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EDITORIAL

This Bulletin sees the publication of our two thousandth abstract. The Bulletin is also just over ten years old. The Festival of Britain is upon us and patches of dry land have been seen recently in my garden. Such a singular concatenation of events surely demands an Anniversary Edition of the Bulletin complete with colour plates and special articles. Unfortunately there is neither money nor labour for such a venture, and we must remain content with trying to keep abreast of the abstracts in the same old humdrum way.

Looking back over the past ten years, I think it is true to say that more has been achieved than was thought likely or even possible in the first days of the British Rheologists' Club, and the knowledge gives us hope for the future. We are gratified to find that the Bulletin is finding its way abroad and the latest subscribers include one in an ex-enemy country and one behind the so-called "Iron Curtain". To these new "foreign" members we bid a hearty welcome. Never was peace between nations desired so earnestly or so widely as now, and never did peace seem so hard to preserve. I am, however, firmly of the opinion that the more the ordinary peoples of the world meet one another and come to understand their respective problems, fears and difficulties—which do not vary much the world over—the less will be the likelihood of future armed conflicts.

The British Society of Rheology is open to all, and we require of our members only that they be sincerely interested in rheology and willing to contribute, so far as may be in their power, to the advancement of the science. The primary object of the Society is to provide a forum for the discussion of rheological problems. In so doing, however, it does unquestionably help to establish social contacts between individuals having at least one common interest, and in this way our Society may help in a small but not necessarily negligible way in the promotion of international understanding and cooperation.

As a minor scientific society we are also vitally concerned with the preservation of that spirit of free enquiry, appeal to experiment and open discussion and criticism of results, on which the science of the past was based and to which it owed most of its success.

In the past thirteen years we have seen this freedom increasingly curtailed in the holy name of Security. An increasing number of scientists now work more or less in isolation and are not permitted to publish or discuss the results of their labours. The early scientist, who for the most part made his investigations from sheer curiosity and the joy of discovery, is being replaced by a new species of scientific stooge, who, a mere unit like a hen in an egg farm, is expected to produce "results" at stated and frequent intervals for the information of a superior. He knows not the implications of his work and cannot take an intelligent interest in it even if he wished. Scientific research degenerates to an irksome job to be got through as quickly as possible before proceeding to matters more congenial. These tendencies cannot be good in the long run either for science or for humanity at large. It is beyond the power of our small Society to halt them or reverse them; but it is worth remembering that freedom to publish, discuss and criticize has not been enjoyed by all men since the creation. Throughout the ages the tendency has usually been the other way. Authority has never taken kindly to discussion and criticism, nor to the holding of views other than those officially approved. Our freedom as scientists comes to us as a precious heritage in defence of which men have given their lives and property. It will be preserved only at the cost of ceaseless vigilance.

V. G. W. HARRISON.

PHYSICS OF LUBRICATION

We have received a review copy of *Physics of Lubrication*, published as Supplement No. 1 to the *British Journal of Applied Physics* by the Institute of Physics, 47, Belgrave Square, London, S.W.1. This is now available in stiff board covers at a price of fifteen shillings. This Supplement contains the text and discussion of the papers presented at the symposium held jointly by the British Rheologists' Club and the Manchester and District Branch of the Institute of Physics in Manchester from 29 June to 1 July, 1950. For this reason it does not seem proper to review it in these columns. It will suffice to say that as several of the contributors are well-known members of the British Society of Rheology, the papers must be good! The printing is as near faultless as anything in this imperfect world can be, and it makes us wish the material presented at other conferences could be published so speedily and well. *Physics of Lubrication* represents excellent value and we can warmly recommend those who have not yet seen it to obtain a copy.

ADVERTISEMENT

The National Institute for Research in Dairying, Shinfield, Reading, has a vacancy from September for a physicist to carry out research work on physical (mainly rheological) properties of cheese and other dairy products.

The post is on the S.S.O. grade with a starting salary of £670 for men or £545 for women and carries F.S.S.U. benefits. Candidates should have a first or second class honours degree in physics with some research experience, preferably rheological.

Applications, giving details of age, qualifications and experience, should be sent to the Secretary, National Institute for Research in Dairying.

When one party or another thinks himself the sole possessor of absolute truth, it becomes only natural that he should think his neighbour absolutely in the clutches of Error or the Devil. But once get a man to see that none of them has the whole truth, but that they are mutually complementary, that the complete truth can be found only in the combined views of all, after that which is false in each of them has been sifted out—then true brotherhood in religion will be established. The same applies in the physical world.

H. P. BLAVATSKY.

RHEOLOGY ABSTRACTS

NOTE.—The initials following the Abstracts are those of the abstracting member except for the following abbreviations for abstracts reproduced 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, Packaging and Allied Trades Research Association.
SCI. ABSTR.	Science Abstracts.
B.S.A.	Building Science Abstracts.
J.I.S.I.	Journal of the Iron and Steel Institute.

1961. The physics of the deformation of metals.

E. N. DA C. ANDRADE. *Endeavour*, 1950, 9, 165.

Methods are enumerated for revealing the crystalline grain structure of metals and a brief account is given of the interatomic forces on which depend the behaviour of metallic crystals under stress. The large discrepancy between actual behaviour and that theoretically predicted is even more marked in the case of metal single-crystals. Stretched metal single-crystals have a band structure and it is believed that deformation takes place by slipping along glide planes. This sliding is attributed to the propagation of dislocations, which is illustrated by models. Impurities hinder this propagation and harden the metal and the behaviour of single-crystals can only be explained by a system of structural irregularities. Creep at high temperatures and pressures is considered and an equation governing this phenomenon is interpreted.

SCI. ABSTR.

1962. The Rehbinder effect.

E. N. DA C. ANDRADE, R. F. Y. RANDALL AND M. J. MAKIN. *Proc. Phys. Soc., Lond. B*, 1950, 63, 990.

According to Rehbinder the immersion of wires of certain metals in non-polar paraffin containing a little oleic acid increases the rate of flow of the metal under a given stress and increases the electrical resistivity. The experiments described show that the mechanical effect can be obtained with single crystals of Cd if the surface is contaminated by a thin oxide layer, which is known to increase the critical shear stress, but not if the surface is clean. The effect is accordingly attributed to the disruption of the hardening surface layer by the active agent and not to penetration into the metal, as assumed by Rehbinder. It has not been found possible to detect any electrical effects with Cd or Pb crystal wires having either clean or contaminated surfaces.

AUTHORS.

1963. The effect of an electric field on the viscosity of liquids. II.

E. N. DA C. ANDRADE AND C. DODD. *Proc. Roy. Soc. A*, 1951, 204, 449.

To obtain the true effect of an electric field on the viscosity of liquids measurements must be made with alternating fields whose frequency lies within a certain range. As the effect is very small a very sensitive method of measurement of viscosity must be devised and various temperature effects must be eliminated. Apparatus and methods are described which allow comparative viscosities to be consistently measured, with

and without field, to within a few parts in a million. With this disposition, it has been shown that for non-polar benzene there is no effect as large as 1 part in 100,000, even with the highest applied fields. With polar liquids, however, there is a true, but small, increase of viscosity proportional to the square of the field. A brief theoretical discussion is given, in which it is shown that electrostriction cannot be responsible for the effect.

AUTHORS.

1964. **Fisher electroviscometer range extended to 50,000 centipoises.**

ANON. *Laboratory*, 1950, 19, 122.

A new bobbin has extended the range of this viscometer from 5,000 to 50,000 centipoises.

B.C.R.A.

1965. **A further study of the relationships between the mechanical properties of Cheshire cheese and grader's judgments.**

M. BARON AND R. HARPER. *Dairy Industries*, 1951, 16, 45.

Continuing their earlier work (*ibid.* 1950, 15, 407), the authors have carried out a second year's study of cheese in the store and compared the data, subjected to factor analysis, with those of the earlier year. The factor loadings for the individual tests, objective and subjective, are decidedly different but the general configuration of the three-dimensional (vector) model is encouragingly stable. This paper deals with the dairying aspects of the work: for the physics, see Harper and Baron, *Brit. J. Appl. Phys.*, 1951, 2, 35.

G.W.S.B.

1966. **High-elasticity characteristics of non-crystallized rubber.**

G. M. BARTENEV AND L. A. VISHNITSKAYA. *J. Tech. Phys., USSR*, 1950, 20 (7), 858. *In Russian.*

A method of obtaining equilibrium curves in tensile stressing is presented, based on measurements of butadiene-styrol rubber. The theory of the high-elastic deformation is compared with the experimental data. Vulcanizates of butadiene-styrol rubber obey, within wide limits ($\lambda=1$ to $\lambda=5$) of tensile stressing, a linear law of deformation (Bartenev's formula), $\sigma=E_{\infty}(\lambda-1)$ Wall's formula is correct only up to about 60% tensile deformation; here the two theories agree. Thus the calculation of the number of molecular chains per unit volume of rubber is possible by the simplest formula $N=E_{\infty}/3kT$. The character of the dependence of the elastic modulus E_{∞} on vulcanization time agrees with results previously obtained in 2-dimensional deformation of butadiene-styrol rubber.

SCI. ABSTR.

1967. **Approximate theory of the high-elastic deformation of rubber.**

G. M. BARTENEV. *J. Tech. Phys., USSR*, 1950, 20, 461. *In Russian.*

The deformation of rubber may be regarded as a phenomenon of "mechanical polarization." The analogy between electric and mechanical polarization does not, however, come out completely owing to the 3-dimensional structure of the rubber and the structure of the macromolecules. An approximate deformation law, satisfactorily representing the experimental facts in the whole range of tests, is given for the case of 1-dimensional tensile stressing of rubber specimens. Wall's and Guth's formula cannot be applied to the rubbers tested. Proportionality between stress and strain was found to exist for rubber within wide limits. This is in agreement with the theory presented as well as with the experiments. The limit of proportionality lies at about 40 kg/cm². Below this the stress in constant deformation is directly proportional to the absolute temperature, whereas above this limit the temperature relation of the stress has a more involved character.

SCI. ABSTR.

1968. Lubrication with materials in the solid state.

F. T. BARWELL AND A. A. MILNE. *Physics of Lubrication, Supplement No. 1 of Brit. J. Appl. Phys.*, 1951, pp. 39-43.

Talc, vermiculite, flake graphite, paraffin wax and various metallic soaps were used as lubricants between flat mild steel surfaces, and coefficients of friction were determined with average loads of 40 lb./in.² and relative velocities of 0.01 cm/sec. and 0.4 cm/sec. Only graphite, the metallic soaps and paraffin wax were found to be effective lubricants.

A.G.L.

1969. The lubrication of rough steel surfaces by a series of metallic soaps.

F. T. BARWELL AND A. A. MILNE. *Physics of Lubrication, Supplement No. 1 of Brit. J. Appl. Phys.*, 1951, pp. 44-48.

Tests were carried out over a wide range of velocities and temperatures and a hard slider was used pressed against a soft plate with a roughness of approximately 50 μ . For metallic soaps the results approximated closely to the empirical law: $\log(\text{friction}) \propto \log(\text{velocity}) + \text{a constant}$ over the range 0.001 cm/sec. to 0.6 cm/sec. The melting point of solid lubricants was very critical, higher temperatures giving a marked increase in friction. Differences in metallic ion or acid radical in the soaps had comparatively little effect on the friction other than that due to the physical state of the lubricants. Microscopic examination of surface damage showed that the solid lubricants were very effective but with the melted lubricants considerably greater contact occurred.

A.G.L.

1970. Experimental studies on the vibration of concrete.

S. G. BERGSTRÖM AND S. LINDERHOLM. *Bulletin No. 18, Swedish Cement and Concrete Research Institute, Royal Institute of Technology, Stockholm.*

An account of researches involving the development of measurement procedures for studying the transmission of energy in concrete and the linkage between the vibrator and the concrete. Apparatus and methods were developed for measuring pressures, displacements, compaction, acceleration of vibrator, and power absorbed. The results are tabulated and discussed.

B.S.A.

1971. The spreading behaviour and lubricating properties of mixed liquids.

E. B. BIELAK, E. W. J. MARDLES AND E. D. TINGLE. *Physics of Lubrication, Supplement No. 1 of Brit. J. Appl. Phys.*, 1951, pp. 58-62.

Measurements of rate of radial flow of several liquids and their binary mixtures over or between various polished surfaces have been correlated with friction results on the same surfaces.

Changes in the molecular association of the liquids on admixture are considered to account for observed divergences from the simple mixture law $sml\mu \sim \mu$ where $sml\mu$ represents the friction calculated from the observed values of the single constituents of the binary mixture and μ the observed friction value of the mixture.

A.G.L.

1972. Determination of the first deviation from the Hooke law by means of hardness testing according to Ludwik.

R. BOECKLEN. *Zeits. f. Metalkunde*, 1950, 41 (9), 295. *In German.*

In order to derive strength properties from hardness indentations, suggestion is made of deriving yield strength by considering maximum deformation diameter around a conical indentation. Comparison tests made with 3 conical indenters of ground and hardened steel, sintered carbide and diamond, all with an included angle of 30 deg.

Diamond indenter had highest surface finish and operation was more or less free from friction. Roughness of other indenters led to increase in apparent hardness. Tests on wrought quasi-isotrope, ferrous and non-ferrous metals showed that yield strength can be determined for elongations of 0.01 and 0.02%. Only exception was annealed steel of low carbon content.

I.D.I.B.

1973. Viscosity data of organic liquids.

J. W. M. BOELHOUWER, G. W. NEDERBRAGT AND G. VERBERG. *Appl. Sci. Res.*, 1950, **A2** (4), 249.

Viscosities have been measured of thirty-seven organic liquids, with molecular weights ranging from 120 to 807, and the viscosity-temperature curves obtained are compared with those of *n*-paraffins. The influence of ring structures and polar groups on viscosity is discussed.

AUTHORS.

1974. Hardening and relaxation as basic phenomena of plastic deformation.

M. A. BOLSHANINA. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, 1950, **14** (2), 223. *In Russian.*

An hypothesis is advanced that the process of plastic deformation is composed of two concurrent processes, those of hardening and relaxation. On this basis a polytropic equation is derived which describes qualitatively all the characteristics of the flow curves. Maxwell's relaxation equation is corrected. A number of experimental results from tensile tests on various metals is adduced to support this hypothesis, and it is further applied to explain some other characteristics of plastic deformation, e.g., the effect of deformation velocity on the path of the flow curve and the stronger effect of this velocity on the flow curves of low melting-point metals. The hypothesis is also used to establish relations between the dynamic coeff. σ_1/σ_2 [where σ_1 and σ_2 are the stresses corresponding to deformation velocities v_1 , v_2 ($v_2 > v_1$)], melting point and experimental temp., and also to establish relations between energy absorbed, deformation velocity and melting point.

SCI. ABSTR.

1975. Stress-strain properties of natural rubber under biaxial strain.

B. B. S. T. BOONSTRA. *J. Appl. Phys.*, 1950, **21**, 1098.

Tube-shaped samples were stretched in a direction parallel to the tube axis and at the same time inflated to cause a tangential extension. In this way 600% axial and 300% tangential elongation could be attained simultaneously. The stresses were calculated from the pressure in the tube and the dynamometer readings. The results are plotted as axial stress-strain curves at different tangential elongations ranging from 0—300%. The curve for a higher tangential elongation lies at higher stresses than that for a lower tangential elongation; the differences are, however, larger than the theory predicts. At 600% axial elongation stress relaxation was measured at different tangential elongations. It appears that the relaxation constant is independent of the tangential elongation.

AUTHOR.

1976. The viscosity of liquid helium between 2 and 5°K.

R. BOWERS AND K. MENDELSSOHN. *Proc. Roy. Soc., A* 1951, **204**, 366.

The viscosity of liquid helium has been measured with a flow method between 2 and 5°K. The coefficient of viscosity decreases with decreasing temperature over the whole range. A particularly interesting feature is a sharp drop in the viscosity above the λ -point which coincides with an anomalous fall in the entropy in the same temperature interval. Possible explanations of this phenomenon have been discussed.

AUTHOR.

1977. Microhardness tester for metals at elevated temperature.

A. BRENNER. *J. Res. Nat. Bur. Stand., R.P.* 2185, 1951, 46 (2), 126.

An apparatus has been devised for measuring the hardness of electrodeposited coatings at temperatures up to 900°C in an inert atmosphere. Coatings thicker than about 0.07 mm. (0.003in.) may be tested. The main parts of the apparatus are: (1) the indenting mechanism consisting of a Vickers diamond mounted on a shaft of fused silica, (2) a mechanical device for raising or lowering the indenter, (3) a micrometer device for orienting the specimen under the indenter, (4) the heating unit. The force on the indenter is varied either by dead weight loading or by changing the gas pressure inside the apparatus. Some typical measurements made with the apparatus are given.

AUTHOR.

1978. Plastic flow of platinum wires.

R. P. CARREKER, JR. *J. Appl. Phys.*, 1950, 21, 1289.

The strain time behaviour of annealed Pt wires at constant stress and temperature is reported for a wide range of experimental conditions, namely: 1,550 to 78°K, 900 to 40,000lb./in.², 0.001 to 0.1 strain, 10⁻¹ to 10⁻⁶ min⁻¹ strain rate. Relations were found which describe the results satisfactorily.

AUTHOR.

1979. Method for determining the modulus of elasticity by means of low-frequency oscillations.

M. M. CHNUSJTJOV AND M. A. BABITJEV. *Zavodskaya Lab.* 1950, 16 (1), 52; abstr *Mekanfoerbundets Litt.*, 1950, 2 (9), 2. In Swedish; original in Russian.

Simple method, applicable both to metallic and non-metallic materials. A long cylindrical test-piece is inserted in a base-plate, with other end firmly fixed in a transverse arm. From the arm are suspended 2 pendulums at equal distances from the test-piece. When one is set in motion, the other starts to swing, whereby amplitude of oscillation of first pendulum decreases and that of the second increases. Eventually first comes to standstill, while other reaches greatest amplitude. Process then repeated in reverse direction. Under certain conditions, well known in practice, a joint proportionality is reached between time and modulus of elasticity (*ME*); thus possible, by measuring time with a chronometer, to obtain desired *ME*. Details of construction of apparatus fixing of test-piece, and influence of various factors upon accuracy of determinations. Tables appended giving values obtained for *ME* of other materials, such as lead, plexiglas, and steel.

I.D.I.B.

1980. Plastic deformation.

P. CICALA. *Atti. Accad. Naz. Lincei (R.C. Sci. Fis. Mat. Nat.)*, 1950, 8, 583. In Italian.

The main features of the many diverse theories of plastic deformation due to a body having undergone an elastic strain are described. An idea of Batdorf and Budiansky based on the concept of slip is examined mathematically by tensor analysis. Agreement of the resultant formula with experiment is good when applied to various particular examples.

SCI. ABSTR.

1981. On the critical load of a disk compressed beyond the elastic limit.

P. CICALA. *Atti. Accad. Naz. Lincei (R.C. Cl. Sci. Fis. Mat. Nat.)*, 1950, 9, 67. In Italian.

An investigation of the forms of equilibrium that obtain when a strip of material supported on its 4 sides and free in the centre is being compressed lengthwise. The mathematical analysis permits the conclusion that the load which begins to deform the plate transversely, when calculated on the basis of the Batdorf-Budiansky theory, agrees

with the experimental values; and that, while the deformation of the plate grows, the resistance of the plate increases without, however, reaching the value of the incremental theory.

SCL. ABSTR.

1982. An introduction to boundary and extreme pressure lubrication.

D. CLAYTON, *Physics of Lubrication, Supplement No. 1 of Brit. J. Appl. Phys.*, 1951, pp. 25-33.

A survey of the subject for the benefit of the non-specialist.

A.G.L.

1983. Effect of low polymer upon the intrinsic viscosity of a high polymer.

D. CLEVERDON, *Nature*, 1951, 167, 196.

Viscosities at 25°C of solutions of different concentrations of a high molecular weight polystyrene, X, in benzene and in benzene containing a 0.6% and 0.1% resp. of a low molecular weight polystyrene, A, were measured. The quantity $\eta_r - 1/c$ was plotted against C and the zero concentration intercept $[\eta]$ read off. $[\eta]$ was dependent upon the concentration of A.

Evidently the higher the concentration of A the more tightly X is coiled.

E.W.J.M.

1984. The design of nonlinear leaf springs.

S. P. CLURMAN, *Trans. Amer. Soc. Mech. Engrs.*, 1951, Feb., 155.

It is occasionally desirable to incorporate into a mechanism a spring having a particular nonlinear force-deflection relationship. This need may arise in the design of computers, certain control mechanisms, and special shock-absorbing systems. A technique is developed whereby leaf springs may be designed to follow arbitrary functions having increasing first derivatives. Some experimental results are discussed. A device is described which will produce a spring characteristic having a decreasing first derivative.

AUTHOR.

1985. The flow and fracture of a brittle material.

L. F. COFFIN, JR., *J. Appl. Mech.*, 1950, 17, 233.

The mechanism of flow and fracture of a grey cast iron can be understood if one considers the microstructure to consist of a ductile structure with a random dispersion of cracks due to the graphite flakes following the concept of Fisher. A notch effective stress can be calculated for a critically situated crack by a knowledge of the external stresses, a plastic stress-concentration factor of 3, and a residual tensile stress at the sharp edge of the crack, based upon either the "maximum-shear" theory or the "distortion-energy" theory. This allows the formulation of generalized plastic stress-strain relationships and renders grey cast iron applicable to the many known solutions for plastic flow of ductile metals. Fracture in the region of tension-tension and tension-compression can be evaluated by a similar analysis, using the same stress-concentration factor and the same residual stress.

AUTHOR.

1986. The viscosities of organic vapours.

P. M. CRAVEN AND J. D. LAMBERT, *Proc. Roy. Soc. A*, 1951, 205, 439.

The viscosities of the vapours of ethane, *n*-hexane, cyclohexane, benzene, methyl chloride, ethyl chloride, methyl alcohol, diethyl ether, acetaldehyde, acetone and acetonitrile have been measured at temperatures 35, 50, 65 and 78°C and pressures between 1 and 3 cm. Measurements were made by observing the damping of a pendulum swinging in the vapour. A linear relation between coefficient of viscosity and temperature was found in all cases. The ratios of thermal conductivity to viscosity were calculated, using thermal conductivity values obtained recently in the same temperature range. The

observed values of the Eucken factor for non-polar vapours show systematic positive deviations from the theoretical values; strongly polar vapours show systematic negative deviations; weakly polar vapours show intermediate behaviour. The theoretical implications of these phenomena are discussed.

AUTHORS.

1987. A contribution to the study of the form of the stress-strain curves of metals and its physical interpretation.

C. CRUSSARD AND B. JAUL. *Rev. Métall.*, 1950, 47, 589. *In French.*

Using a Chevenard microtester, a study has been made of the curves of Al (principally), Cu, Zn and Mg. Results have been interpreted in terms of the equation $\sigma = \sigma_0 + A\epsilon^m$ (σ =stress, ϵ =strain, σ_0 , A and m being constants). A suitable log-log plot reveals the existence of two stages, each satisfied by an equation of this form, but with different constants. A wide investigation has been made of the variation of these constants with certain factors: grain-size, diameter of the wire (for same grain-size), speed of extension, etc. In the region of the first parabola, e.g., the curves of m or A as a function of grain-size (N grains/mm²) were similar, and for all N , $A=100m-35$ (in kg/mm²). For large grains, m -values vary largely with diameter, but converge as N increases. The point of transition to the 2nd parabola is almost independent of N , or the speed of test, and of the diameter and is taken to be characteristic of the metal. It is associated with a process of polygonization in the grains. The influences of impurities, and of temperature, are discussed. The results are interpreted in terms of dislocation concepts with particular reference to the mechanism proposed by Cottrell.

SCI. ABSTR.

1988. Energy absorption in deformations of opposite sign in copper.

M. M. DEGTAREV. *J. Tech. Phys.*, USSR, 1950, 20, 440. *In Russian.*

It is shown experimentally that the main part of the absorbed energy in plastic deformation is the fraction of the energy of the residual stresses. Furthermore, it is found that in compression deformation of Cu specimens preliminarily put under tensile stress, there is at first a relief of the residual stresses from the tensile pre-stressing, and only after reaching higher degrees of deformation does an accumulation of latent energy in the specimen take place. The special machine designed for the tests and the measuring set-up are described.

SCI. ABSTR.

1989. Extrusion behaviour of viscoelastic materials.

F. D. DEXTER AND G. J. DIENES. *J. Colloid Sci.*, 1950, 5, 228.

The relation between visco-elastic properties and extrusion characteristics is discussed. It is shown that materials characterized by non-linear deformation-time properties necessarily exhibit a non-linear relation between rate of discharge and pressure in extrusion. Specifically, the pressure of delayed elastic elements leads to a relation which shows that, for linear visco-elastic materials, the volume rate of discharge increases more than proportionately with increasing pressure. The important factor to be recognized is the time the material spends in the die. This time, on a volume average basis, is determined by the material, pressure, and die geometry. For a given visco-elastic material the time spent in the die may be altered by changing the pressure or the die geometry. Increasing pressure, for example, decreases the average time spent in the tube and thereby lowers the apparent or effective viscosity. A simple quantitative theory is presented based on a conventional visco-elastic model. Even in simple cases, however, such a mathematical representation appears to be unduly complex. More tractable equations are derived assuming a power function for the deformation/time curve. It is of interest to note that, in this case, a power function describes also the corresponding volume rate of discharge/pressure curve. The influence of die geometry is also shown. The present analysis is limited to linear visco-elastic materials, i.e., substances whose

deformation at any given time is proportional to the applied stress. Some preliminary experiments are described which can be used to compare deformation/time and extrusion behaviour. The experimental results are in quite good agreement with the proposed theory. B.C.R.A.

1990. **Fundamental study of clay. X. Water films in monodisperse kaolinite fractions.**

W. H. EAST. *J. Amer. Ceram. Soc.*, 1950, **33**, 211.

The H_2O film in contact with kaolinite averages $<100\text{\AA}$ in thickness at low forming pressures and is a continuous H_2O phase extending from the crystal surface to the total equilibrium thickness. Because of the unsymmetrical surface atomic structure, the films may be thicker on the hydroxide-atom surface than on the oxygen-atom surface. Exchangeable ions are believed to be adsorbed on all crystal surfaces and influence the films both by characteristic ion hydration and by polarization, the latter causing unique particle orientation. Since both quartz and gibbsite possess water films and exhibit definite plasticity, there is good reason to believe that most minerals may fulfil these conditions in the proper environment. The cardinal principle seems to be to reduce the size distribution to the colloid range, which results in a force network that may be controlled by the exchangeable ions. Plate-like particles enhance plasticity, but the films associated with the equidimensional jagged quartz particles permit some extension before film rupture. The fact that Na-quartz is plastic confirms Norton's "stretched-membrane" theory of plasticity, but the need for Na counter-ions indicates that the force network is also related to colloidal phenomena. As H_2O is withdrawn from the plastic mass, the membrane is drawn down into the capillaries, causing increased attraction forces. Simultaneously decreasing the film thickness brings the particles closer together, intensifying the repulsion forces between the lyospheres and resulting in an equilibrium force network between the two. If this picture is correct, the forces acting between individual particles are repulsive in nature. B.C.R.A.

1991. **Use of coaxial-cylinder viscometers and capillary-tube viscometers for suspensions.**

G. F. EVESON, R. L. WHITMORE AND STACEY G. WARD. *Nature*, 1950, **166**, 1074.

With the coaxial-cylinder viscometer (ratios of annular gap to particle diameter from 5:1 to 110:1) no sigma phenomenon was detected with suspensions of methyl methacrylate polymer spheres of diameter 38 to $388\ \mu$ in an aqueous solution of lead acetate and glycerol. Possibly, the coaxial cylinder type of viscometer is preferable to the capillary tube viscometer for suspensions when the measured viscosity varies with the bore of the capillary, increasing with increasing diameter. E.W.J.M.

1992. **On the stationary creep rate.**

N. S. FASTOV. *J. Tech. Phys., USSR*, 1950, **20**, 543. *In Russian.*

It is shown that the only empirical quantitative relation so far established on the creep rate in the steady phase of this 3-phase process, viz. $v = v_0 \sinh \sigma/\sigma_0$, where σ is the stress applied, and v_0 and σ_0 are constants of the material, must be supplemented by a temperature relation for the stationary creep rate, the suggested form of which is $\log v = a_0 - a_1/T + b_0(1 - T_{\text{crit}}/T)\sigma$, where all constants, including T_{crit} , can be determined experimentally. This relation represents correctly the "reversal" of the sense of the variation of the creep rate v stress at the "critical" temperature.

SCI. ABSTR.

1993. **The boundary layer.**

G. I. FINCH. *Physics of Lubrication, Supplement No. 1, of Brit. J. Appl. Phys.*, 1951, pp. 34-35.

A review of the present state of knowledge of the liquids and solid lubricant boundary layer. The structure of the layer is discussed and the effects of heat and sliding on this structure—particularly on the orientation of the lubricant molecules. A.G.L.

1994. Young's modulus and its temperature dependence in 36 to 52 per cent. nickel-iron alloys.

M. E. FINE AND W. C. ELLIS. *Trans. Amer. Inst. Mining and Metallurgical Engineers*, 1950, **188**, 1120. T.P. 2921 E; *Jnl. of Metals*, Sept., 1950.

Young's modulus of elasticity in metals usually decreases with rising temperature, but an almost zero thermoelastic coefficient is observed in some ferro-magnetic alloys over a limited range of temperature. In these alloys, as the temperature rises an increase in modulus arising from loss of ferromagnetism compensates the normal decrease. Iron-nickel alloys containing 36-52 per cent. nickel are among the materials which behave in this manner. In the investigation reported, carried out in the Bell Telephone Laboratories, dependence of modulus and thermoelastic coefficient on cold working and annealing were studied in the nickel-iron range mentioned. The major series of alloys was melted and cast in vacuum, from electrolytic nickel and electrolytic iron. This series was supplemented by some alloys of similar type to which manganese (0.38-0.65 per cent.) was added: these were prepared by melting both in air and in vacuum, the vacuum-melted alloys being cast in a helium atmosphere. The samples were swaged cold, to the desired diameters, with intermediate annealing treatments. The method used for measuring the modulus and thermoelastic coefficient is described, with drawing. The results, reported at length in tables and graphs, show that the temperature of zero coefficient in these alloys depends on composition, and on straining and annealing history. Cold work greatly extends the temperature range of the zero coefficient: e.g. alloys containing nickel of the order of 42.5 per cent., when cold-worked and subsequently annealed at 400°C. or 600°C. show nearly zero mean thermoelastic coefficients between -50° and +100°C. The general behaviour of the modulus and its temperature dependence are explained on the basis of three ferromagnetic effects: (1) the direct effect of the energy of ferromagnetism on the modulus, (2) the stress-produced volume magnetostriction within the domains, and (3) the stress-produced linear magnetostriction.

NICKEL BULL.

1995. Further studies on the melt viscosity of polyisobutylene.

T. G. FOX, JR. AND P. J. FLORY. *J. Phys. Colloid. Chem.*, 1951, **55** (2), 221.

Previous studies of the melt viscosity of polyisobutylene fractions are extended to cover the molecular weight range from 530 to 1,480,000 at temperatures from 217° to -40°C. A pipette-type viscometer is used for viscosities up to one poise and a straight capillary-type viscometer for higher viscosities. Molecular weights are calculated from intrinsic viscosities of solutions and from cryoscopic measurements. A close relationship is shown between the dependence on molecular weight of the specific volume, the viscosity-temperature coefficient and the viscosity at constant temperature. These relationships are discussed in terms of a concept of the liquid state of polymers developed in a previous paper relating to polystyrene.

G.E.B.

1996. Multiplication processes for slow moving dislocations.

F. C. FRANK AND W. T. READ, JR. *Phys. Rev.*, 1950, **79**, 722.

Purely topological reasoning can explain how a very large amount of slip can result from the motion of a single dislocation line, and the quantitative treatment is similar to the theory of crystal growth, allowance being made for mutual repulsion between turns. Another process occurs when a part of a dislocation lies in one glide plane (the remainder lying outside the plane), and this is discussed for the case where the "end-points" may be considered fixed.

SCI. ABSTR.

1997. The vibrational properties of wood.

E. FUKADA. *J. Phys. Soc. Japan*, 1950, **5**, 321.

Lateral vibrations of a rectangular bar of airdried wood (20 cm × 2 cm × 0.5 cm) with pieces of iron attached at the ends were excited electromagnetically. The oscillating bar induces an alternating current in a pickup coil, which is amplified, rectified and

measured on a microammeter. Young's modulus was determined from the resonance frequency. The log. dec. was found from the total rectified charge flowing in the pick-up circuit. This charge was determined ballistically after switching off the exciting voltage. A correction is applied for the finite time of switching. Each mode in the frequency range 100-5,000 c.p.s. was determined. 28 samples of wood were tested and classified by the log. dec./frequency curves.

SCI. ABSTR.

1998. Thermodynamics and rheological behaviour of elasto-viscous systems under stress.

F. H. GARNER, A. H. NISSAN AND G. F. WOOD. *Phil. Trans., A*, 1950, **243**, 37.

The systems discussed were obtained by dissolving Al and Ca soaps of fatty and naphthenic acids in hydrocarbons with the aid of peptizers. They behave similarly to solutions of rubber in benzene. Rheologically, they exhibit certain peculiarities associated with secondary flow phenomena.

B.C.R.A.

1999. Tensile properties of ingot iron at low temperatures.

G. W. GEIL AND N. L. CARWILE. *J. Res. Nat. Bur. Stand., Wash.*, 1950, **45**, 129.

True stress-strain curves obtained in tension tests at temperatures ranging from -196° to $+100^{\circ}\text{C}$. with ingot iron as annealed, normalized, quenched and tempered, hot-rolled and cold-drawn are presented. Numerous simultaneous load and diameter measurements were made during the entire course of each test. The effects of prior thermal and mechanical treatment of the iron on the true stress-strain relations are discussed. Graphs are presented showing the influence of the testing temperature, the ferrite grain size and the initial condition of the iron on the work-hardening characteristics, namely, strain-hardening and strain-ageing. The effects of the above factors on yield stress and ultimate stress, and on true stress and true strain at maximum load and at fracture, are presented. The twinning of iron in the tests at low temperatures is briefly discussed.

AUTHOR.

2000. Treatise on the physical chemistry of the silicates. Vol. III, Silicates in industry.

P. GILARD. *Brussels*, 1949 (*Société des Etudes des Composés Siliceux*).

The general principles discussed in Vol. I are applied to clays, ceramic products and slags as used or produced in industrial processes. The constitution, plasticity, porosity, permeability and other physical properties of clay are dealt with.

B.S.A. (ABR.).

2001. Bovine sterility and pregnancy in relation to the rheological properties of cervical secretions.

F. A. GLOVER AND G. W. SCOTT BLAIR. *Nature*, 1951, **167**, 285.

Using more highly-developed methods of procedure and more satisfactory viscometers large scale tests are proceeding. A typical curve relating a rheological parameter plotted logarithmically against time is shown. For the non-pregnant animal at oestrus a sharp minimum was obtained. Conception generally occurs at the lowest point of the curve and the rheological parameter may serve as some indication of the degree of sub-fertility. The rheological results with sterile heifers are quite unlike that of fertile animals.

E.W.J.M.

2002. Control of plastic clay for jiggering chinaware.

R. E. GOULD AND R. W. CLINE. *Bull. Amer. Ceram. Soc.*, 1950, **29**, 291.

Methods for controlling the properties of clay for use in automatic jiggering are described. It is pointed out that existing tests for plasticity are not able to detect variations in plasticity which affect automatic operation. Steps taken in a typical installation to ensure uniformity of clay are described.

B.C.R.A.

2003. Viscometric titration.

S. J. GREEN AND A. DRAYCOTT. *Nature*, 1951, **167**, 119.

Some indication of the complexity of coal tar resins has been obtained using Kümicke's method of adding increasing quantities of a precipitant to the colloidal solution and noting the corresponding decreases in viscosity. Stepwise curves obtained with dextrans and sucrose solutions are shown.

E.W.J.M.

2004. The preparation and plasticity of porcelain mixes.

E. GREINER. *Ber. deut. keram. Ges.*, 1950, **27**, 99.

Discussing the influence of the method of grinding on plasticity, it is suggested that, during grinding, crystals should be moved parallel to their plate structure, not destroyed by impact, as in cylinder grinding. The superiority of bodies made in the old days with chaser mills is attributed mainly to a more careful grinding, which preserved the platy structure.

B.C.R.A.

2005. The application of factor analysis to tests on cheese.

R. HARPER AND M. BARON. *Brit. J. Appl. Phys.*, 1951, **2**, 35.

After discussing the basic principles of factor analysis, the authors describe the application of the technique to the study of the relationship between a series of objective rheological tests and subjective judgments on cheese. Two studies were made on groups of about 200 cheeses made in successive seasons and these indicate that the various "factors" are stable. At least three independent sources of variation have been detected. The first two of these are closely related to the measurement of surface hardness and the subjective assessment of crumbliness. The third important "source of variation" could not be identified with any realisable tests. The authors state that although the evidence is not entirely conclusive from the present investigation alone, it is becoming increasingly evident that purely objective measurements cannot be used alone to predict efficiently some of the important subjective assessments and that with many important products it is these subjective characteristics which form the final criterion of judgment of the usefulness or effectiveness of the product.

A.G.L.

2006. Studies on the nature of subjective judgments on cheese-grading.

R. HARPER AND M. BARON. *J. Dairy Res.*, 1950, **17**, 329.

Three judges, one of whom was a cheese grader of long experience, one a research worker and the third a research assistant, and, for certain experience two others without specialised training in grading, were asked to score a number of Cheshire cheese with respect to firmness, flavour and overall quality. Firmness, so judged, was compared with the results of measurements made with a sphere indenter.

Under these conditions of the experiment, the professional grader showed no unusual degree of consistency and his discrimination covered a more restricted range than that of the other judges. He did not regard "firmness," as such, to be of any great importance; and, perhaps for this reason, his discrimination of "firmness" was much poorer than that of the scientist who had not specialized in cheese grading. Regular participation in the experiment was shown to be beneficial: occasional judgments from others not regularly concerned were generally poor.

It is concluded that, in future studies of the craftsmanship of skilled graders, it would be better to ask for comparisons of "body" rather than of the less familiar and more specialized concept of "firmness."

G.W.S.B.

2007. Föppl's theory of rolling friction.

G. HEINRICH. *Ost. Ingen. Arch.*, 1950, **4** (5), 363.

The author proves that the contact condition of Hertz is not met by the Föppl equations. In case of equal elastic constants of the contacting parts only the Hertz

pressure distribution is possible. The formulae for the distribution of clinging stress and of perpendicular pressure are really more simplified than with Föppl. The slip is calculated and compared with the results of trials made by G. Sachs. Rolling friction power is also calculated.

AUTHOR.

2008. The application of rate-process theory to glass. II. Viscosity.

F. B. HODGDON AND D. A. STUART. *J. Appl. Phys.*, 1950, **21**, 1160.

In previous efforts to derive an equation for the temperature-viscosity relation of glass it has been assumed, tacitly or otherwise, that glass is a simple liquid. Since glass is not a simple liquid, it is necessary to find a model that will, in its reaction to applied stresses, have the same characteristics as a specimen of glass. By the use of Eyring's rate-process theory, such a model is proposed and several equations relating viscosity to time and to temperature are derived. The equations include an equation that relates the viscosity of any glass specimen to time, one which defines the rate of removal of internal strain, and an equation which relates the viscosity of a specimen an infinite time after beginning of a test to the temperature of the test. This final viscosity is the viscosity usually reported in the literature. It is found that the parameters in the equation reduced to infinite time can be calculated from the chemical composition of the glass and the viscosity of any given glass can be predicted at any temperature over a very wide range. Curves and tables are included to show the agreement of experiment and theoretical values.

AUTHOR.

2009. The application of rate-process theory to glass. I. breaking strength.

F. B. HODGDON, D. A. STUART AND F. E. BJORKLUND. *J. Appl. Phys.*, 1950, **21**, 1156.

An equation relating the ultimate strength of glass and porcelain to time under load is derived using the rate-process theory of Eyring. The data of Preston and co-workers are used to calculate the constants in the equation. The agreement between theoretical and experimental results is excellent.

AUTHOR.

2010. Approximate solutions of problems of plane plastic flow.

P. G. HODGE, JR. *J. Appl. Mech.*, 1950, **17**, 257.

A method of approximating the stress and velocity fields in problems of plane plastic flow is presented. A general procedure for finding the deformed pattern of an originally square grid is devised and applied to two examples. The results are compared with known continuous solutions and with experiments.

AUTHOR.

2011. The method of characteristics applied to problems of steady motion in plane plastic stress.

P. G. HODGE, JR. *Quart. Appl. Maths.*, 1951, **8** (4), 381.

A method is outlined for obtaining the stress, strain, and thickness distribution in a thin sheet which is strained plastically in its plane. For the particular case of steady motion, a method is given for obtaining directly the final solution to certain types of boundary value problems. A step by step procedure is indicated for the general case of non-steady motion.

AUTHOR.

2012. The determination of the viscosity of molten metals.

M. R. HOPKINS AND T. C. TOYE. *Proc. Phys. Soc., Lond. B*, 1950, **63**, 773.

Measurements may be made up to temperatures of about 900°C. The metal is contained in a cylindrical crucible which is allowed to oscillate about its axis under the control of the torsion in a suspension wire. The theory of the method is considered. The viscosity of Zn has been determined in the temperature range 430°C. to 480°C. and the results are given.

AUTHOR.

2013. Making raw materials and ceramic bodies plastic.

M. INZIGNERI. *Industr. Ceram. Silicati*, 1950, 3 (8), 9.

The many theories of plasticity are a proof of the complexity of the problem. The main concepts of plasticity are given. The lamellar structure, particle size, presence of air and Norton's stretched-membrane theory are discussed in their relation to plasticity. The capacity of the clay minerals to interchange their surface cations with cations in the surrounding medium is discussed. The hydration of the surface cations and the attraction between the clay particles, and of the non-plastic quartz and feldspar, to the positive cations bound to the clay minerals are explained. The most favourable conditions of attraction between the particles, and therefore of plasticity, are explained on the basis of the theory of condensers (the Helmholtz double-layer theory). The potential creating the best conditions of plasticity should be low. In the series, H, Al, Be, Sr, Ca, Mg, NH_4 , K, Na, Li, the dielectric const. decreases and the thickness of the double layer increases. At the borders of the lyosphere, in the presence of the last elements, there will be strong forces of repulsion favouring deflocculation. Schlösing showed that colloidal clay is present only to a very limited extent. It was also shown that hydration is not simple physical mixing but that a chem. reaction occurs. The clay can be considered as electrolyte or acid, formed by macro-anionic clay- OH^- bound to H^+ , which can be substituted by Ca^{2+} , Mg^{2+} , Na^+ , K^+ , NH_4^+ , etc. The quantitative determination of the exchange capacity is described; it is proportional to the plasticity. The conclusion is drawn that in the natural state the most plastic clays are those bound to the alkaline-earth metal cations, and containing a certain amount of minerals with high exchange capacity. Pfefferkorn's method was used to measure plasticity. To the clays were added CaO , $\text{Ca}(\text{OH})_2$, $\text{Al}_2(\text{SO}_4)_3$ (calc. as Al_2O_3), CaSO_4 , CaCl_2 , and BaCl_2 . All except the CaO were added to the clay slip in soln. or suspension; the CaO was added dry. Then they were mixed mechanically and poured on to plaster batts. The results were very good and the most striking with CaO . Small amounts of $\text{Al}_2(\text{SO}_4)_3$ mixed with $\text{Ca}(\text{OH})_2$ also gave very good results. To clay with a Pfefferkorn number of 24, the addition of 2% CaO increased the plasticity number to 32; but above a value of 26, flocculation becomes increasingly marked with swelling and irregular formation of lumps. The transformation therefore of a poorly plastic clay into a highly plastic one is very difficult on an industrial scale because of the great amount of H_2O that would have to be added to avoid the above trouble. This applied also to all the clays tested. Increasingly the plasticity only slightly, i.e., by adding in this case (%): 0.5 CaO , 0.7 $\text{Ca}(\text{OH})_2$, 3.24 $\text{Al}_2(\text{SO}_4)_3$, or 0.5 $\text{Ca}(\text{OH})_2 + 0.1 \text{Al}_2(\text{SO}_4)_3$ gave trouble. In the next case CaSO_4 , CaCl_2 , BaCl_2 were compared with CaO in increasing the plasticity of a kaolin; their effect was negligible. This same kaolin was further ground finely, increasing the Pfefferkorn No. from 30.8 to 32.9 and by addition of 1% CaO or $\text{Ca}(\text{OH})_2$ or 1% Al_2O_3 (6.40 $\text{Al}_2(\text{SO}_4)_3$ to 35. Ware formed from clay with plasticity increased to the practical limit of 26 became much more workable, and the rejects after drying and firing decreased. The breaking strength of the dried product was also determined; in general there was an increase in strength, but this was not always proportional to the increased plasticity.

B.C.R.A.

2014. The penetrometer method for the testing of workability in the manufacture of clay bricks.

I. S. KAINARSKY AND I. YA PIVEN. *Stek. Keram.*, 1950, 7 (7), 13.

The working properties of a plastic ceramic mix of a given comp. can be indirectly assessed by its water content. However, the water content of different clays of a normal working consistency varies over a wide range. The limits of workability of plastic mixes are set in practice by the making process used. Therefore, to test the quality of mix it is necessary to determine its workability rather than the water content. The cone penetrometer is both simple and reliable.

B.C.R.A.

2015. Deviations from Hooke's law and the domain of stability.

A. KAMMERER. *C.R. Acad. Sci., Paris*, 1950, **231**, 681. *In French.*

A non-linear stress-strain relation is used to define the limiting surface of the region of stability.

SCI. ABSTR.

2016. On the Young's moduli and the internal friction of papers.

H. KAWAI AND N. TOKITA. *J. Phys. Soc., Japan*, 1950, **5**, 365.

The effect of humidity, amplitude and frequency on the modulus and internal friction were investigated. From considerations of the energy required to move a portion of a fibre clamped at each end, the internal friction is shown to be independent of amplitude whilst a modified Voigt model is proposed when it depends on amplitude.

SCI. ABSTR.

2017. Microhardness, Mohs' scale, and hardness series.

M. M. KHRUSHCHOV. *Doklady Akad. Nauk. USSR*, 1950, **72** (4), 779. *In Russian.*

Tests with minerals by micro-hardness methods, using diamond pyramid of square base and 136 deg. angle, showed that they can be arranged according to increasing hardness numbers in same order as in Mohs' scale (*Zavodsk Lab.*, 1947, **13** (9), 1121). All standard minerals included in test; in case of diamond test made with 3 sided pyramid (*Zavodsk Lab.*, 1950, **16** (2), 193). In expressing results by diagrams showing log hardness number—log number in Mohs' scale—there was nearly linear relation. Thus hardness of solid bodies could be expressed by: $H_0 = 0.7 \sqrt[3]{H}$, where H_0 is hardness class, and H hardness number in kg/sq mm. determined by micro-hardness impression tests (*Zavodsk Lab.*, 1949, **15** (2), 213; *Bibl. Ind. Diamond Appl.*, 1949, **6**, 489).

Expressing hardness by classes has following advantages compared with Mohs' scale: (a) greater accuracy by fully objective methods of test; (b) independence of so-called 'standards'; (c) hardness class appears as derivative of hardness number, having all essential features to become basis for evaluating hardness of solid bodies; (d) interval between cordundum and diamond, representing only one unit in Mohs' scale, takes about 6 classes of hardness, thus correcting serious defect in Mohs' scale; its irregularity in region between 9 and 10. New class system also has advantages over that of R. R. Ridgway. Numerical numbers for classes are similar to those of Mohs' scale for 9 and lower, but much more reliable and accurate. Graphs reproduced from authors' previous articles show general agreement of classes with Mohs' scale. Brief ref. to work of S. D. Dmitriyev, E. M. Onitsch and E. W. Taylor.

I.D.I.B.

2018. The interpretation of the phenomena of apparent viscosity of slips: application to casting.

C. KIEFER. *Bull. Soc. Franç. Céram.*, 1950, **7**, 43.

The mechanism by which electrolytes influence the bonds between the water molecules and micelles of a clay slip, and therefore its fluidity, is described. The fact that the fluidity decreases, after reaching a certain max., with increasing electrolyte concn. is explained as the result of ionic interactions, due to the simultaneous increase of the cations with the anions. The action of various electrolytes is discussed, and it is pointed out that slips with Na_2CO_3 cast more quickly, but settle out easily, whereas those with the silicate do not settle, but are longer in casting. Methods of deducing the amount of additive necessary for max. fluidity, based on the quantity and mineralogical distribution of the clay substance in the body, are outlined.

B.C.R.A.

2019. A new method for measuring the elasticity of crystals.

W. KLEBER. *Fortschritte Mineralog.*, 1950, **26**, 73. *In German.*

For determining modulus of elasticity of isotropic bars, Le Rolland and Sorin have developed double pendulum method which is easy to handle and allows tests to be carried out rapidly. Method investigated by Liebold from theory of vibration. With

slight alterations, method can be used for determining torsion modulus. For investigating main elastic constants of crystals of cubic system, suggests production of 2 differently orientated single crystal bars, whereby it is favourable to have crystal main axis parallel to bar axis. Such crystal bars permit determination by bending test s_{11} and torsion test s_{44} . When carrying out measurement on an arbitrarily orientated bar s_{12} is obtained.

I.D.I.B.

2020. Determination of elastic constants of solids by pulse method.

KRISHNAJI. *Proc. Nat. Inst. Sci., India*, 1950, 16, 227.

A short summary is given of Knott's theory relating to a plane longitudinal wave incident upon the interface of a liquid and an isotropic elastic solid and it is shown how the elastic constants of the solid can be deduced from observations of the energy transmitted by the solid for different angles of incidence. A pulse method using a quartz crystal transducer operating at 2.5 Mc/s is described with which the elastic constants of Al, Fe, brass and Malabar stone were measured.

SCI. ABSTR.

2021. Scuffing temperatures of boundary lubricant films.

T. B. LANE. *Physics of Lubrication, Supplement No. 1, of Brit. J. Appl. Phys.*, 1951, pp. 35-38.

Blok postulated that for every combination of lubricant and sliding system a characteristic local temperature exists at the surface of contact at which lubrication fails and scuffing occurs. This has been confirmed by the author on the "two-ball machine." It was shown that for a range of oils tested the failure temperature increases with viscosity.

A.G.L.

2022. Failure of metals as a consequence of dislocations.

N. F. LASHKO. *J. Tech. Phys., USSR*, 1950, 20, 884.

The unsatisfactory subdivision of metal failures into viscous and brittle failures (represented as failure without preceding plastic deformation) should be replaced by a more adequate theory, especially as there is no agreement yet on the kinetics of the development of the viscous failure in solid bodies and, more particularly, on the role of the dislocations in it. The final phase of the viscous failure of a solid body is preceded by plastic deformations which partly constitute weakening and partly solidification processes. The latter feature is thought to be partly due to displacements or dislocations prohibiting slipping in certain directions. It is ultimately a question of local damage and the character of the dislocations on points of weakness of the material which decides where the general failure originates. These points become centres of dislocation or displacement faces, and on these the disruption of the continuity of the solid starts. This theory is demonstrated by microphotographs.

SCI. ABSTR.

2023. The correspondence principle in the theory of plastic deformation.

M. F. LASHKO. *J. Tech. Phys., USSR*, 1950, 20, 880. *In Russian.*

The theory of plastic deformation of solids is based on investigations of anisotropic monocrystals and isotropic (or rather quasi-isotropic) bodies. For each of these two domains of investigation relationships of plastic deformation have been established. For monocrystals these were formulated in terms of the elementary deformation phenomena taking the form of crystallographic displacements and twinning. For the quasi-isotropic body the relationships concern distribution of stresses and deformations, not considering the character of the plastic deformations in individual monocrystalline grains. The macroscopic phenomena are investigated by optical methods, etching figures, etc. Yet the plastic deformation in the grain-size monocrystals of the quasi-isotropic body proceeds by the same elementary processes of displacement and twinning as in isolated monocrystals. The different principles of investigation introduce here the same kind of artificial duality as in many other fields of science, physics above all. In analogy to

principles of correspondence in other fields, this seems particularly necessary and appropriate in plastic deformation. It may be formulated thus: The plastic deformation in the individual grains of the quasi-isotropic body proceeds similarly as in an isotropic crystalline body and is produced by the elementary processes of displacement and twinning characteristic of the monocrystal.

SCI. ABSTR.

2024. Crystalline interaction and the hardness of metals.

P. LAURENT AND M. EUDIER. *Rev. Métall.*, 1950, **47**, 582. *In French.*

The effect of crystal grains in producing anisotropic elastic properties in metals is discussed theoretically. Relations between various elastic moduli are derived, in good agreement with experiment. The problems of hardness are briefly considered.

SCI. ABSTR.

2025. A calculation of the elastic constants of aluminium.

R. S. LEIGH. *Phil. Mag. (Ser. 7)*, 1951, **42**, 139.

A calculation is made of the elastic constants of aluminium which correspond to pure shears without change of volume, and an explanation is given for the fact that aluminium crystals are almost elastically isotropic. Conclusions are drawn about the nature of the density of states near the Fermi surface, and it is shown how the elastic constants may be expected to depend on electron concentration in aluminium solid solutions.

AUTHOR.

2026. Apparatus for the study of creep of dielectric polymers and their dynamic rheological properties.

W. LETHERSICH. *J. Sci. Instrum.*, 1950, **27**, 303.

Apparatus is described for applying a shear stress rapidly to solid materials and for measuring the strain a few msec afterwards. The apparatus can also be used for measuring the dynamic modulus and internal friction coefficient over a range of frequency from 30 to 1,000 c/s. A modified form of the apparatus enables the frequency range to be extended down to 10^{-4} c/s.

AUTHOR.

2027. Plastic wave propagation in a bar of material exhibiting a strain rate effect.

L. E. MALVERN. *Qart. Appl. Maths.*, 1951, **8** (4), 405.

Discrepancies have been found between the results of impact tests on bars and the results predicted by the theory of propagation of a transient wave of plastic deformation based on the assumption that the stress-strain relationship is independent of the rate of strain. The paper extends the theory to apply to materials in which the stress is a function of the instantaneous plastic strain and the strain rate.

R.R.

2028. The rheology of lubricant films.

E. W. J. MARDLES, *Physics of Lubrication, Supplement No. 1 of Brit. J. Appl. Phys.* 1951, pp. 7-12.

Measurements have been made of the rate of radial spread of a pool of liquid on polished horizontal surfaces or between optical flats, approaching or receding in a normal direction. Various lubricants and liquid mixtures were employed. The results obtained indicate divergences from normal hydrodynamic behaviour and are specific to the liquid used and the material of the surface.

Rupturing of liquid films with "pin-holing" has been observed during the thinning of the films, onset depending on the type of surface and lubricant. Evidence of the "wringing" together of flats has been obtained from sliding results at low pressure and by the separation of totally-immersed flats by normal pull with small forces.

A.G.L.

2029. New method of measuring the modulus of elasticity and the possibility of using it on concrete.

A. MARGARIT. *Rev. Cienc. Apl.*, 1950, 4, 333. *In Spanish.*

An oscillatory system is employed to transmit energy to a similar system via a specimen of the material under test, and a theoretical study of the problem shows that the method can be used to determine the modulus of elasticity of the material. The technique has been applied to determine the variation of the modulus of concrete with age, but no results are given. Oscillograms illustrate the movements of the various parts of the system.

SCI. ABSTR.

2030. Friction coefficient in sliding and scratching of metals.

E. N. MASLOV. *J. Tech. Phys.*, USSR, 1950, 20, 888. *In Russian.*

A special testing machine was designed for measuring the friction forces in sliding and scratching contact. The friction coefficient in scratching contact, and also in cutting friction under various tools, is considerably higher than in sliding friction, which is non-destructive. This is explained not only by cleaner and larger contact areas in scratching friction, but even more due to the removal of very thin metal layers near the cut and to the raising of the edges of the latter.

SCI. ABSTR.

2031. On electro-osmosis and streaming-potentials in diaphragms. II. General quantitative relationship between electro-kinetic effects.

P. MAZUR AND J. TH. G. OVERBEEK. *Rec. Trav. Chim. Pays-Bas*, 1951, 70 (1), 83.

A general proof is given for the equality of the streaming-potential E/P and the electro-osmotic transport of liquid V/I , independent of the structure of the diaphragm. The presence of surface conductance and even inhomogeneity of the material from which the diaphragm is constructed, does not impair this relation. Three other relations involving also the streaming current and the electro-osmotic counter pressure, can easily be derived on the same base.

The proof is given by two independent methods, one method using a model of a diaphragm, which consists of a network of simple capillaries, the other treatment being based upon the thermodynamics of irreversible processes.

AUTHORS.

2032. A study of boundary lubricant films by electron diffraction.

J. W. MENTER. *Physics of Lubrication, Supplement No. 1 of Brit. J. Appl. Phys.*, 1951, pp. 52-54.

The work, carried out with long chain hydrocarbon films, shows that good boundary lubrication occurs only when there is a closely packed solid film of oriented molecules on the surface.

A.G.L.

2033. Plasticity.

C. E. MOORE. *Claycraft*, 1950, 23, 579.

Thin films of water attached to the surfaces of the clay particles may account for observed plastic behaviour. Notes are given on the influence of grain size and the importance of the development of acidity in ageing or souring by inducing flocculation. De-airing probably improves wettability by removal of the air which hinders wetting; uniform water distribution is of major importance.

B.C.R.A.

2034. Temporary reduction of viscosity of liquids at high rates of shear.

W. J. MORRIS AND R. SCHNURMANN. *Nature*, 1951, **167**, 317.

Measurements of the temporary reduction in viscosity of tetradecane at various temperatures, castor oil, medicinal paraffin, and other oils, at different rates of shear extending to 350,000 sec.⁻¹ are tabulated. Temporary viscosity reductions are obtained with any type of liquid including liquids normally of Newtonian flow.

E.W.J.M.

2035. The lubrication of cotton and other textiles.

E. MOSS. *Physics of Lubrication, Supplement No. 1 of Brit. J. Appl. Phys.*, 1951, p.19.

The removal of natural wax from cotton fibres in the finishing process and the introduction of other surface layers, as in dyeing, tend to increase the friction between cotton and other surfaces. Low and uniform friction is important in processes such as knitting and stitching and this can be achieved by the use of suitable lubricants.

A.G.L.

2036. The plastic-elastic behaviour of matter. (Dispersion of the modulus of elasticity with periodic deformation).

F. H. MÜLLER. *Z. Electrochem.*, 1950, **54**, 204.

Hooke's Law of elasticity and Newton's equation for viscosity do not allow for a general treatment of the elastic and viscous behaviour of matter. This is especially true of typically plastic matter. There is no clear concept of plasticity as there is an idealized, clear conception of elasticity and viscosity. It is only possible to describe the mechanical properties with Hooke's Law and Newton's equation in the case of metals, crystals, true low-molecular liquids and gases. Glasses in the softening range and certain other materials cannot be treated in an exact way, but in 1867 Maxwell formed an equation combining elasticity and viscosity. In 1939 W. Kuhn continued on the basis of Maxwell's equations which explain the relationship between the modulus of rigidity at infinitely fast deformation, the time of relaxation and the viscosity constant. With most materials not only one bond mechanism with a specific modulus of elasticity, and only one time of relaxation is effective, but a whole series of bond mechanisms are necessary for the description of the mechanical behaviour. To measure all these effects the "relaxation spectrum" is used, where the distribution of the mechanisms in relation to the relaxation time is shown. The methods described in British and American literature are similar to the author's method, which is analogous to that used for dielectric dispersion, and for that reason is called elastic dispersion. Organic plastic materials undergo a sinusoidal, periodic mechanical deformation and the elastic forces are determined. The time of relaxation is a function of the temp. and frequency. For the exact determination of the "relaxation spectrum" only the laborious method of determining the frequency curve can be used. To measure the desired effect it is essential to use a suitable method of deformation. The author recommends the bend test with a special apparatus; one end of the specimen is fixed to a hard steel spring, from which the light is deflected, and the other end is moved by an eccentrically moving rod. Theoretical as well as practical reasons are given for not using the elongation-compression method, the torsion method, simple shearing, etc. Various curves are shown at either constant temperature or constant frequency. The experiments will be continued to show the connection between the deformation properties and chemical structure, and their parallel dielectric behaviour.

B.C.R.A.

2037. The law of constant resolved shear stress in crystal plasticity.

F. R. N. NABARRO. *Phil. Mag.*, (Ser. 7), 1951, **42**, 213.

The formula of Peach and Koehler for the total force acting on a dislocation in a stressed crystal is derived by the use of a theorem due to Colonnetti. The same method distinguishes conservative motions of the dislocation, which do not alter the volume,

from other motions. The components of the total force which produces conservative motions acts in the glide plane, and is proportional to the same component of the total stress as appears in the law of resolved shear stress discovered experimentally by Schmid.

AUTHOR.

2038. Analysis of aqueous solutions by measurement of viscosity and conductivity.

H. W. NICOLAY, W. ERNST AND H. WEGKAMP. *Chem. Weekbl.*, 1951, **47**, 88.

Viscosity or conductivity, combined with density, can be used as an analytical criterion for the concentration of sodium sulphate and potassium chloride in saturated sodium chloride solutions. Viscosity can also be used for determining the concentration sodium hydroxide solutions. Tables and diagrams are given.

P.G.M.

2039. Variation of amplitude-dependent internal friction in single crystals of copper with frequency and temperature.

A. S. NOWICK. *Phys. Rev.*, 1950, **80**, 249.

The amplitude-dependent internal friction which originates in the motion of dislocations in single crystals of Cu is studied as a function of frequency and temperature. Quantities are introduced which express the dependence of internal friction and of Young's modulus on strain amplitude and it is shown that these quantities are significant measures of the properties of a crystal. Measurements made between -60°C. and $+33^{\circ}\text{C.}$ show that the observed internal friction can be expressed as the product of a function of temperature and a function of amplitude alone. The data also indicate that the internal friction and elastic modulus are frequency independent when the structure sensitivity of the material is taken into account. The results are considered in terms of two viewpoints: a mechanism of relaxation by which dissipation is controlled through a rate process, and simple hysteresis, by which the stress-strain loop is independent of the rate of traversal. It is shown that the latter mechanism gives much better agreement with the experimental facts. Finally, simple hysteresis is interpreted in terms of the dislocation theory.

AUTHOR.

2040. On the endurance limit of a round bar with longitudinal grooves.

H. OKUBO. *J. Appl. Phys.*, 1950, **21**, 1105.

It was considered, in a previous paper, that the endurance limit of a material should be determined by the amount of the mean stress in a certain area around a point, instead of the stress at the point, and the extent of the area is determined for several kinds of metals, by using the results of tension-compression fatigue tests. The extent of area where the mean value of stress to be taken has now been determined for a mild steel in another way, viz. by a torsion fatigue test, and the conclusion reached that the extent of area chiefly depends on the kind of metal and is independent of the course of the experiment.

AUTHOR.

2041. The present position of hardness testing of minerals.

E. M. ONITSCH. *Berg & huettenmann Mh montan Hochschule Loeben* 1950, **95**, 12; abstr *Chem. Zentralbl.*, 1950, II, **121** (16), 1870. In German.

Micro-hardness, mostly determined by Vickers method, has proved reliable for hardness measurements and identification of structure, constituents, and crystallites. Disadvantage is that this hardness cannot be directly compared with Mohs' scratch hardness scale commonly used for minerals. Various proposals discussed whereby these 2 forms of measurement could be brought into functional relationship, irrespective of fact that Mohs' scratch hardness and micro-indentation hardness represent different properties; also that Mohs' hardness tests on samples may have depth range up to several hundred micron, while in micro-hardness tests depth is only a few micron.

I.D.I.B.

2042. The determination of the rheological characteristics of liquids having a structure, using a rotational viscometer.

R. M. PANICH AND S. S. VOYUTSKII. *Zovodskaya Laboratoriya*, 1949, **15** (5), 550.

Uses a Stormer viscometer, modified to give absolute results, and an Ostwald. The viscosity-rate of shear curves obtained with the two instruments on a filled rubber sol were very close.

P.M.

2043. The forces exerted on dislocations and the stress fields produced by them.

M. PEACH AND J. S. KOEHLER. *Phys. Rev.*, 1950, **80**, 436.

It is shown that the force $d\mathbf{F}$ exerted on a line element $v d\sigma$ of a dislocation with Burger's vector $\mathbf{f}$ by a stress τ is given by $d\mathbf{F} = -v \times (\mathbf{f} \cdot \tau) d\sigma$. An analogy is drawn between the behaviour of a closed line dislocation in a stress field and the behaviour of a closed current-carrying loop in a field of magnetic induction. Then formulae for the stress components caused at any point of an infinite elastically isotropic crystal by a line element of a general Burger's dislocation are deduced from Burger's expressions for the displacements. These formulae bear a close analogy to the Biot-Savart formula of electromagnetic theory. Both of these results taken together constitute a complete system for the investigation of the mutual interaction of dislocations in an infinite elastically isotropic crystal.

AUTHOR.

2044. Spontaneous gelation of alkaline casein dispersions.

K. F. PLOMLEY, H. G. HIGGINS and J. F. HAYES. *Nature*, 1951, **167**, 1951.

Viscosity-time curves for different regions of the high pH range and for the dependence of viscosity and rate of gelation on pH are shown. The search for the specific groups concerned in the gelation process and their mode of linkage is proceeding.

E.W.J.M.

2045. A comparison of torsion pendulum type viscometers for measurement of viscosity in dairy products.

F. E. POTTER, E. F. DEYSHER AND B. H. WEBB. *J. Dairy Sci.*, 1949, **32**, 452.

Three different viscometers—MacMichael, Brookfield, Mojonnier-Doolittle—were compared for measurements on evaporated and condensed milk, ice-cream mixes and similar materials. Operated under standardized conditions, the viscometers gave interconvertible apparent viscosities on an empirical basis.

G.W.S.B.

2046. Penetration tests.

PRECISION SCI. CO. *Chem. and Engng. News*, 1950, **28** (45), 3914.

Penetrometer Timer makes penetration measurements absolute by eliminating possibility of human error. Operator flicks timer control switch to "on" position. Needle is free to allow penetration for 5 sec; needle then gripped and held immovable. Timing is made precise by synchronous motor and cam actuating micro-switch to solenoid holding needle shaft.

I.D.I.B.

2047. Transition between laminar and turbulent flow in various liquids.

G. RAUMANN, I. S. NIXON AND K. G. DENBIGH. *Research, Lond.*, 1950, **3**, 520.

Experimental studies have been carried out on the transition between laminar and turbulent flow in the following liquids: water, acetone, butanol, ether and solutions of benzopurpurin and polymethyl methacrylate. Most of the work was carried out at 20°C., but experiments on ether were conducted also at 0°C. and -80°C. The results confirm the correctness of the Reynolds number in determining the stable type of flow, and it seems therefore that the viscosity and the density are the only properties

of the fluid which are of significance with regard to the mechanism of the fully developed turbulent motion. On the other hand, it has been noted that there are certain specific differences of behaviour between the various liquids regarding the ease of transition between laminar and turbulent flow. The presence of colloidal particles, in particular, seems to facilitate the transition. It is also shown that the pressure drop in a straight tube continues to be proportional to the fluid velocity in the quasi-turbulent region between Reynolds numbers of 2 200 and 5 000. Above $Re=5\ 000$ the present results are in agreement with the equation of Blasius.

AUTHORS.

2048. The rheological aspect of hydrodynamics.

M. REINER. *Quart. Appl. Maths.*, 1951, 8 (4), 341.

Tensor analysis of the most general relation between stress and rate of deformation leads to five coefficients of viscosity of which three are the ordinary (shear) viscosity μ , the coefficient of volume viscosity μ_v and the coefficient of dilatancy δ , while one coefficient may be connected with the 'Weissenberg effect.' The Stokes-Navier equations of hydrodynamics in which μ_v is neglected, can be used consistently only when the volume of the flowing liquid is constant.

AUTHOR.

2049. On a variational theorem in elasticity.

E. REISSNER. *J. Math. Phys.*, 1950, 29, 90.

A new variational method is proposed for obtaining approximate solutions of boundary value problems, which, unlike earlier methods, gives equal weight to the stress-equilibrium equations and the stress-displacement relations. Its advantages are illustrated in deriving two-dimensional equations for the transverse bending of plates.

SCI. ABSTR.

2050. Rheology of suspensions of high solid concentration.

P. J. RIGDEN. *Nature*, 1951, 167, 197.

The fractional volume of voids in the compacted dry powders is an important factor controlling the relative viscosity of powder in liquid systems. When the void space of the dry compacted powder, (a method has been developed for determining the mean pore radius r), is just filled with liquid the pores comprising the voids consist of liquid filaments and presumably the total pore volume and r are related to the relative viscosity of the dispersion. Observations with a large number of mineral type powders of various degrees of fineness in bitumen seem to support this view.

E.W.J.M.

2051. The rheological analysis of solid and liquid systems. RN/1435/PJR.

Summaries of Road Research Notes, January 1951, No. 21, 9.

The object of rheological analysis is to deduce from purely rheological considerations information about the structure of a disperse system, e.g. solutions of macro-molecules in solvents or suspensions of solids in liquids. The analysis is based essentially on the interpretation of consistency curves (shear velocity-stress plots) at various temperatures. This note outlines the principles of this method of analysis and gives an example of its application to the behaviour of filler-tar systems. It is shown that these systems are essentially in the dispersed state, although at very high filler concentrations unordered aggregations of particles are formed which are broken down under very small shear stresses leading to a characteristic structural viscosity curve.

D.C.B.

2052. The present position of the laboratory work at the road research laboratory on fillers and filler-binder systems. RN/1439/PJR.

Summaries of Road Research Notes, January 1951, No. 21, 9.

This note describes briefly recent work on the relation between the flow properties

of filler-binder mixtures and the structure of the voids in the dry fillers. It is shown that :—

(i) Fillers can be dispersed in tar or bitumen up to a limiting concentration beyond which the binder can no longer fill the voids in the compacted filler. This limiting concentration is the system of maximum density for the two components and is also the system of maximum relative viscosity (corresponding to optimum binder content).

(ii) At low filler concentrations the systems are essentially simple Newtonian liquids (η_{rel} being independent of temperature); at higher concentrations they show structural viscosity and η_{rel} is dependent upon temperature.

(iii) Rheological analysis of the experimental data indicates that the systems are essentially in the dispersed state, although at high concentrations weakly-held, unordered aggregation of particles occurs.

(iv) None of the primary characteristics of a filler is suitable, by itself, for evaluating the influence of it on the flow properties of mixtures.

(v) The packing properties of a filler are of more significance and the fractional voids (ϵ) in the dry compacted is uniquely related to cv max. (corresponding to optimum binder content) by the relation $\epsilon = 1 - (cv) \text{ max.}$

(vi) The relative viscosity of filler-binder systems containing different fillers can be correlated, over a limited range of low concentration, by expressing the concentration of filler (cv) in terms of an effective volume fraction (ce) given by $ce = cv/cv \text{ max.}$ although its use does not, by itself, provide a means of predicting η_{rel} at high concentrations.

(vii) Two main factors determine the rheological behaviour of these systems at high concentration; they are the volume concentration of filler and the mean pore radius of the voids in the filler at the packing appropriate to any particular concentration.

D.C.B.

2053. The viscosity of suspensions of spheres. II. The effect of sphere diameter.

J. V. ROBINSON. *J. Phys. Colloid Chem.*, 1951, 55 (3), 455.

The viscosities of suspensions in sugar solutions of three sizes of glass spheres, respectively 3-4 μ , 4-10 μ , and 10-30 μ in diameter, are measured, using a rotational viscometer described in an earlier paper. The 'effective volume' of the spheres which includes a supposed immobilised liquid shell around the sphere, is derived from the viscosity data. It is concluded that the "effective volume" is greater in the viscous sugar solution than in water and that the increase in "effective volume" is greater as the size of the spheres decreases. "Effective volumes" were also determined directly from sedimentation volumes and were found to have a range, depending upon the packing force, which embraced the values derived from the viscosity measurements.

G.E.B.

2054. The viscosity of chalk mud.

F. SCHMELING. *Tonindustr.-Z.*, 1950, 74, 147.

Experiments show the dependence of the viscosity of chalk mud on H₂O content, temperature and particle size. The data are of importance in cement technology.

B.C.R.A.

2055. Review of the progress of dairy science. Section C. Part II. (Rheology).

G. W. SCOTT BLAIR. *J. Dairy Res.*, 1949, 16, 439.

A belated review covering, approximately, the years 1942-7.

G.W.S.B.

2056. The hardness and strain-hardening of plasticine.

G. W. SCOTT BLAIR AND M. BARON. *Brit. J. Appl. Phys.*, 1951, 2, 71.

When plasticine is subjected to indentation tests with a sphere hardness tester using a series of increasing loads, and allowing time at each load for indentation virtually

to cease, the yield values increase with increasing depth of indentation. Meyer coefficients apparently increase from values of less than 2.0 at small loads and soon reach a constant value of about 3.5, although after very long times they may increase still further. But in such experiments, stress, strain and time are all varying. If the stress is maintained at a constant value, the rate of indentation progressively slows down with time, but the Meyer coefficient under these conditions is less than 2.0.

The authors conclude (contrary to the view of earlier workers) that plasticine does "work-harden" considerably in most accepted senses of the term, but they advocate a more precise definition of "work-hardening." They also point out that the material shows a slow elastic recovery to a much greater extent than has previously been realised.

A.G.L.

2057. Electrical conductance and viscosity in the system tetra-n-butylammonium picrate—n butyl alcohol at 91°.

R. P. SEWARD. *J. Amer. Chem. Soc.*, 1951, 73, 515.

The product of limiting conductance and viscosity was found to be substantially equal to the conductance-viscosity product of the pure salt. The data appear to indicate that the picrate is a weak electrolyte when at low concentrations but that it becomes a strong electrolyte at high concentrations.

E.W.J.M.

2058. The lubrication of metals by long chain organic compounds.

K. V. SHOOTER. *Physics of Lubrication, Supplement No. 1 of Brit. J. Appl. Phys.*, 1951, pp. 49-51.

Bowden and his collaborators have shown that for efficient boundary lubrication, chemical reaction and soap formation must occur. An investigation has been made using a series of fatty acids and the friction results show that reaction and soap formation occur and that more than a monolayer of soap is required on each sliding surface for good lubrication.

A.G.L.

2059. The conversion of fibrinogen to fibrin. III. Sedimentation and viscosity. studies on clotting systems inhibited by hexamethylene glycol.

S. SHULMAN AND J. D. FERRY. *J. Phys. Colloid Chem.*, 1951, 55 (1), 135.

Sedimentation and viscosity measurements are made on systems containing bovine fibrinogen and thrombin with hexamethylene glycol. The specific viscosity increases gradually with time and approaches a constant value many times that at the start of the reaction. It is concluded that the fibrinogen is progressively converted into a product which is capable of associating end-to-end to form highly asymmetric aggregates.

G.E.B.

2060. The concentration dependence of viscosities in dilute solutions.

R. SIMHA. *J. Coll. Sci.*, 1950, 5, 386.

At very low concentrations, at which the solute molecules either retain their identity and original shape or form low-order aggregates, the concentration dependence of the reduced specific viscosity η_{sp}/c results from two factors, hydrodynamic interaction, and aggregation. An expansion for the latter and a simplified description of the former are presented. On the basis of the complete theory previously given, the effect of particle shape and solvent is discussed.

AUTHOR.

2061. Development of an apparatus for measuring continuously the "consistency" of clay.

M. J. SINGER. *T.N.O. Nieuws*, 1951, 6 (3), 39. *In Dutch.*

It is of great industrial importance to be able to measure the consistency of clay during its flow through technical presses. This consistency is dependent on many

factors, but one of the most important is the moisture content of the mass of homogeneous clay. Many methods have been proposed, but they are mostly laboratory methods and do not allow measuring the consistency continuously.

The Ceramic Institute T.N.O. (Gouda, Netherlands) has succeeded in developing such an apparatus. A ball is hanging in the clay on a vertical thread, which is fixed to a spring. The movement of the ball is dependent on the consistency of the clay and is registered by a meter. The apparatus is able to register a difference in consistency of the clay of 3° by addition of 0.12% of water. The addition of water can be regulated automatically in such a way that the consistency of the flowing clay is kept constant.

A.v.R.

2062. Theory of the influence of the speed on the resistance of metals to plastic deformation.

L. D. SOKOLOV. *J. Tech. Phys., USSR*, 1950, 20 (4), 447. *In Russian.*

Discussion of the numerical evaluation of analytical expressions of the relation between resistance to plastic deformation and rate (speed) of deformation from some modern theories of plasticity. Most suitable and corresponding to experimental facts are relations $\sigma = \sigma(v)$ obtained by comparing athermal and thermal plasticity, the latter being well represented by the temperature relation of the relaxation time $\tau = \tau_0 \exp(U(\delta)/kT)$, where $U(\delta)$ is the activation energy depending on the degree of deformation. Dislocation theories based on considerations of microplasticity give correct relations for small deformations. The validity of the Zener-Hollomon formula is confined to regions of low homologous temperatures. From examination of Vitmans and Stepanov's [*J. Tech. Phys., USSR*, 1939, 9, 1070] as well as the author's own formulae, it appeared that these are suitable and convenient for practical calculations provided the coefficient n of the Vitman-Stepanov formula is known as a function of the homologous temperatures, the degree of deformation and number of admixtures to the base metal.

SCI. ABSTR.

2063. Reasons for the characteristics of breakdown of elasto-anisotropic bodies.

A. V. STEPANOV. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, 1950, 14 (1), 122. *In Russian.*

Theoretical. Methods of representing the elastic properties of elasto-anisotropic bodies and evaluating the acting stresses in anisotropic bodies are discussed. In comparing elasto-anisotropic and elasto-isotropic bodies the following points are considered: the state of stress depends on the angle between the directions of the acting force and the axes of anisotropy of the sample; the direction of maximum stress does not coincide with the direction of maximum deformation; the direction of maximum stress does not coincide with the direction of the acting force; the state of stress depends on the period of the acting force (e.g., the difference between figures of pressure and strike for crystals); in anisotropic laminae the effect of the concentration of stress along the direction of the highest value for Young's modulus, and deconcentration for the direction with the least value for Young's modulus is manifest; there exist characteristic forms of stress inherent in all anisotropic media, and consequently analogous forms of breakdown; the results of interaction of an external force depend on its sign.

SCI. ABSTR.

2064. Fitting mathematical theories of plasticity to experimental results.

F. D. STOCKTON AND D. C. DRUCKER. *J. Colloid Sci.*, 1950, 5, 239.

It has been shown that stress-strain relations become more and more complicated the more data they have to fit. Although useful relations were found for only part of the data of Taylor and Quinney on Cu tubes, many tests can be fitted by simple incremented theories.

B.C.R.A.

2065. **Elastic constants of the heptahydrates of magnesium and zinc sulphates.**
R. V. G. SUNDARA RAO. *Proc. Indian Acad. Sci. A*, 1950, **31**, 365.

The elastic constants of the orthorhombic crystals, Mg and Zn sulphate heptahydrates have been determined by the ultrasonic method. The elastic moduli and the compressibilities for the same are also calculated.

AUTHOR.

2066. **Finite elastic straining.**

K. H. SWAINGER. *Appl. Sci. Res.*, 1950, **A2** (4), 281.

Finite elastic straining is analysed with all quantities referred consistently to the deformed body taken as the function domain. The straining-displacement of a typical point is relative to a set of axes imbedded in the body at one arbitrary point and rotating in fixed space with that neighbourhood if necessary in a particular problem. The resulting plane stress equations have precisely the same form as in the classical theory but relate to true quantities in the deformed body. Any boundary value problem already solved for the classical infinitesimal strains theory can be applied directly as a finite strains solution for the deformed body.

AUTHOR.

2067. **The plastic deformation of optical glass.**

E. W. TAYLOR. *J. Soc. Glass Technol. (Trans.)*, 1950, **34**, 69.

A comparison was made of the impressions produced under given loads by a pyramidal-ended diamond indenter in fluorite, in calcite samples with surfaces both normal to and parallel to the optic axis, and in 15 types of optical glass. The most perfect rectangular impressions were obtained in fluorite; in the glasses a "pin cushion" was the usual shape. "Diamond pyramid hardness" numbers were calculated from

the formula $\frac{2P \sin \frac{1}{2}\theta}{d^2}$ where P is the load in kg., d the average length, in mm., of the

diagonals of the indentation. The highest values were recorded with barium crown glasses and the lowest with the flints, the hardness falling off with increase of PbO content. The displaced material resulting from indentation was piled up round the sides of the impression in a mound. Some observations were made on the furrows produced by drawing the loaded diamond point across the glass surface.

B.C.R.A.

2068. **Anomalous viscosities in the MnO-SiO₂ system.**

H. TOWERS AND J. KAY. *Trans. Brit. Ceram. Soc.*, 1950, **49**, 341.

Viscosity measurements have been made on slags in the MnO-SiO₂ system. Slags in which the molar ratio SiO₂/MnO ≥ 1.0 possess anomalous viscosities in that their apparent viscosity decreases with increase in rate of shear. A quantitative mathematical hypothesis has been offered in explanation of this behaviour and related to dissociation of silicate structures in the liquid.

B.C.R.A.

2069. **Physics of rubberlike materials.**

L. R. G. TRELOAR. *Nature*, 1951, **167**, 425.

Synopsis of four lectures at the Royal Institution, Nov., 1950.

To account for the large elastic deformability of rubberlike materials it is necessary to find a molecular mechanism involving long-range forces. Following Busse, 1932, who discussed the problem using a molecular network model, the mechanism for the elasticity of the individual molecular chain was considered by Meyer, Kuhn, Guth and Mark and others. In their kinetic theory of elasticity, the thermal fluctuation of the molecular chain comprising probably 20,000 carbon atoms was given the central role. The Joule effect, 1859, follows as a thermodynamic consequence. Recently, exact mathematical relations have been obtained representing the mechanical and other physical properties of rubber in terms of the statistical properties of a network of long-

chain molecules. For the case of a simple elongation the relation between the force, F , per unit area of the unstrained cross-section and the extension ratio α is $F=NkT(\alpha-1/\alpha^2)$ where N is the number of chains, or molecular segments between junction points of the network, k is Boltzmann's constant, and T the absolute temperature. The same formula is valid for a compression in one direction ($\alpha<1$). It is seen that the force-extension relation is non-linear, in agreement with experiment. For simple shear, on the other hand, the relation between shear stress t and shear strain σ is linear, and is given by the equation $t=NkT\sigma$.

This conclusion that rubber should obey Hooke's law in shear but not in elongation or compression explained what had long been known from observation and was a striking initial success for the network theory.

E.W.J.M.

2070. Temperature coefficient of hardness.

E. F. TRUSSOVA. *Zhurn. Tekhn. Fiz.*, 1950, 20, 79; abstr *Chem. Zentralbl.*, 1950 II, 121 (16), 1795. In German; original in Russian.

Tests made with aluminium alloys of Ag, Cu, Mg, Si and Zn, and with copper alloys of same plus Ni and Sn—up to 5% content of alloying element. Hardness tests made at 20 and 500 deg. C. Strengthening effect of additions even at 500 deg. still substantial. With all alloys, temp. coefficient of hardness is larger than with pure metal and increases with amount of addition (optimum limit not given). Relative temp. coefficient correlated with room temp. hardness is, with Al and alloys, approx. constant; with Cu it is larger than with Cu alloys.

I.D.I.B.

2071. On the accuracy of apparatus for measuring impact hardness of metals

A. G. TULINOV. *Zavodskaya Lab.*, 1950, 16 (2), 211; abstr *Chem. Zentralbl.* 1950, II, 121 (12), 1397. Original in Russian.

With Poldi hammer impact hardness of metals can be determined with accuracy of $7\% \pm$. For this, necessary that test-pieces should be sufficiently massive and rest on firm and solid base; surfaces must be very carefully cleaned also. Comparative or blank test-piece must be of approximately same hardness as that of actual sample. Diameter of both impressions should not differ by more than 0.5 mm. Impact force of Poldi instrument should be so controlled that diameter of impression on blank (control) test-piece should be within 2.5 to 4 mm. In evaluating, only true geometrical impressions with clearly defined outlines should be used.

I.D.I.B.

2072. The measurement of viscosity. I. Fundamentals.

H. UMSTATTER. *Arch. tech. Messen*, Issue No. 178 (Ref. V9122-6), T129-30 (Nov., 1950). In German.

A review of the ways in which a measured viscosity coefficient can depend on the previous history of the material, on rate of shear, temperature, pressure and on concentration in the case of colloidal or macro-molecular substances.

SCI. ABSTR.

2073. Influence of the character of preliminary work-hardening on the softening of a metal in plastic deformation.

L. I. VASILEV. *J. Tech. Phys.*, USSR, 1950, 20, 458. In Russian.

It is found that in the tensile stressing of tin specimens after a preliminary substantial deformation by extrusion through a nozzle and drawing, a reduction of the deforming pressure is observed, which contradicts the normal experience. A possible explanation is that in certain conditions the relief of the preliminary work-hardening stresses will not compensate for the deformations of the tensile stressing, i.e., the relaxation will overlap with the hardening or solidifications.

SCI. ABSTR.

2074. Elastic and photoelastic properties of some optical glasses.

K. VEDAM. *Proc. Indian Acad. Sci. A*, 1950, **31**, 450.

The elastic and photo-elastic constants for a set of 18 optical glasses of widely varying composition have been measured. The elastic constants and the quantities p_{11} , p_{12} , q_{11} and q_{12} have in general no correlation with the density or the refractive index. However, when glasses of similar composition are compared, the photo-elastic constants are found to increase, as the Pb content in the glass increases; also the value of p/q is found to diminish progressively thus confirming Pockels' observations.

AUTHOR.

2075. The consistency of enamel mixes.

L. VIELHABER. *Glas-Email-Keramo-Techn.*, 1950, **1** (1), 6.

A survey is given of plant methods of testing the enamels before use and of methods of setting. Simply to run enamel from a ladle is too primitive and should no longer be used. Letting a definite quantity of enamel run from a nozzle (generally 5 mm. dia.) to give a measure of viscosity provides a certain indication, but this method has found no application in plants, since apparently it does not cover all the essential factors. More suitable is the dip-stick method, in which a cylinder with a surface of 4 sq. cm. is dipped into the mix and, after the enamel has run off, the weight is determined of the amount that has remained on the cylinder. Irwin's method is also satisfactory; in this a definite amount of enamel is run on to a plate and the dia. to which it expands is measured. The consistency of the mix is very much influenced by the addition of water; evaporation of a known quantity of enamel in order to determine the water content is too cumbersome for a plant. It is better to determine the s.g. since this is changed according to the amount of water added. This determination is important not only for the testing of the water content: each enamel has its most favourable s.g. according to its use. The enamel may show all the desired test values and yet may be unusable for other reasons, for instance it may slip off or run, etc. (thixotropy). To remedy this there are several setting agents that can bring the enamel to its proper consistency. The agents most commonly used are borax, boric acid, all carbonates, some chlorides, saltpetre, etc. The action of these agents varies, depending on the type of enamel.

B.C.R.A.

2076. Electrical behaviour of non-aqueous disperse systems.

A. DE WAELE AND R. W. RAINBIRD. *Nature*, 1951, **167**, 244.

The high specific inductive capacities of flocculated systems cannot be ascribed entirely to the reduction of volume of the dielectric medium arising from the presence of the conducting particles as deflocculated systems of similar volume concentration show values little greater than that of the medium. Rather is it connected with the friction exhibited by the thin quasi-solid interstitial films of the medium, which give rigidity to the dispersion at concentrations of disperse phase well below those corresponding to critical packing.

E.W.J.M.

2077. Viscosity of lubricating oils at high rates of shear.

A. F. H. WARD, S. M. NEALE AND N. F. BILTON. *Physics of Lubrication, Supplement No. 1 of Brit. J. Appl. Phys.*, 1951, pp. 12-17.

The authors used a high speed concentric cylinder type of viscometer with a very small adjustable clearance. The stator was water cooled. Rotor speeds up to about 5000 r.p.m. could be achieved and accurately measured. The temperatures of the rotor were measured by means of a copper-constantan thermocouple.

The results obtained show that ordinary lubricating oils show anomalously low viscosities at high rates of shear, and that this fall in viscosity is much more marked in experiments at lower temperatures. The decrease in viscosity was in fact a function both of the rate of shear and of the temperature. This could be interpreted in terms of a balance between the orientation produced by the velocity gradient and the disorientation caused by Brownian motion. Addition of a viscosity index improver to the oil gave a more marked anomalous effect.

A.G.L.

2078. An atomistic interpretation of deformability and brittleness.

W. A. WEYL. *Glastechn. Ber.*, 1950, **23**, 174.

The mechanical properties of glasses, metals and even rubber become more similar when the materials are tested under conditions that exclude the influence of imperfections. An attempt is made to explain the different effect of flaws in metal and glasses. The behaviour of solid bodies under shearing stress and the process of fracture are not only a consequence of the forces of cohesion, but are influenced also by the arrangement of the atoms and the polarizability of the ions. Atomic arrangements, characterized by strong asymmetric fields, lead to plastic deformations. By this the energy thresholds between the positions of equilibrium are determined. The absolute distance between these positions is given by the symmetry in the structure of the material and by the direction of the shearing stress. The activation energy of the flowing process is primarily dependent on the polarizability of the flow units and decreases with increasing polarizability of the ions. Practical examples to explain these theories are described. The different degrees of brittleness of Na, K, Ag and Tl halogenides are shown. If the mechanical properties were only a consequence of the forces of cohesion, i.e., Coulomb's forces between the atoms of the substance, no great difference in the behaviour of NaCl and AgCl would exist. NaCl is brittle, but AgCl can be deformed plastically at room temperature. The influence of various factors on the toughness of the material is discussed, such as symmetry of atomic structure, temperature, pressure, the surroundings and the electronic configuration of the ions. The flow of brittle marble, when subjected to hydrostatic pressure, is explained. Thermal diffusion is compared with the effects of a plasticizer in organic plastics. The increase in strength of NaCl crystals dipped in H_2O is explained. Polarizability is discussed and it is shown how, when Ag-ions approach each other, mutual deformation is caused. Every Ag-ion forms a dipole, orientated in such a manner, that the resultant causes attraction or that the forces of repulsion, caused by equal charge of the ions, are reduced by the dipole forces of opposite charge. Other examples are given. The extreme brittleness of glass is discussed thoroughly. The main causes of brittleness of glass at room temperature are: the glass-forming ions exert strong forces on each other, so that their re-arrangement at low temperature proceeds slowly, and further Si^{4+} , Ca^{2+} , Na^+ , O^{2-} are of the inert gas type. Their force fields cannot be easily adapted to the surroundings. The lack of polarizability causes strong repulsive forces when ions with equal charge, such as two Si^{4+} ions, slide past each other. Glasses are not in an orderly state, therefore the atoms cannot find a new state of equilibrium under the action of an external force without considerable rearrangement.

B.C.R.A.

2079. Viscosity-temperature dependence.

I. WILLIAMSON. *Nature*, 1951, **167**, 316.

The author using Brancker's equation (abstract 1854) namely, $\eta(1-a/T)=b$ which can be written $1/\eta=1/b-a/bT$, found the linear relation between $1/\eta$ and $1/T$ does not fit viscosity data for plasticising liquids. On the other hand, if the data are plotted as η against η/T approximately straight lines are obtained which deviate only near the origin.

E.W.J.M.

2080. The rate of deformation and mechanical properties of the structure in clay slips.

K. F. ZHIGACH AND E. G. KISTER. *Dok. Akad. Nauk., USSR*, 1949, **67**, (6), 813.

It is shown that the thixotropic structure that develops in aged clay slips can be broken down stepwise, if the rate of deformation of the slip is sufficiently slow. Some results of this "pulsation" are given for bentonite slips.

B.C.R.A.

BOOK REVIEW

The Elements of Soil Mechanics in Theory and Practice. BY K. L. NASH. Constable & Co. Ltd., London. 9s.

This little book, as stated on the title page, is a record of four public lectures which the author delivered at King's College, London. In the limited space available, he has attempted to give a concise review of soil mechanics and its practical applications. In the first lecture, after a short historical introduction, he deals with site exploration, soil classification and the fundamental properties of clays and sands. The second lecture covers the density of soil, the conditions governing the percolation of water and its effects, and a simple explanation of the theory of consolidation. In the third lecture, Mr. Nash describes the measurement of shear strength and its application to the stability of slopes, retaining walls and footings; and the subject of the fourth is the application of soil mechanics to the design and construction of roads and runways, including "natural" stabilisation by drainage and compaction, and "artificial" stabilisation by the addition of other substances to the soil. At the end of the book, there is a comprehensive bibliography, which appears, however, to serve rather as an acknowledgment of the various sources from which the author has collected material than as a list of references to assist the reader seeking further information on specific subjects.

The author does not claim to set forth original theories or experimental data; but he has succeeded in compressing a great deal of information into a small space, and the book is well illustrated throughout. It is not surprising, therefore, that many important topics are referred to very briefly, and, in some instances, formulae—for example, those relating to densities, void ratio and specific gravity of particles—are quoted without explanation. On the other hand, in dealing with shear strength, Mr. Nash gives an explanation of the various types of shear stress which is remarkably clear, in spite of its brevity. The lectures were given, presumably, with the object of stimulating interest in soil mechanics and of showing the active part which the universities are taking in teaching and research in this important subject. As such, they are appropriate, but to many readers the publication of the lectures in book form may give the impression of covering too wide a field for the size of book. This work should, however, prove of value to engineers and others as a general picture of soil mechanics and its applications, and as an introduction to the more comprehensive text-books.

ENGINEERING.

Definition.

RHEOLOGY is the science of the deformation and flow of matter.

Objects.

The objects for which the Society is established are the advancement and diffusion of a knowledge of rheology pure and applied and for this purpose especially :

- (i) To co-ordinate the activities of Rheologists in the British Isles.
- (ii) To further the appreciation of the importance of rheology in industry.
- (iii) To facilitate the pooling of information with respect to problems and new methods of research.

Membership.

Anyone who is interested in rheology is eligible for membership.

Subscription.

Each member is required to pay a subscription of £1 per annum.

Activities.

Co-operation with Rheologists overseas has been maintained since the Society started as the British Rheologists' Club in 1940. Meetings, with lectures and discussions, exhibitions and visits to laboratories where rheological methods and equipment are in use, are arranged regularly at various centres in this country.

Conferences were held in Oxford, 1944, at Bedford College, London University, 1946, at Hulme Hall, Manchester, 1947, at Bristol University (Wills Hall), 1949 and at Reading University, 28th to 30th September, 1950. The Society participated in the first International Rheology Conference, The Hague, Holland, September, 1948.

The Officers will be happy to act as a medium for the arrangement of informal contacts between individual members for discussion of urgent technical problems of mutual interest.