revising, for a new edition, my *Ten Lectures on Theoretical Rheology*, in which I used the definition (1), but inclined to change over to (4), I should be grateful to know the views of those members of our Club who have come across this problem.

Yours sincerely,

M. REINER.

RHEOLOGY ABSTRACTS

NOTE.—The initials following the Abstracts are those of the abstracting member, except for the following abbreviations for abstracts 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.

1055. Mechanical Toughness of Glass.

L. V. AFANASYEV and Y. E. FEIN. *Stek. Keram. Prom.*, **11**, 16, 1947.

Factors influencing the mechanical strength of glass are considered and the effects of temperature, surrounding atmosphere, and the purpose for which the glass is used are discussed.

B.C.R.A.

1056. Creep of Metals and Recrystallization.

E. N. DA C. ANDRADE. *Nature*, **164**, 410, 1948.

The normal creep of a polycrystalline metal rod extending longitudinally under constant stress can be represented by the formula $l = l_0 (1 + \beta t^{1/3}) e^{kt}$ where l is length at time t , l_0 the initial length and β and k are constants. This gives a final rate of extension per unit length which tends to become approximately constant.

Recrystallization during creep has been shown to produce increased rate of flow. Using a sample of pure lead which crystallizes under stress, the crystals increasing in size from about 0.05mm. up to about 0.3mm. linear dimensions, a stage of accelerated creep was observed during the first ten minutes followed by a final creep at an approximately constant rate.

E.W.J.M. (see Abstr. 934).

1057. Elasto-viscous Effect in Shellac.

S. BASU. *Indian J. Phys.*, **22**, 55, 1948.

Elasto-viscous properties of T. N. shellac and partially polymerized samples were measured. The total extension is due to three distinct processes: (1) true elastic deformation, (2) delayed elastic deformation and (3) a viscous flow. These processes are explained by attributing an iso-colloidal structure to shellac. Calculation of the relaxation time shows that the dispersed phase consists of micelles, whose formation is due to secondary forces between the molecules. The dispersion medium consists of monomeric particles. On partial polymerization, the polymeric products form a part of the dispersion medium, increasing its viscosity. The low value of extension is explained by the granular nature of the micelle.

SCI. ABSTR. (See Abstr. 836).

1058. The Strength Properties of Paper.

J. BEKK. *Papierwereld*, **1**, 292, 310, 326, 1947.

The purpose of the investigations was to establish a relation between the substance and strength of paper, and the samples prepared were derived from five varieties of pulp: unbleached kraft and sulphite, bleached sulphite and linen (rag) and unbleached straw. Each sheet (*i.e.*, fifteen samples for each pulp) was tested for tensile strength and stretch at breaking point, burst, tear and circular tensile strengths, bending resistance and folding endurance. Only two pulps (bleached sulphite and rag) showed an increase in breaking length with increased beating; the others indicated no clear relationship. The unbleached straw paper showed an increase in stretch at breaking point with beating, the bleached rag just the reverse,

and the other samples no certain relationship ; while for all samples substance and stretch at breaking point increased correspondingly. Bursting strength was found to increase somewhat with substance, but to remain fairly constant over the higher range ; for bleached sulphite and unbleached straw the burst increased with beating, otherwise no definite relationship was established. Tearing strength increases gradually with substance but was found to decrease with beating for bleached sulphite and rag, and with unbleached kraft and sulphite at degrees of beating above 55° S.R. Initially circular tensile strength shows an increase with substance to 80g/sq. m. and then remains fairly constant, and also shows an increase with beating for both bleached and unbleached sulphite papers—otherwise no relationship was apparent. Bending resistance increases with substance, but for unbleached kraft and bleached rag decreases with beating. The folding strength increases with increasing substance, not proportionately but at a greater rate, especially so the lower the degree of beating (as shown particularly by bleached rag paper). A definite agreement can be discovered amongst the tensile, burst, tearing and circular tensile strengths. Although a comparatively close relationship exists between tensile and circular tensile strengths, calculation one from the other is impossible since their ratios are not constant in any respect. The relationship between tensile and burst is less close, and that between burst and circular tensile even less. Nevertheless, tensile, burst and circular tensile can be reckoned as one group of strength properties, as they are influenced in the same way by substance, and since for paper made from bleached sulphite the degree of beating also exercises a similar influence on these strength properties. P.A.T.R.A.

1059. A Penetroviscometer for Very Viscous Liquids.

J. J. BIKERMAN. *J. Colloid Sci.*, **3**, 75, 1948.

A new viscometer is described. The viscosity is calculated from the rate of descent of a heavy vertical rod in a coaxial tube filled with the liquid, the viscosity of which is greater than about 1,000 poises. B.C.R.A.

1060. A Coaxial Cylinder Viscometer of Wide Utility.

R. F. BOWLES. *J. Oil Colour Chem. Assoc.*, **31**, 87, 1948.

1061. Creating a Technology of the Wet Strength of Paper: a Condensed Report of the Study of the Wet Strength of Paper.

W. BRECHT. (See Abstr. 841).

1062. The Consistency of Plastic Suspensions of the Bingham Type.

H. DE BRUYN, H. DOLS and C. KUYPER. *Rec. Trav. Chim.* **62**, 696, 1943.

In the case of the plastic suspensions of carbon in mineral oil it is deduced that the temperature coefficient of the consistency is determined almost entirely by the medium of suspensions. In order to describe the curved part of a $D - \tau$ diagram more exactly by means of constants, the concept of liquidation tendency is introduced. G.M. (See Abstr. 365).

1063. The Rate of Shear-Shearing Stress Diagram ($D - \tau$ - diagram) of Plastic Suspensions.

H. DE BRUYN. *Rec. Trav. Chim.* **63**, 611, 1943.

The plastic behaviour of suspensions is considered from the point of view of energy, of structure and of mechanics. The similarity and the difference is pointed out between the method of analyses of the $D - \tau$ data of suspensions of the Bingham type given in the article and the Williamson method.

The plastic behaviour of suspensions in general is characterized by three constants :—the liquidation tendency L and the plasticity limits τ_1 and τ_3 . G.M.

1064. **Rheology of Thermoplastic Materials.**

R. BUCHDAHL. *J. Colloid Science*, **3**, 87, 1948.

The flow properties of polystyrene were studied at 135–200°C. by means of a rotational viscometer. P.A.T.R.A. (See Abstr. 681).

1065. **Studies in Boundary Lubrication – II.**

W. E. CAMPBELL and E. A. THURBER. *Trans A.S.M.E.*, p. 401, 1948.

The apparatus consisted of a three-legged slider on an optically plane surface of hardened tool steel enclosed in a desiccator the atmosphere in which could be accurately controlled. The slider consisted of three spheres clamped between two plates.

The load necessary to start the slider slipping on the surface under various conditions was measured.

It was found that the presence of moisture increased the co-efficient of static friction between the slider and the plate when lubricated by different pure compounds and oils. The increase was not noted when the lubricant was moist but the plane dry ; it was evident when dry lubricant was used on a moist surface. Hence it was concluded that the increase is connected with the adsorption of water molecules on to the metal. The increase in friction appeared with steel, brass and glass when water was absorbed.

Discrepancies noted in previous experiments reported in the literature on the oiliness of lubricants might well be due to the uncontrolled humidities of the atmospheres of the different experiments using static-friction methods.

The phenomenon observed was reversible : when the moist surfaces were dried the friction drops to its original low value and when they were remoistened it rose again almost to its full high value.

Views advanced in the Discussion that the effects observed were due to “capillary action” were not accepted by the authors. A.H.N.

1066. **The Strength of Soils under Dynamic Loads.**

A. CASAGRANDE and W. L. SHANNON. *Proc. Am. Soc. C. Engrs.*, **74**, 591, 1948.

In connection with studies on the stability of slopes in the Panama Canal, under the effects of bombing, laboratory investigations on the strengths of soil and soft rocks under dynamic loading have been carried out at Harvard University.

The specimens were tested in triaxial compression. Three types of apparatus were used : (a) *pendulum loading* which was best suited for a time of loading between 0.01 and 0.05 sec., (b) *falling beam loading*, for the range 0.5 to 300 secs., (c) *hydraulic loading* for any time greater than 0.05 sec., and primarily for the higher stresses required in testing the soft rocks.

Tests were made on a sand, and it was found that the strength increased by only about 10 per cent on decreasing the time of loading from 1,000 secs. (standard static test) to 0.1 secs. With four clays, with a static compression strength of the order 1 to 4 kg./cm.², the increase over this same range of testing time varied from 140 to 180 per cent. On reducing the time of test to 10 secs. the strength increased between 115 and 140 per cent. Tests on a shale, with a static strength of 60 kg./cm.² showed an increase of 160 per cent. on reducing the time of loading to 0.06 secs.

For the clays and shale the modulus of deformation for fast transient loading was approximately twice the value for the usual static test, while little change could be observed with the sand. A.W.S.

1067. **Elastic Recovery and Relaxation of Concentrated Solutions of Macromolecular Substances.**

Y. CONSEILLER. *C.R. Acad. Sci., Paris*, **225**, 1007, 1947.

Concentrated solutions of macromolecular substances, which are true liquids,

also possess some of the characteristics of plastic solids. They show elastic recovery, e.g. when an applied force is suddenly removed, and the relaxation of the internal elastic stress can be followed directly. Two constants can be defined and measured : (a) time of relaxation ; (b) time of elastic recovery ; these are different in general, (a) usually < (b), the latter varying from 1 to 10^3 sec., depending on the nature of the system, the concentration and the age of the solutions. Results are given of measurements on solutions of nitrocellulose. SCI. ABSTR.

1068. **The Effect of Temperature and Mixed Solvent Composition on the Intrinsic Viscosity of GR-S.**

L. H. CRAGG and T. M. ROGERS. *Canad. J. Res.*, **26B**, 230, 1948.

Experiments lend support to the theory of Mark and others that $[\eta]$ is highly sensitive to variations in the shapes of flexible long-chain molecules. These shapes are dependent on the nature of the solvent. $[\eta]$ is shown to be comparatively independent of temperature. G.W.S.B. (See Abstr. 750).

1069. **A New Apparatus for the Study of Hysteresis and Internal Friction in Plastics Subjected to Alternating Flexion.**

G. DAWANCE. *Inst. Tech. Batiment Trav. Pub. I*, No. 34, 1947.

The apparatus is described and figured and some test results obtained with it are presented and discussed. With this apparatus it is possible to measure the damping capacity of plastics under loads varying from the fatigue limit, where direct measurement is impracticable. The hysteresis cycles are recorded photographically. B.S.A.

1070. **A Flowmeter for Measuring Small Liquid Flows.**

W. L. DENNIS. *J. Sci. Instr.* **25**, 317, 1948.

The flow rate is measured by recording the pressure drop across a capillary, through which the liquid is forced by an external pressure. The instrument is calibrated using liquids of known viscosity. It is only applicable to Newtonian fluids and the density of the fluid must be known. J.E.C.

1071. **Thixotropic Viscoelastic Systems.**

B. A. DUNNELL and G. HALSEY. *Textile Res. J.*, **18**, 178, 1948.

An attempt is made to explain the thixotropic behaviour of certain fibres on stretching by postulating a number of potential-energy surfaces, which may govern the nature of the viscous flow within the fibre. Equations are obtained relating rate of elongation and applied stress, and these equations are integrated numerically to give a relationship between applied stress and actual elongation. P.A.T.R.A.

1072. **Theory of the Anelastic Fluid.**

C. ECKART. *Rev. Mod. Phys.*, **20**, 232, 1948.

It is shown, by mathematic analysis, that in the case of an anelastic fluid, slow steady motions and the diffusion of vorticity obey the same laws as in the Stokes-Navier theory of a viscous fluid. Hysteresis is, however, exhibited by the response of density to pressure. This hysteresis vanishes for very low and very high frequencies. The compressibilities for these two limiting cases approach different real values. For intermediate values the compressibility is a complex number, corresponding to the hysteresis. The velocity of propagation is also a complex number which is a function of the frequency. The two roots of this function determine two relaxation times ; one root is associated with the hysteresis, the other with viscosity.

SCI. ABSTR. (See Abstr. 974).

1073. Absolute Measurements of the Depth of Abrasion, a Testing Method for Dentifrices.

J. J. EHRHARDT. *Appl. Sci. Res.*, **A1**, 87, 1948.

A sensitive interferometric method was developed for studying the abrasive effect of tooth-pastes. This method revealed also details in the structure of tooth-material. SCI. ABSTR.

1074. Electroviscosity. I. The Flow of Liquids Between Surfaces in Close Proximity.

G. A. H. ELTON. *Proc. Roy. Soc. A*, **194**, 259, 1948.

The conditions governing the rate of flow of ionic and non-ionic liquids in narrow channels are examined, and it is shown that in certain circumstances the electrical resistance to shear in ionic liquids, due to the effect of an electrical potential gradient on the ions of the surface layers, may assume considerable importance relative to the mechanical (viscous) resistance to shear. The results of this analysis are of important application in various fields, and offer an explanation of anomalous results obtained by numerous experimental workers. SCI. ABSTR.

1075. Electroviscosity. II. Experimental Demonstration of the Electroviscous Effect.

G. A. H. ELTON. *Proc. Roy. Soc. A*, **194**, 275, 1948.

Preliminary experimental evidence for the existence of the effect in ionic liquids is submitted. The theoretical predictions have been qualitatively confirmed. The rate of approach of surfaces in various liquids has been observed, and it has been demonstrated that equilibrium distances of separation under finite pressures are very small. SCI. ABSTR.

1076. A Rheological Study of Solutions of Nitrocellulose.

D. FENSOM and J. H. GREENBLATT. *Canad. J. Res.*, **26B**, 215, 1948.

Nitrocellulose solutions tend to be dilatant (*sic*) at low values of $[\eta]$ and thixotropic at high values. Likewise with increasing concentration, there is a tendency to pass from "dilatancy" through Newtonian behaviour to thixotropy. Both "dilatancy" and thixotropy tend to decrease with increasing temperature. Goodeve's theory of thixotropic structure is discussed. G.W.S.B. (See Abstr. 273).

1077. Pseudoplastic Flow Properties of Lyophilic Colloids.

E. K. FISCHER and C. H. LINDSLEY. *J. Colloid Science*, **3**, 111, 1948.

Rheological measurements on two typical pseudoplastic materials, methyl cellulose and starch, are presented. Data were obtained on a rotational (modified Stormer) viscometer. Methods of computation are presented which provide values in absolute units. Since the viscosity of pseudoplastic materials is dependent on the rate of shear, this factor must be specified to have data which are significant and independent of a given instrument. When data obtained on the rotational viscometer were compared with data from capillary viscometers, the agreement was fair, in view of the rough approximation to rate of shear in the latter instrument. In the cases studied, there was no evidence for linearity in the curves of torque *vs.* rate of shear, nor was there any indication of an intercept on the torque axis corresponding to a yield value. P.A.T.R.A. (See Abstr. 885).

1078. Measurement of Young's Modulus and its Variation with Temperature. Use of an Acoustic Transmission Wire.

C. FLORISSON. *C. R. Acad. Sci.* **223**, 18, 1946.

An experimental method is briefly described which may be used to investigate the variation of the modulus of various steels up to 800 deg. C. and various types of brass up to 460 deg. C. I.D.I.B.

1079. **A Method of Detecting Incipient Fatigue Failure.**

H. W. FOSTER. *Proc. Soc. Exp. Stress Anal.*, **4**, 25, 1947.

To provide a method of inspection which could be used in large structural fatigue tests and also in hidden areas of service structures, it is suggested that small insulated wires be cemented to the most critical areas of the structure, so that failure would be determined by the rupture of the wire and loss of electrical continuity. Desirable properties for the wire, and results of tests using several kinds of wire are reviewed. Installation techniques, including cementing, electric wiring, locating failures, and failure-indicating characteristics, are discussed. SCI. ABSTR.

1080. **Viscosity-Molecular Weight, Viscosity-Temperature Relationships for Polystyrene and Polyisobutylene.**

T. G. FOX and P. J. FLORY. *J. Amer. Chem. Soc.*, **70**, 2384, 1948.

Using a coaxial falling cylinder viscometer the viscosities of polystyrene and polyisobutylene fractions over wide molecular weight ranges were determined at various temperatures up to 217°. At 217° some deviation from the relation $\log \eta = A + \frac{C}{\bar{M}_w}$, where $\bar{M}_w$ is the average molecular weight and A and C are constants, was observed. E.W.J.M. (See Abstr. 1121).

1081. **Some New Anisotropic Time Effects in Rheology.**

S. M. FREEMAN and K. WEISSENBERG. *Nature*, **161**, 324, 1948.

Experiments made on isotropic materials of the visco-elastic type show that anisotropic time effects are produced even in isotropic materials during transitions between shear-free and sheared states, and that in the case of laminar shearing displacements the tangential and normal components of stress conform to the theory, showing simultaneously different times of build-up under a stationary rate of displacement, different times of relaxation under constantly maintained displacement and different frequencies of vibrations under harmonically varying displacements. B.C.R.A.

1082. **Some New Rheological Phenomena and their Significance for the Constitution of Materials.**

S. M. FREEMAN and K. WEISSENBERG. *Nature*, **162**, 320, 1948.

A description with photographs of new rheological experiments using various coarse and fine grained materials (cellular and fibrous types). The results are discussed from the standpoint of the Continuum Theory of the elasticity of volume and form. E.W.J.M. (See Abstr. 667).

1083. **Modulus of Elasticity and the Structure of Glasses.**

J. GILLOD. *Verres et Réfract.*, No. 1, 26, 1948.

There is a connection between Young's modulus of a material and its structure. The variations of the modulus for glass depend on the composition of the glass and the heat treatment to which it has been subjected. B.C.R.A.

1084. **A Simple Capillary Viscosimeter.**

G. E. VAN GILS. *Rec. Trav. Chim.*, **65**, 595, 1946.

A pipette viscometer is described, which can easily be cleaned and, as far as accuracy is concerned, is almost equal to the Ostwald viscometer. G.M.

1085. **The Grading of Aggregates and Workability of Concrete.**

W. H. GLANVILLE, A. R. COLLINS and D. D. MATTHEWS. *D.S.I.R. Road Res. Tech. Paper No. 5* (2nd edn.), 1947.

The revised edition of this report, originally published in 1938, contains some new data for aggregates of 1½ in. maximum size. Methods of measuring workability,

including the slump test, compacting factor test, heap test and slab test, are described. A full account is given of the ways in which workability may be influenced by such factors as (1) cement, (2) aggregate grading, particle shape and cement content, (3) presence of crusher dust, and (4) admixtures, relevant experimental data being presented. The strength of any "workable" concrete depends on the water/cement ratio alone, provided the material is fully compacted. Workability is defined as that property which determines the amount of useful internal work required to compact the concrete; it is best measured by the compacting factor test, although the subsidiary heap and slab tests provide additional information. B.S.A. (Abridged).

1086. Rheological Properties of Concentrated Dispersions of Solid Particles.

J. S. GOURLAY. *Internat. Chem. Congress*, London, 1947; *Paint Manuf.*, **17**, 319, 1947.

Using a Goodeve viscometer, the variations of the viscosity at infinite rate of shear and Goodeve's coefficient of thixotropy (actually a yield value) have been determined for a number of concentrated dispersions (e.g., zinc oxide in linseed or antimony trioxide in resin solutions). P.A.T.R.A.

1087. The Effect the Consistency Curve has had on the Development of Particles of Modern Viscometers.

H. GREEN. *J. Colloid Science*, **3**, 29, 1948.

The construction of the viscometer for such materials as Bingham bodies has passed through the stages exemplified by the single-point capillary viscometer, the multiple-point viscometer, and the multiple-point rotational viscometer. There is one step indicated which has not yet been accomplished and that is a viscometer employing rates of shear so high that they compare in magnitude with the rate of shear employed by roller coating machines and high speed printing presses. The difficulty here will be to obtain those high rates of shear without creating objectionable increases in temperature. P.A.T.R.A.

1088. A General Kinetic Theory of Liquids. V. Liquid He II.

H. S. GREEN. *Proc. Roy. Soc. A*, **194**, 244, 1948.

An examination of the detailed application of the general quantum theory of fluids to liquid He II. It is shown that although the classical laws of hydrodynamics and thermodynamics are formally obeyed by the quantum liquid, important divergencies arise in the manner of their interpretation. Without introducing any assumption other than the validity of the general laws of quantum mechanics, it is possible to explain qualitatively and quantitatively the well-known properties of liquid helium, including the thermodynamic discontinuity, the thermomechanical effect, the transfer effect, and the presence of thermal waves in the liquid. The connection with earlier theories is traced, and it is shown that although they are in agreement with the theory here proposed in certain respects, their fundamental concepts are in need of considerable revision. The theory can be applied with slight changes to the phenomenon of superconductivity. SCI. ABSTR. (See Abstr. 598, 679, 741, 742).

1089. On Creep and Relaxation. II.

B. GROSS. *J. Appl. Physics*, **19**, 257, 1948.

A phenomenological theory of the elastic after-effect can be formulated with the aid of the principle of superposition. In a previous paper the theory of the transient effects, caused by the sudden application of a constant load or a constant deformation has been developed. In the present paper the theory of the steady-state behaviour under alternating load and deformation is given. Relations are established between the loss factor, the storage factor, the distribution functions and the Laplace transforms of the creep—and the relaxation—function. B.C.R.A. (See Abstr. 599).

1090. **Appraisalment, based on the Principle of Similarity, of the Suitability of Materials for Subjection to Static, Dynamic and Thermal Stresses.**

H. HAGEN. *Die Technik*, 3, 6, 1948.

The relations of similarity are used for deriving quality figures based on the properties of the materials and are compounded to give values which characterize the behaviour of the materials under the different kinds of stresses. While static and dynamic problems have been treated before in this manner the method of reducing the quantities concerned to dimensionless ratios is here extended to deal also with thermal stresses, and quantities are defined which enable temperature resistivity and resistivity to temperature fluctuations to be compared. This extension is especially helpful in the development of materials for i.c. engines and gas turbines. Tables and graphs show quality figures for static, centrifugal, oscillating and thermal stresses for various metals and ceramics.

SCI. ABSTR.

1091. **On a Possible Explanation of the Bridgman Effect—the Increase in Strength under Uniform Pressure on all Sides.**

V. L. HERMAN. *C.R. Acad. Sci. U.R.S.S.*, 51, 671, 1946.

The more recent experiments of Bridgman and others have revealed that cylinders made of pure metals or of alloys can sustain an axial compressive force of much higher value than usual at atmospheric pressure if they are simultaneously subjected (besides the original load) to a uniform pressure on all sides. This paper gives a possible qualitative and, to a certain degree, quantitative explanation of this effect based on the macroscopic condition for the formation of plastic strains in anisotropic media as obtained by the author.

B.S.A.

1092. **A Theory of the Yielding and Plastic Flow of Anisotropic Metal.**

R. HILL. *Proc. Roy. Soc. A*, 193, 281, 1948.

A theory is suggested which describes, on a macroscopic scale, the yielding and plastic flow of an anisotropic metal. The type of anisotropy considered is that resulting from preferred orientation. A yield criterion is postulated on general grounds which is similar in form to the Huber-Mises criterion for isotropic metals, but which contains six parameters specifying the state of anisotropy. By using von Mises' concept of a plastic potential, associated relations are then found between the stress and strain-increment tensors. The theory is applied to experiments of Körber and Hoff on the necking under uniaxial tension of thin strips cut from rolled sheet. It is shown, in full agreement with experimental data, that there are generally two equally possible necking directions whose orientation depends on the angle between the strip axis and the rolling direction. As a second example, pure torsion of a thin-walled cylinder is analysed. With increasing twist anisotropy is developed. In accordance with recent observations by Swift (*Engineering*, 163, 253, 1947), the theory predicts changes in length of the cylinder. The theory is also applied to determine the earing positions in cups deep-drawn from rolled sheet.

SCI. ABSTR. (See Abstr. 769).

1093. **Hardness Conversion Chart for Nickel and High-Nickel Alloys.**

E. P. HUSTON. *Proc. Amer. Soc. Testing Materials*, 47, 770, 1947.

The work reported comprised two separate, but inter-related, sections. The first covered the refinement or classification of a large mass of hardness data, the second consisted in the use of this refined and classified data for the establishment of linear relationships and calculation of least squares equations. The methods adopted and typical experimental results are described in considerable detail.

The investigation showed the relationship between a ball scale and a cone or

pyramid scale to be of practical importance in the correlation. Primary factors involved and those established in the course of the work are summarized.

The conversion chart established as a result of this work is shown. It is believed to be valid for nickel and high-nickel nickel-copper, nickel-copper-aluminium, nickel-chromium-iron and nickel-aluminium-silicon alloys, over the ranges of hardness normally encountered in such materials.

NICKEL BULL.

1094. **Cold Working of Aluminium at Low Temperatures.**

T. S. HUTCHINSON. *Nature*, **162**, 374, 1948.

Experiments on the cold working of aluminium at room temperature showed that the metal is spontaneously self-recovering but when the plastic deformation occurs at the temperature of liquid air and the specimen is maintained at that temperature lattice distortion occurs.

On allowing the specimen to warm up to room temperature it was found by the X-ray back-reflection method that recrystallization had occurred.

E.W.J.M.

1095. **The Influence of Delayed Elasticity on the Rate of Annealing of Glass.**

G. O. JONES. *J. Soc. Glass Technol. (Trans.)*, **31**, 218, 1947.

It is shown that the influence of delayed elasticity on the rate of annealing of glass can be very significant, particularly in the early stages of an annealing process. There is no reason to expect the annealing rate to be "Maxwellian"; moreover, the true law of annealing rate cannot be determined until more data are available about the delayed elastic effects. In previous investigations on the subject, the influence of delayed elasticity has not been recognized as such, but has been confused with the change in viscosity which also proceeds continuously at temperatures in the annealing range. In spite of this confusion, past workers have accounted for their experimental results to a fair degree of approximation; the error must, however, lead to anomalies and probably accounts for those which remain in the work of H. R. Lillie and others.

B.C.R.A. (See Abstr. 991).

1096. **Viscous Slip along Grain Boundaries and Diffusion of Zinc in Alpha-Brass.**

T'-S. Kê. *J. Appl. Phys.*, **19**, 285, 1948.

The viscous behaviour of the grain boundaries in 70-30 α -brass was demonstrated by anelastic measurements. It was shown that the grain boundaries cannot sustain permanently a shear stress and have a coefficient of viscosity decreasing with an increase of temperature. Using the same α -brass specimen, the activation energy associated with the stress-induced preferential orientation of pairs of Zn atoms in α -brass (which is a diffusion process) was determined. This activation energy was found to be identical, within experimental error, with the activation energy associated with the grain boundary slip in α -brass. This indicates that the slip in α -brass is a diffusion process and the diffusion mechanism is similar to the volume diffusion in α -brass.

SCI. ABSTR. (See Abstr. 705).

1097. **Mechanical Behaviour of Crystal Boundaries in Metals.**

R. KING, R. W. CAHN and B. CHALMERS. *Nature*, **161**, 682, 1948.

Specimens of Sn consisting of two crystals and a straight boundary were loaded to provide a shear stress on the boundary. Lateral displacement occurred a few deg. below the melting point (shear stress component 590 gm./cm.², initial rate of relative movement 7×10^{-4} cm./hr.; max. movement recorded 0.1 mm.).

SCI. ABSTR. (See Abstr. 531).

1098. **On the Law of Resistance in the Case of Turbulent Flow through Smooth Tubes.**

A. N. KOLMOGOROFF. *C.R. Acad. Sci. U.R.S.S.*, **52**, 663, 1946.

In place of the well-known type of formula for the coeff. of resistance, ξ , in terms of the Reynolds' number (Re) in the case of turbulent flow in smooth tubes, viz $1/\xi^{1/2} = A \log(\text{Re} \xi^{1/2}) + B$ (1), Konakov has suggested a formula of the type $1/\xi^{1/2} = A \log \text{Re} + B$ (2), (*C.R. Acad. Sci. U.R.S.S.*, **51** (No. 7) (1946)). The author shows that Konakov's analysis leads not to formula (2) but to formula (1) for large Reynolds' numbers. Deviations from this can occur only when the value of Re is of the order 1,000's or 10,000's.

SCI. ABSTR.

1099. **The Influence of Traces of Water on the Plasticity of Starch and Quartz Suspensions in Organic Media.**

H. R. KRUYT and MISS F. G. VAN SELMS. *Rec. Trav. Chim.*, **63**, 407, 1943.

Suspensions of starch and quartz in CCl_4 and similar media are plastic (thixotropic) only in the presence of water. The yield value is a function of the water content. The relation between size of particle, water content, and yield value is studied.

G.M. (See Abstr. 390, 1126).

1100. **An Improved Tackiness Meter.**

J. M. LAMBERT and R. A. McDONALD. *Rev. Sci. Instrum.*, **19**, 119, 1948.

An instrument is described in which all manual operations have been reduced to a minimum and the actual "tack" measurement is performed automatically. The scale is a "Toledo" postal scale with a capacity of 3 lb. and modified so that, when preloaded, contact pressure and separating force can be read directly. A time switch allows the sample to be held in contact for extended periods. A screw adjustment provides for any contact pressure up to 20 oz. A wiring diagram is given.

B.C.R.A. (See Abstr. 439).

1101. **The Weldability of Steels, and a New Weld-Cracking Test.**

P. L. J. LEDER. *Engineering*, June 11th, 1948.

The paper is concerned with cracking in the heat affected area of the parent plate adjacent to a weld, particularly in high tensile steels. A new weld-cracking apparatus is developed which measures the stress across the weld directly instead of measuring stresses arising out of the thermal expansion and contraction of the test plates.

M.W.T. (Abridged).

1102. **Shrinkage and Creep in Concrete.**

F. M. LEA and C. R. LEE. *Soc. Chem. Ind.*, p. 7, May 1946.

Symposium on "Shrinkage and Cracking of Cementive Materials."

A survey is given of the known facts concerning creep and shrinkage in cements and the various theories as to their cause are discussed. The effects on the shrinkage of such variables as the character of the aggregates, the water and cement contents of the mix, the casting and curing conditions, and the size and shape of the specimens are indicated. It is considered, however, that since resistance to cracking is not determined alone by the free shrinkage characteristics, observations of shrinkage stress development under conditions of restraint would be of more direct practical value. A summary is given of the effect on the creep characteristics of such variables as the magnitude and rate of loading, concrete composition, the moisture and temperature condition of the cements and the size of the specimens.

B.S.A. (Abridged).

1103. On the Application of Laplace Pairs to the Analysis of Relaxation Curves.

H. H. MACEY. *J. Sci. Instr.*, **25**, 251, 1948.

A method is described to find the distribution function of the relaxation coefficient, defined as the reciprocal of the relaxation time, from experimental data using the known Laplace Pairs. J.E.C. (Abridged).

1104. The Rheology of Paper.

S. G. MASON. *Pulp & Paper Mag. Canada*, **49**, 207, 221 (Convention Issue), 1948.

This paper presents an account in general terms of an investigation of the flow and elastic properties of paper now being carried out at the Pulp and Paper Research Institute of Canada and following the pattern of similar researches under way at the Swedish Forest Products Research Laboratory. A rheological model describing the stress-strain-time relationship of paper and a possible method of evaluating the role of the nature, arrangement and bonding of the fibres in a sheet of paper are discussed.

P.A.T.R.A. (See Abstr. 1006).

1105. Viscosity and Shear Elasticity Measurements of Liquids by means of Shear Vibrating Crystals.

W. P. MASON. *J. Colloid Sci.*, **3**, 147, 1948.

By employing torsional and shear vibrating crystals, viscous and shear waves can be set up in liquids. As discussed in a former paper, the loading of such waves apply to the crystals provides a measurement of the viscosity and shear elasticity in liquids. Methods for cutting torsional crystals of ammonium dihydrogen phosphate and quartz are discussed. Calculations indicate that such crystals can generate high shearing rates in light liquids, and this technique may be of interest in determining the effects of high rates of shear on viscosity. Frequencies in the megacycle range can be covered by using thickness shear crystals covered with thin films of the liquid. The technique has been employed in measuring the properties of three liquids in detail. These are polyisobutylene, arochlor and silicone putty. The last two show shear elasticities in the crystalline range while the first one has a much lower shearing modulus than is obtained in crystalline materials. It is suggested that this low shearing modulus is connected with a combination of rotation and translation which occur with different activation energies.

B.C.R.A. (See Abstrs. 713, 842).

1106. The Laminar Boundary-layer equations of Bodies of Revolution. Motion of a Sphere.

D. MEKSYN. *Proc. Roy. Soc.A*, **194**, 218, 1948.

A continuation of previous work. The general boundary-layer equations are derived for axially symmetrical motions of bodies of revolution; the equations are partially solved for a sphere, and the results compared with experimental measurements.

SCI. ABSTR. (See Abstrs. 557, 558, 624, 625).

1107. Determination of the Viscosity of Glass by means of Nomograms.

M. V. OKHOTIN. *Stek. Keram. Prom.*, No. 11, 8, 1947.

Three nomograms show the relationship between alumina content, sodium content, calcium and magnesium content, temperature and viscosity.

B.C.R.A.

1108. Rectilinear Plastic Flow of a Bingham Solid. III. A more General Discussion of Steady Flow.

J. G. OLDROYD. *Proc. Camb. Phil. Soc.*, **44**, 200, 1948.

All possible velocity distributions are obtained by solving a single linear 2nd-order differential equation, and some special classes of velocity distributions are discussed. In the present method the equations are first solved, and then suitable

boundaries are found. This is illustrated by an example. The family of curves representing velocity contours are also possible velocity contours for rectilinear viscous flow. The velocity distributions represent exact solutions of the equations of motion.

SCI. ABSTR.

IIIO9. Rectilinear Plastic Flow of a Bingham Solid. IV. Non-Steady Motion.

J. G. OLDROYD. *Proc. Camb. Phil. Soc.*, **44**, 214, 1948.

The equation of motion in a region of plastic flow is the same as the equation for heat conduction in a medium of variable conductivity, in which heat is being generated. In this analogy, a yield surface corresponds to a conducting boundary moving through the medium in such a way that no heat is conducted to it. For a 2-dimensional rectilinear motion, exact solutions of the equations were found. These correspond to a uniform gradient and uniformly accelerated plane boundary. The velocity distribution was calculated in the case of a plastic solid in a circular pipe being suddenly subjected to a pressure gradient.

SCI. ABSTR. (See Abstr. 896).

IIIOO. Measurement of Enamel-Slip Consistency by means of the Brookfield Viscosimeter.

E. M. OLIVER. *J. Amer. Ceram. Soc.*, **31**, 128, 1948.

An instrument commonly employed to measure the viscosity of truly viscous liquids was tested to determine its applicability for evaluating consistencies of enamel slips which are solid suspensions in a water medium. Within wide limits of specific gravity differences and variations in set resulting from electrolyte additions the Brookfield viscometer afforded comparable information with the pick-up and slump tests employed as references.

B.C.R.A.

IIII. Stresses in Glass and their Measurement.

A. A. PADMOS and J. DE VRIES. *Philips Tech. Rev.*, **9**, 277, 1947-8.

In manufacture of glassware it is usually necessary to liquefy glass by heating and then to let shaped objects cool down. In this process stresses will often arise which may cause the glass to crack. The same is the case when fusing together glass parts or glass to metal when coefficients of expansion of component parts differ appreciably. The determination of stresses in glass objects can best be done by investigating the resulting double refraction. It should be first investigated whether the materials possess those properties which make them suitable for fusing together. Philips are employing a method where small plates of glass or metal to be used are fused to a standard glass and stress is deduced from double refraction, from which it can then be concluded whether the material in question is suitable for the purpose.

I.D.I.B.

IIII2. A Theoretical Determination of the Elastic Constants of Ice.

A. H. A. PENNY. *Proc. Camb. Phil. Soc.*, **44**, 423, 1948.

A simple Barnes model is taken. The H-atoms are assumed to lie in the centre between two O atoms, and only nearest-neighbour interaction is considered. Regularity is also assumed, since any four neighbouring O atoms lie at the vertices of an almost regular tetrahedron. Under these conditions there are two atomic constants. Two of the experimental measurements of the constants of polycrystalline ice are used to calculate the atomic constants, and then the five elastic constants for a single crystal.

SCI. ABSTR.

IIII3. Rheological State as a Criterion of Dispersion.

J. PRYCE-JONES. *Chem. & Industr.*, No. 15, 233, 1948.

The degree of dispersion of fine particles in a fluid increases as the system passes through the following sequence of rheological states : plasticity $\rightarrow$ pseudo-plasticity $\rightarrow$

false-body→thixotropy→dilatancy→Newtonian flow. It is not possible to express degree of dispersion or "the coefficient of dispersion" in numerical terms, but comparative data can have wide industrial applications. B.C.R.A.

III4. The Flow of Suspensions—Thixotropy and Dilatancy.

J. PRYCE-JONES. *Proc. Univ. Durham Phil. Soc.*, **10**, 427, 1948.

The effect of the following factors on the "relative viscosity" of a suspension (the ratio of the viscosity of the suspension to the viscosity of the fluid) is discussed: temperature, volume concentration of the particles, mean particle size, the anisotropy factor for particle size, the viscosity of the fluid, the rate of shear thixotropy, and the dispersion coefficient. P.A.T.R.A.

III5. Testing the Viscosity of Glaze.

S. A. RABINOVICH. *Stek. Keram. Prom.*, No. 8, 12, 1947.

A brief description is given of a device consisting of a ceramic crucible into which glaze is placed in a dry state. The crucible has a hole in the bottom and the glaze, when heated, flows into a glass vessel below, in a period of time which depends on the temperature and viscosity of the glaze. The results of tests performed with this instrument show great accuracy. B.C.R.A.

III6. The Effect of Various Treatments on the Stresses in Glass-to-Metal Seals.

G. D. REDSTON and J. E. STANWORTH. *J. Sci. Instr.*, **25**, 138, 1948.

A photoelasticity method was used to investigate the sum of the radial and circumferential stresses in glass to metal seals. The effect of temperature, high temperature oxidation and humidity on the seal was studied.

J.E.C. (See Abstrs. 588, 804).

III7. The Hydrodynamics of Non-Newtonian Fluids, I

R. S. RIVLIN. *Proc. Roy. Soc., A*, **193**, 260, 1948.

The classical theory of the hydrodynamics of viscous fluids depends on the assumption of a particular law governing the relations between the components of stress in a fluid and those of the strain-velocity. This assumption limits its applicability to Newtonian fluids. Here the most general possible relations between the stress and strain-velocity components, which can be obeyed by an incompressible, visco-inelastic fluid, are derived. These relations also apply to an incompressible, visco-elastic fluid in a steady state of laminar flow. It is shown how equations of motion and boundary conditions can be obtained if these relations are known. Two problems involving laminar flow are then discussed in some detail. These are: (i) the torsional motion of a cylindrical mass of fluid, produced by means of forces applied to its plane ends, and (ii) the laminar flow of a mass of fluid contained between two coaxial cylinders rotating with different angular velocities. It is found in case (i) that, in general, normal tractions must be applied to the plane surfaces of the fluid, in addition to the azimuthal tractions expected from the classical theory, in order to produce the specified motion. Analogous results are obtained in case (ii). These results apply even when centrifugal forces are neglected and so imply a qualitative difference between the behaviour of fluids in general and those for which the special case of classical hydrodynamics is valid. P.A.T.R.A. (See Abstrs. 1016, 1017, 1018).

III8. Normal Stress Coefficient in Solutions of Macromolecules.

R. S. RIVLIN. *Nature*, **161**, 567, 1948.

The normal stress coefficient is roughly calculated on Kramer's model for a solution of polystyrene in xylene in steady laminar flow. It is shown that it may be of significant value. SCI. ABSTR.

II19. **Modulus of Elasticity of Aggregates and its Effects on Concrete.**
H. A. LA RUE. *Proc. A.S.T.M.*, **46**, 1298, 1946.

In general, aggregates with a high modulus of elasticity develop correspondingly higher moduli in the concretes than stone having low moduli. A.G.W.

II20. **On Checking of Tension, Compression and Hardness Testing Machines, and Instruments for this Purpose.**

J. SALOKANGAS. *Finnish State Inst. Tech. Res.*, 1947.

Discussion of imperfections in relation to the specifications for the various methods of testing. A.G.W.

II21. **Synthesis of Multichain Polymers and Investigation of their Viscosities.**

J. R. SCHAEFGEN and P. J. FLORY. *J. Amer. Chem. Soc.*, **70**, 2709, 1948.

Non-linear condensation polymers of controlled structure were prepared using ϵ -caprolactam and various multifunctional co-reactants. Four series were prepared in which the number of chains subtended by the central unit was one, two, four and eight respectively, and it was found that $\log \eta$ was proportional to the square root of the average molecular weight. E.W.J.M. (See Abstr. 1080).

II22. **Further Experimental Evidence for the Theory of Quasi-Properties.**

G. W. SCOTT BLAIR and J. E. CAFFYN. *Nature*, **162**, 368, 1948.

The authors discuss the rheological behaviour of a material in terms of complex entities in which a number of magnitudes taken together describes the process which the material undergoes as a result of a specified test. Data not in conformity with Nutting's equation could be accounted for by using "intermediate" fractional differential equations after integration. E.W.J.M. (See Abstr. 644).

II23. **Rheology of Foodstuffs.**

G. W. SCOTT BLAIR. *Research*, London, **1**, 453, 1948.

A short review, mainly concerned with the experimental methods available for investigation. SCI. ABSTR.

II24. **Investigations on Structural-Mechanical Properties and Thixotropy in Oleo-Collodial Systems.**

E. E. SEGALOVA and P. A. REBINDER. *Kolloidnyi Zh.*, **10**, 223, 1948.

A study is made of solutions of Calcium Stearate in mineral oils by measuring the rate of penetration and ultimate total penetration of a standard loaded cone into the materials to be tested.

Two types of structure are postulated—condensed and dispersed—the latter being associated with thixotropy.

Both loading and recovery curves are shown and conditions of relaxation of stress under constant deformation are discussed.

The data are claimed to support a model consisting of a dashpot and spring in parallel in series with a second dashpot and a second spring in series. The series dashpot has a yield-value, so that the material requires five parameters to describe its total behaviour. An excellent bibliography is appended. G.W.S.B.

II25. **The Textile Institute Viscosigraph.**

H. J. SELLING and F. L. J. VAN LAMOEN. *Chem. Weekblad.*, . . . 602, 1947.

The apparatus described is designed for measuring continuously the "viscosity" of starch solutions during heat treatment. G.M.

II26. **Apparatus for Measuring the Consistency of Plastic Suspensions**
F. G. VAN SELMS and H. R. KRUYT. *Rec. Trav. Chim.*, **62**, 398, 1943.

A description is given of two apparatus for measuring the rheological properties of suspensions: one according to H. L. Röder, the other designed by the authors. The advantages and disadvantages of these two apparatus are discussed.

G.M. (See Abstrs. 390, 1099).

II27. **The Hercules High-Shear Viscometer.**

J. W. SMITH and P. D. APPLGATE. *Paper Trade J.*, **126**, 60, 1948.

The theory of rotational-type viscometers is discussed and definitions are given of rheological terms used in this paper. The construction of the Hercules High-Shear (rotational-type) viscometer is described and illustrated; this is designed so that rates of shear above 5,000 reciprocal seconds are easily employed. A constant temperature bath is omitted and the machine is run at room temperature, which is satisfactory for the study of high-solids pigment suspensions if the room temperature does not vary too widely.

P.A.T.R.A.

II28. **The Viscosity and Nature of Glass.**

J. E. STANWORTH. *J. Soc. Glass Technol. (Trans.)*, **32**, 20, 1948.

The viscosity-temperature properties of glass are discussed on the basis of the theories of Frenkel and of Eyring, and it is concluded, in contrast to the views of Seddon, that the moving particles, at least in the temperature range above the annealing temperature are not large compared with single molecule size. The rapidly changing viscosity can be explained on the basis of changing entropy and energy of activation, the moving particles remaining constant in size with change of temperature. Some suggestions are made concerning the effect of temperature and of composition changes on the energy of activation.

B.C.R.A.

II29. **Creep of Metals Subjected to Compression Stress.**

A. H. SULLY, G. N. COLE and G. WILLOUGHBY. *Nature*, **162**, 411, 1948.

Working with nickel-chromium alloys comparative data were obtained for tensile and compressive creep under a stress of nine tons/sq. in. at 815° C. In tensile tests tertiary creep (initiated by atomic re-arrangement—the initial stages of recrystallization) proceeds at an accelerating rate until fracture ensues; while in corresponding compression tests creep proceeds at a series of accelerating and decelerating rates.

E.W.J.M.

II30. **Dynamic Straining of Amorphous or Quasi-Amorphous Substances.**

K. H. SWAINGER. *Research*, London, **1**, 473, 1948.

A general theory on straining is evolved for amorphous or quasi-amorphous substances in which normal stresses induce normal strains.

SCI. ABSTR. (Abridged). (See Abstrs. 817, 919, 1031, 1032).

II31. **Immersion of a Cylinder in a Viscous Medium Filling a Vessel of Axial Symmetry.**

S. M. TARG. *C.R. Acad. Sci. U.R.S.S.*, **54**, 305, 1946.

The cylinder is immersed end-on, with constant velocity, and equations are written down for the resulting motion of the viscous fluid. An expression is derived for the resulting force acting on the end of the cylinder and this is approximated in the cases where the vessel is a cylinder or a cone.

SCI. ABSTR. (See Abstr. 1026).

1132. Impact Loading of Structures.

D. LAUGHARNE THOMSON. *Engineering*, 166, 409, 1948.

The author proposes to include in the expression for the strain-energy (W) for non-linear elastic stress-strain relations the quadratic form of higher derivatives of the displacement (u) as follows:—

$$2W = \int_0^L \left\{ E \left(\frac{\partial u}{\partial x} \right)^2 + C_2 \left(\frac{\partial^2 u}{\partial x^2} \right)^2 + C_3 \left(\frac{\partial^3 u}{\partial x^3} \right)^2 + \dots \right\} dx$$

This equation is valid for the extension in the x direction of a thin rod of length L , while $E, C_2, C_3 \dots$ represent appropriate coefficients of stiffness. The equation yields for extensional vibration

$$\rho \frac{\partial^2 u}{\partial t^2} = E \frac{\partial^2 u}{\partial x^2} - C_2 \frac{\partial^4 u}{\partial x^4} + C_3 \frac{\partial^6 u}{\partial x^6} - \dots$$

The physical interpretation of this result is discussed. In this connection the author confuses Poisson's ratio as applied for elastic strain with a similar number calculated "when the yield point was passed," which may be named "plastic" Poisson-ratio but is a rheological constant entirely different from the former.

M.R. (Compare also Swainger, Abstr. 506).

1133. Plastic Flow in Cast Iron, at Room and Elevated Temperatures, with Special Reference to Relief of Stress.

C. R. TOTTE. *Inst. British Foundrymen, Paper No. 900*, June 1948.

The author considers the deformation characteristics of cast iron, especially the relation between elastic and plastic flow, to be susceptible to considerable variations, according to the mode and speed of application of stress.

NICKEL BULL. (Abridged).

1134. Recent Developments in Photo-Elasticity.

J. WARD. *Trans. Inst. Mar. Engrs*, 59, 223, 1947.

In an historical introduction, the methods of obtaining stresses by (a) colour matching, (b) compensation are considered, and the problem of separating the principal stresses P and Q is examined. Details of construction of polariscopes and some of the elasticity and optical theory necessary for the study of photo-elasticity, especially with reference to the technique of using monochromatic circularly-polarized light and counting interference fringes, are given; the latter is fully explained. Suitability of materials (e.g. B.T.-61-893, Catalin 800 and C.R. 39) is discussed with special regard to creep and edge stresses. Examples, with photographs, of stress analysis are given for discs and rollers, gear teeth, lathe turning stresses, forced fits, eccentric loading and for a boiler tube plate. For 3-dimensional work, the scattered light method and the frozen stress technique with application to dynamic loading is mentioned. A discussion by others includes the determination of $(P + Q)$ by solving Laplace's equation by successive approximations, reference to dynamic loading arising from centrifugal forces and the problem of plane strain investigated by plane stress models.

SCI. ABSTR.

1135. Control of the Moisture Content and "Body-Firmness" of Cheddar Cheese.

H. R. WHITEHEAD. *J. Dairy Res.*, 15, 387, 1948.

The importance of an adequate routine in the manufacture of (New Zealand) Cheddar Cheese is stressed but the opinion is expressed that quantitative rheological

measurements as proposed by Scott Blair *et al.* are desirable. The effects of gross variations in fat and protein content of milk on cheese consistency are discussed.

G.W.S.B.

1136. **The Analysis of Strain and its Graphical Representation.**

D. H. WILLIS. *Engineering*, 166, 457, 1948.

A very clear derivation of Mohr's circle for plane strain, showing how this is to be constructed from data measured on a "strain rosette". M.R.

BOOK REVIEWS

RHEOLOGY IN RELATION TO PHARMACY AND MEDICINE

G. W. SCOTT BLAIR.

The Pharmaceutical Press, London.

This small publication of twenty pages and fifty-eight references consists of two University lectures given at the request of the University of London at the College of the Pharmaceutical Society, November, 1947.

The author in the lectures, ("Principles of Rheological Measurement" and "Psycho-physical Studies of Some *Secundum Artem* Processes") indicates the exceedingly complex rheological problems encountered by doctors, medical research workers and those engaged in pharmacy and kindred subjects; and the difficulty in knowing just what to measure or how to measure a property when the material system does not remain unchanged when it is deformed during the test. On the psychological side it appears that the essence of craftsmanship in handling materials depends not on any innate superiority in sensitivity but in the acquiring of those "organized masses of experience" which makes possible a high reproducibility in giving judgments of such complex entities as firmness. The expert's judgment by no means always agrees with physical measurements of properties analysed out from the firmness-Gestalt. The subjects discussed include a short history of rheological measurements from early times, high-elasticity, "spinnbarkeit", the flow of blood and other biological materials, the human body as a testing device and the general theory of rheology.

E.W.J.M.

THEORETICAL AERODYNAMICS

PROFESSOR L. M. MILNE-THOMSON.

Macmillan and Company, London.

Professor Milne-Thomson's well-established reputation as a writer of text-books that are models of clarity, presentation and style will not be diminished by this book, which is a delight to handle and to read. The only criticism of note that can be directed against it is its limited range, imposed by the author's somewhat restricted interpretation of the term "theoretical" in the title; in his view, apparently, theoretical aerodynamics covers only such subjects as aerofoil theory and its ancillaries, the dynamics of perfect gases, and classical stability theory. Thus, apart from a passing reference in the first chapter, boundary layers and viscosity are not discussed.

This is a pity, since they provide the link between perfect-fluid flow theory and the flow of real fluids, without which the jump from one to the other must always appear arbitrary and somewhat mysterious.

The first two chapters deal with basic ideas and the more important aspects of Bernoulli's theorem, and the next four give a very detailed discussion of aerofoil theory in two dimensions, including a valuable review of the fundamentals of complex function theory, essential to an understanding of this theory. Modern developments are most in evidence in this part of the book; the conjugate relationship between vorticity and downwash is emphasised, and consideration is given to the so-called "inverse problem" that has attracted attention in recent years, namely, the design of aerofoil sections to have a given pressure distribution. The works of Goldstein and Lighthill, in this connection, are not referred to, but presumably they were not available during the preparation of the book. The next four chapters deal with vorticity in three dimensions, induced velocity, and the aerofoil of finite aspect ratio, and include a fairly comprehensive survey of lifting line theory and some of the developments in lifting plane theory; the latter refer to the work of Blenk, Krienies and Kinner, but not to the recent work of Falkner, Mutterperl and Weissinger. Propellers are discussed, though only at an elementary level, and there is a chapter on wind-tunnel corrections, which includes an illuminating discussion of Jacobian elliptic functions. The treatment of the elements of compressible-flow theory, for both subsonic and supersonic flow, covers two-dimensional linearised theory, plane shock waves, and the hodograph theory as developed by Temple, but does not refer to von Karman's work. The author's reluctance to mention viscosity makes the section on the formation of shock waves somewhat inadequate.

The three chapters on simple modes of flight and stability are perhaps the least valuable of the book, as they contain little that is new and much that is out of date. The "strip" method for determining lateral-stability derivatives is recommended, though it is now largely discarded in favour of more accurate methods. The non-dimensional forms given for the derivatives differ in certain respects from those currently accepted. The terms "metacentric ratio" and "focus", used in the book, have long given place to "static margin" and "aerodynamic centre", and the latter term is not now used for the quarter-chord point. The theory of manoeuvre points and manoeuvre margins plays an essential part in modern stability analysis, but no reference is made to it. Finally, there is a chapter on the theory of vectors, of which considerable use is made throughout the book. Valuable features are the occasional pertinent digressions into mathematical theory, which the author has skilfully inserted without breaking the continuity of the book. Numerous excellent examples are collected at the end of each chapter.

Engineering, July 2nd, 1948.