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THE BRITISH SOCIETY OF RHEOLOGY

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INTERNATIONAL COMMITTEE ON RHEOLOGY

At a meeting of members of the Second International Congress on Rheology on July 28th, 1953, it was decided to form an International Committee on Rheology.

The mandate of this Committee is :

1. to be a permanent body for organising future International Congresses on Rheology;
2. to encourage new national organisations for the study of rheology;
3. to act as co-ordinating body in other aspects of international co-operation in the field of rheology.

The committee will consist of about ten members as follows :

1. representatives nominated by existing national organisations on Rheology (Germany, Great Britain, Japan, Netherlands, U.S.A.; and in the near future, France). Awaiting official nominations by these organisations, the following members of the Congress have accepted temporary membership :

France	..	..	Prof. H. Weiss
Germany	..	..	Prof. F. H. Müller
Great Britain	..	..	Mr. A. G. Ward
Netherlands	..	..	Dr. R. N. J. Saal
U.S.A.	..	..	Dr. R. S. Spencer

2. representatives from some other countries where there is appreciable activity in rheology, the temporary members at their first meeting have co-opted :

Mr. E. Forslind	..	(Sweden)
Prof. B. Gross	..	(Brazil)
Prof. A. Peterlin	..	(Yugoslavia)
Prof. M. Reiner	..	(Israel)

Further it is hoped to invite rheologists from India to nominate a member.

The temporary secretary of the Committee is Dr. R. N. J. Saal (Royal Dutch/Shell Laboratories, Amsterdam).

Further details concerning the organisation will await the appointment of permanent members by the national societies.

SUMMARIES OF PAPERS read at meetings of the Society

Some theories of the Weissenberg effect

A. S. LODGE

(The British Rayon Research Association, Manchester)

In a Newtonian liquid, the normal components of stress in uniform laminar shear flow are equal. A liquid in which they were unequal would, in a laminar shear flow with curved streamlines, exhibit Weissenberg effects, as a consideration of the balance of forces will show. Several current theories of liquids agree qualitatively in predicting Weissenberg effects, but show important differences in the values they predict for the normal components of stress.

Roberts¹ has recently measured these components in stationary flow for a number of liquids, using cone/plate and cone/cone viscometers in which the uniformity of shear rate was checked by direct measurement of the state of flow. These experiments are likely to prove of historic significance, since they furnish the first direct measurement of the complete state of stress in a liquid in a known state of flow. The main results are

$$P_{11} - P_{22} > 0, \quad P_{22} - P_{33} = 0,$$

where P_{11} , P_{22} , P_{33} are the normal stress components on planes normal to the direction of flow, on the shearing planes, and on planes normal to the other two. $P_{11} > 0$ denotes a tension. The liquids used included a 5% solution of a rubber in xylene, and a 3% solution of aluminium laurate in a hydrocarbon oil; they all showed marked elastic shear recovery. The shear rates were in the range 5 to 100 sec.⁻¹

The following theories are consistent with these results.

1. *Weissenberg*.² The stress in a flowing liquid is assumed to be an isotropic function of an elastic strain. When this strain is a finite simple shear, $P_{11} > P_{22}$. The value of $P_{22} - P_{33}$ depends on the form of the stress-strain relation, but Weissenberg has predicted the value zero on the basis of an assumption³ which relates the normal stress components on planes to the history of their normal displacements from parallel neighbouring planes. This assumption is satisfied by the idealized materials governed by the following two theories.

2. *Oldroyd*.⁴ Some of the possible relations between stress, rate-of-strain, and their first order time derivatives are considered. One such relation gives $P_{11} > P_{22}$, and $P_{22} = P_{33}$.

3. *Green and Tobolsky*.⁵ The kinetic theory of rubberlike elasticity is extended to allow for breaking and creating of junction points, and might, I suggest, be applied to polymer solutions. The final equations (in the absence of permanent junction points), which are equivalent to a particular case of Oldroyd's equations, give $P_{11} > P_{22}$ and $P_{22} = P_{33}$.

The following theories conflict with Roberts' results.

4. *Reiner*,⁶ *Rivlin*.⁷ The stress is assumed to be an isotropic function of the rate-of-strain tensor. It follows that $P_{11} = P_{22}$. Weissenberg effects can occur only when $P_{22} - P_{33}$ differs from zero.

5. *Garner, Nissan, Wood*.⁸ Weissenberg effects arise from stress variations set up by an assumed tendency for high energy colloid fragments to migrate from regions of high shear rate to regions of low shear rate. It is assumed that $P_{11} = P_{22} = P_{33}$. No Weissenberg effects would arise in conditions of uniform shear rate.

Paper read at Durham, 27th March, 1953

REFERENCES

1. J. E. ROBERTS. *Ministry of Supply Report A.D.E.* 13/52 (1952).
2. K. WEISSENBERG. *Arch. des Sci. Phys. et Nat.* **17** (1935), 1. cf. p. 100.
3. K. WEISSENBERG. *Proc. Int. Rheol. Cong.* (1948) (North-Holland 1949), 1-29 cf. pp. 35/36.
4. J. G. OLDROYD. *Proc. Roy. Soc.*, **A200** (1950), 523, cf. equation (65).
5. M. S. GREEN AND A. V. TOBOLSKY. *J. Chem. Phys.*, **14** (1946), 80, cf. equation (B1).
6. M. REINER. *Amer. J. Math.* **67** (1945), 350.
7. R. S. RIVLIN. *Proc. Roy. Soc.*, **A193** (1949), 260.
8. F. H. GARNER, A. H. NISSAN, G. F. WOOD. *Phil. Trans.*, **A203** (1950), 37.

Some problems in mixing granular materials used in road construction

A. R. LEE

(Road Research Laboratory, Harmondsworth, Middlesex)

1. *Mixing soil and cement for stabilized soil construction.*

Road bases can be constructed by mixing cement with soil to increase its strength and its resistance to softening by moisture. This is done either in a stationary mixing machine or by spreading the cement on the soil and tilling it in.

In the latter method machines have been developed for spreading the cement in the required proportion. The uniformity of longitudinal and lateral distribution has been studied. The cement is mixed with the soil in depth by rotary tillers and the cement content at various points in the mixture determined by chemical analysis, thus establishing the vertical, transverse and longitudinal variability of distribution.

The degree of dispersion of the cement in the mixture can be evaluated by determining the compressive strength of specimens made from it; the strength increases asymptotically to a maximum as the period of mixing increases. The uniformity of distribution obtained with a mixing machine is compared with that obtained with a standard laboratory mixer which is assumed to give 100 per cent dispersion after a fixed period. Comparisons of this type have been made with a number of machines available for mixing soil and cement for road construction.

2. *Mixing of concrete for road construction.*

Very dry concrete is used in the construction of concrete roads in this country. Mixers which have been satisfactory with concrete of wetter consistency are subject to two faults with dry concrete—(1) material sticks in the mixer, (2) even distribution of the coarse solid particles is more difficult. These factors produce concrete which is not uniform either throughout one mix or from mix to mix. To examine these factors a method of estimating the efficiency of a concrete mixer has been devised. The concrete is sampled as it is discharged from the mixer and each sample is broken down to determine the relative proportions of the constituents by washing over suitable sieves.

Each type of commercial mixer has advantages and disadvantages and no one type is definitely better than any other. As a result of tests and observations of the behaviour of the concrete in the mixer drum a new type of blade has been devised which should result in less sticking and more rapid discharge of the concrete.

3. *Mixing of bituminous road materials.*

A bituminous road consists of a uniform mixture of coarse and fine aggregate and a bituminous binder, the proportions of which must comply with a given specification. In mixing, the materials are proportioned by volume or weight and the final composition is checked by analysis of small samples. The procedure involves a knowledge of the accuracy of the analysis method and the method of sampling. Having established the accuracy of these processes, it is now possible to examine the accuracy of proportioning and mixing given by different plants. It has been found that some mixers permit wide variations to occur within short distances after the material is spread on the road.

Paper to be read at the Symposium at Imperial College, 25th September, 1953

The Mixing of Linseed Oil Putty

K. A. LAMMIMAN

(Research Council of the British Whiting Federation, Bedford)

The types of mixer and the conditions of mixing used in normal commercial practice in making linseed oil putty are briefly described. The conditions are entirely empirical and depend upon the judgement of the skilled putty maker. A study of the process has shown that putties having apparently similar properties when made, but not necessarily the same properties after storage, can be made with the same materials using differing mixing conditions and corresponding variations of oil content. The use of two techniques for determining the adequacy of mixing is mentioned; one utilises measurement of the packed bulk density to show when all air has been eliminated from the mix and therefore when the whiting is completely dispersed. The other involves measurements of the "strength" and extensibility of the putty using the apparatus previously described. (See Bulletin No. 35, August, 1952).

Paper to be read at the Symposium at Imperial College, 25th September, 1953

ACCOUNTS FOR THE YEAR ENDING 30th JUNE, 1953

RECEIPTS						£	s.	d.
Balance on 1st July, 1952	..	..	..	..	..	288	16	8
Members' Subscriptions	..	..	..	..	..	243	5	6
From sale of Bulletin to non-members	..	..	..	..	..	33	16	4
From sale of Proceedings of Conferences	..	..	..	..	..		8	0
Royalties	..	..	..	..	..		1	17
Received in connection with meetings	..	..	..	..	..	166	5	0
Accrued interest	..	..	..	..	..		2	10
						£736	19	0

EXPENDITURE						£	s.	d.
Postage and receipt stamps	..	..	..	..	..	19	12	2
Stationery and printing	..	..	..	..	..	120	19	9
Secretarial help and Committee expenses	..	..	..	..	..	12	11	2
Expenditure in connection with meetings	..	..	..	..	..	157	13	5
Balance on 30th June, 1953	..	..	..	..	..	426	2	6
						£736	19	0

Audited and found correct.

J. GARDNER OLDROYD,
Hon. Treasurer.
6th July, 1953.

A. DE WAELE,
Hon. Auditor.
13th July, 1953.

RHEOLOGY ABSTRACTS

2648. **Brushability recorder.**

Paint, Oil Chem. Rev., 1952, **115** (6), 20, 24, 56-7.

An instrument is described which gives numerical values for the brushing properties of paints, etc. A panel is fixed horizontally on a base so as to be free to oscillate in one direction against spring pressure. The motion of the panel resulting from the drag experienced in brushing out a paint on its surface is transmitted to a pen resting on a travelling ruled paper. An experiment is first performed with a suitable standard paint, then with the paint under test, and the "brushability ratio" of the test paint taken as its figure of merit. This ratio is obtained by dividing the product of trace width and length for the standard paint by the product of the same values for the test paint. By obtaining a second trace on a different area of the same panel after an interval after application of a quantity of paint, working the second quantity into the first, a value for the "wet edge time" is secured.

B.S.A.

2649. **Properties of metallic surfaces.**

London: Institute of Metals 1953, 370 pp. (*Monograph and Report Series No. 13*).

The volume contains thirteen papers presented at a symposium held in London in November, 1952.

2650. **Rheological properties of residual fuel oils in relation to their composition.**

G. C. ACKROYD AND C. M. CAWLEY. *Jour. Inst. Pet.* 1953, **39**, 82.

Results are presented of a study of the anomalous behaviour of wax containing oils. The fluidity of such oils is influenced by their thermal history, the sensitivity to treatment at different temperatures being greatly increased when asphaltenes and resins are present. A decrease in fluidity is associated with a decrease in the size of the wax crystals separating; for a condition of very low fluidity the crystals may be sub-microscopic in size. A wax-containing oil free from asphaltenes and resins may have considerable rigidity and a well-defined yield value. When asphaltenes and resins are present they may, under certain conditions, reduce the rigidity of the system by causing the wax to separate in the form of relatively large aggregates.

Under other conditions the asphaltenes and resins may have little effect, as judged by the pour point, or may substantially increase the rigidity of the system, as judged by yield value. Numerous photomicrographs are appended for oils subjected to various treatments.

A.

2651. **Internal friction of quartz.**

G. A. ALERS. *J. Appl. Phys.* 1953, **24**, 324.

The internal friction of quartz was studied by measuring the logarithmic decrement of a bar vibrating in resonance at its fundamental mode of 21 kc/s and at its second harmonic mode at 42 kc/s as a function of temperature from 200°C. to 440°C. The logarithmic decrement was found to rise rapidly to a maximum of 16×10^{-5} at about 240°C. then fall slowly to a minimum of about 8×10^{-5} at about 350°C., and then rise rapidly up to and beyond 460°C. The high temperature portion shows a temperature hysteresis in which the cooling curve is lower than the heating curve. Furthermore the magnitude and, to a certain extent, the position of the peak may depend upon previous history but heating in a vacuum can reduce the logarithmic decrement curve to a re-

producible one, independent of room temperature handling and thermal gradients (up to 1.5°C/cm.) or stress amplitudes (up to 10 g/mm^2) applied at higher temperatures.

The measured curve can be considered as the sum of two relaxation peaks and an exponential curve. One peak has an activation energy of 27.2×10^3 calories per mole, and the other, 12.6×10^3 calories per mole. The exponential curve appears to be characterized by an activation energy of about 22×10^3 calories per mole but may vary with heat treatment. A.

2652. Tensile and impact properties of high-purity Fe-C and Fe-C-Mn alloys of low carbon content.

N. P. ALLEN, W. P. REES, B. E. HOPKINS AND H. R. TIPLER. *J.I.S.I.*, June, 1953.

2653. Effect of As and Sb on temper-brittleness.

G. W. AUSTIN, A. R. ENTWISTLE, AND G. C. SMITH. *J.I.S.I.*, April, 1953.

2654. On the measuring of cohesional forces of solids, as influenced by liquids.

C. BENEDICKS AND B. EKELUND-KAPPELER. *Ark. Fys.*, 1952, **6**, Paper 8, 73-9.

Experiments on the adhesion between two surfaces of polished brass are reported. SCI. ABSTR.

2655. Anomalous viscous flow at very low rate of shear and small shearing stress.

J. T. BERGEN AND W. PATTERSON, JR., *J. Appl. Phys.*, 1953, **24** (6), 712.

Fluid suspensions of a solid phase in a liquid, for example, paints and printing inks, have been presumed to exhibit anomaly of flow at very low rate of shear. The consistency characteristics of such materials require an experimental shear rate and shear stress much lower than has heretofore been reported.

This paper describes a translated cylinder, or translational, viscometer of a modified Pochettino type, which possesses a shear stress sensitivity of 5×10^{-3} dyne/cm², and a shear rate sensitivity of 1×10^{-4} sec⁻¹. A rubber Latex of high solids content exhibited no anomaly of flow within this range of sensitivity. A rubber dissolved in organic solvent was observed to approximate a Bingham material of 0.05 dyne/cm² yield value, while a gum tragacanth suspension in water exhibited a yield value of 0.4 dyne/cm² with marked post-yield anomalous flow. Household paints exhibited yield values ranging from zero to 6 dyne/cm². These yield values were related to levelling-out of brushmarks, and to sagging or "curtain," except for examples exhibiting marked thixotropic behaviour. Industrial organosol coatings likewise possessed yield values ranging up to 5 dyne/cm² which were related to levelling characteristics. These yield values agree with those postulated by Waring from consideration of the forces of levelling of brushmarks. They are considerably smaller than those reported in the literature from extrapolation of flow curves from much higher rate of shear. A.

2656. Temperature coefficients of non-Newtonian viscosity at fixed shearing stress and at fixed rate of shear.

A. B. BESTUL AND H. V. BELCHER. *J. Appl. Phys.*, 1953, **24** (6), 696.

Viscosity decreases with increasing shearing stress or rate of shear in the non-Newtonian flow of high polymeric systems. It is shown that it follows from this fact that the variation of viscosity with temperature is greater at fixed shearing stress than at fixed rate of shear.

For such systems, it is shown experimentally that the variation of viscosity with temperature at fixed shearing stress is independent of shearing stress. However, the variation at fixed rate of shear is always less than that at very low shearing stress, and decreases with increasing rate of shear. This behaviour is reproduced by Eyring's hyperbolic sine flow equation, which is the antecedent for most other, more adequate, non-Newtonian flow equations. However, this equation is shown to be inadequate in that it predicts incorrect values of shearing stress for the occurrence of non-Newtonian behaviour. A.

2657. Pressure in a liquid.

M. G. BHATAWDEKAR. *Indian J. Phys.*, 1952, **26**, 54-5.

Knowing the potential energy of a liquid, an idea is gained of the intermolecular forces. The pressure within the liquid at different temperatures is calculated by an application of the virial theorem. The virial function is seen to be a function of the volume of the liquid at that temperature; hence an equation of state for the liquid is derived. A.

2658. The creep/time relationship under constant tensile stress.

B. BHATTACHARYA, W. K. A. CONGREVE AND F. C. THOMPSON. *J. Inst. Met.*, 1952, **81**, 83.

2659. Friction on snow and ice.

F. P. BOWDEN. *Proc. Roy. Soc. A.*, 1953, **217**, 462.

2660. Initiation and growth of explosion in liquids and solids.

F. P. BOWDEN AND A. D. YOFFE. *Cambridge University Press*, 1952, 104 pp. (Cambridge Monographs on Physics). Review in *Nature*, **171**, 186 (*Jan.* 31, 1953).

2661. Plastic properties of coking coals.

J. BRONOWSKI, D. FITZGERALD, D. W. GILLINGS AND D. C. RHYS-JONES. Letter in *Nature* **171**, 389-90 (*Feb.* 28, 1953).

2662. Flow of lubricating grease between parallel planes.

L. C. BRUNSTRUM AND H. M. GRUBB. *Institute Spokesman*, 1953, **17** (2), 8.

Comparison of apparent viscosities from measurements of flow in circular and rectangular capillaries show discrepancies ranging from 0-30%. Effect of capillary shape is more pronounced at high shear rates and is greater for the more fibrous greases. This is attributed to the different degrees of fibre orientation in the capillary axis and in the capillary plane respectively. A.A.M.

2663. Stress relaxation in elastomers.

A. M. BUECHE. *J. Chem. Phys.*, 1953, **21**, 614.

The process of chemical stress relaxation in elastomers is examined in some detail. It is predicted that in some cases it will be possible to determine the location of the chemical bond broken. The special cases of relaxation due to scission of cross links and random scission of the polymer are calculated. The shapes of the stress *vs* time curves are widely different. A.

2664. Bulk viscosity of the system polystyrene-diethyl benzene.

F. BUECHE. *J. Appl. Phys.*, 1953, **24**, 423.

The bulk viscosity of the system polystyrene-diethyl benzene has been measured over the concentration range from 8 to 80% by weight polymer and a temperature range from 30 to 130°C. A single sample of polymer was used. The activation energy for viscous flow is found to vary from about 2 to 100 kcal/mole as one goes from pure solvent to pure polymer. Using a series of 15 fractions of polystyrene ranging from 50,000 to 10^6 the molecular weight dependence for the viscosity of this system was measured at two polymer concentrations, 14 and 44 per cent. The results are compared in a qualitative way with what one would expect from existing theory. A.

2665. The measurement of self-diffusion in solid polymers.

F. BUECHE, W. M. CASHIN AND P. DEBYE. *J. Chem. Phys.*, 1952, **20**, 1956-8.

The self-diffusion constant of the macromolecules in plasticized polystyrene and pure poly-*n*-butyl acrylate has been measured over a wide variety of conditions by a radio-active tracer technique. Well-characterized polymer fractions were used throughout. Simultaneous measurements of the bulk viscosity were also made. From the data obtained one is able to show that within experimental error the product of the self-diffusion

constant and the bulk viscosity is equal to a constant. This constant has been predicted by theory, and the agreement with the experimental value is good. Therefore, it appears possible to obtain diffusion constants directly from bulk viscosity data. A.

2666. Flow in visco-elastic fluids.

J. E. CAFFYN. *Kolloid Zeits*, 1952, **129**, 77.

It is shown that the equations developed by Reiner and Rivlin and by Oldroyd lead to a parabolic velocity distribution. The velocity distribution was studied by photographing oil drops.

2667. Variation of the specific viscosity of a solution of rigid macromolecules with frequency.

R. CERF. *J. Phys. Radium*, 1952, **13**, 458-64, *In French*.

A calculation of the complex viscosity under high frequency considering a rigid ellipsoid of revolution. For monodispersed solutions the viscosity is shown to be equal to the sum of the classical term and the Brownian term, this being equal to the classical term times a factor which is a function of the frequency. SCI.ABSTR.

2668. Superflow of helium II through compressed powder.

B. S. CHANDRASEKHAR AND K. MENDELSSOHN. *Proc. Roy. Soc. A.*, 1953, **218**, 18.

2669. The measurement of consistency of soft solids and thickened liquids.

E. B. CLARKE AND E. W. J. MARDLES. *Selected Government Research Reports. Vol. 11. "Lubricants and Lubrication."* H.M.S.O., 1952, p. 87-122. (Based on a R.A.E. report, March, 1948).

2670. Surface effects and the creep of zinc single crystals: I. creep characteristics of clean and oxide-coated crystals.

F. D. COFFIN AND A. L. WEIMAN. *J. Appl. Phys.*, 1953, **24**, 282.

2671. Theory of dislocations.

A. H. COTTRELL. *Progress in metal physics, Volume 4*, 205-64 (1953). London: Pergamon Press.

2672. Temperature dependence of viscosity of gelatine solutions.

B. V. DERYAGIN AND S. M. LEVI. *Kolloidnyi Zh.*, 1953, **15**, 24.

2673. Effects of nuclear radiations on the mechanical properties of solids.

G. J. DIENES, *J. Appl. Phys.*, 1953, **24** (6), 666.

The general nature of radiation effects in solids is reviewed briefly. Current theoretical understanding of the mechanical properties of solids is critically evaluated. The effect of nuclear radiation on the mechanical properties is discussed in detail. It is shown that the changes in the mechanical properties of crystalline substances (mostly metals) can be quite satisfactorily interpreted on the basis of the production of interstitial atoms and vacant lattice sites by fast particle irradiation. Isolated vacancies and interstitials may not be able to account for all the observations, and attention is called to the possible need of postulating the existence of aggregates of these lattice defects. In molecular solids (mostly high polymers) nuclear radiations bring about changes in the substance which are best described as chemical ones. Ions and free radicals are formed leading to subsequent chemical reactions thereby altering the properties of the substance. Drastic changes in the mechanical properties of high polymers are observed. Correlation with structural changes has hardly been started. Experiments are suggested which, in the writer's opinion, should give further insight into the fundamental processes involved. A.

2674. Yield points in bending experiments on zinc crystals.

M. J. DUMBLETON AND B. W. HOWLETT. *Proc. Phys. Soc.*, 1952, **65B**, 882.

2675. Laboratory evaluation of lubricating greases.

E. G. ELLIS. *Scientific Lubrication*, 1953, 5, (2) 11, (3) 13, (5) 18, (7) 17.

The first three parts describe and discuss standard methods of determining the rheological properties of greases. A.A.M.

2676. Measurement of the viscosity of non-Newtonian liquids.

A. G. EPPRECHT. *Chim. Anal.*, 1953, 35, 3.

Author suggests that the older viscometric methods are of limited use.

2677. Liquid metals. I. The viscosity of mercury vapour and the potential function for mercury.

L. F. EPSTEIN AND M. D. POWERS. *J. Phys. Chem.*, 1953, 57, (3), 336-341.

It is shown that, contrary to the results of earlier studies, an excellent fit to the data on the viscosity of mercury vapour can be obtained using a Lennard-Jones 6-12 potential, in spite of the fact that X-ray scattering measurements indicate that this substance is more nearly represented by a 6-9 potential. Viscosity measurements, like second virial coefficient studies, do not appear to be sufficient by themselves to determine the repulsive power uniquely. A detailed survey of the previous studies of the potential function for mercury indicates that the values obtained from the viscosity are quite consistent with the other data. A.

2678. Screw dislocations in thin rods.

J. D. ESHELBY. *J. Appl. Phys.*, 1953, 24, 176.

2679. The role of surface transport in the stability and breakdown of foams.

W. E. EWERS AND K. L. SUTHERLAND. *Austral. J. Sci. Res. A*, 1952, 5, 697-710.

A new theory of foam stability is proposed which demonstrates that the transport of substrate, accompanying a movement of the surface of the bubble film, is a dominant factor in the stability of foams and in the action of foam breakers. The surface moves from a region of low surface tension (high surface pressure) to a region of high surface tension. The surface tension gradients arise from disturbances which may be caused by mechanical or thermal shocks, or by the addition to the surface of particles, droplets, or vapour of a surface-active material. When the surface tension is highest at the centre of disturbance the film will be stable; when the surface tension is lowest at this point the surface film and hence the substrate will be moved away from this point and the film will rupture. A.

2680. On the theories of the plasticity and workability of clay products and the principal methods for their determination.

C. FICAI. *Ceramica*, Milano, 1952, 7 (10), 41.

The definition of plasticity and workability, P. S. Roller's theory of plastic flow, the colloidal theory of plasticity, F. H. Norton's theory of membrane tension, factors determining plasticity, the size of particles and their surface development, the shape and state of aggregation of particles, the colloidal fractions present, the proportion and state of water present in the system, base-exchange and colloidal phenomena, are discussed. B.C.R.A.

2681. Elasticity and thermal expansion of germanium between -195 and 275°C.

M. E. FINE. *J. Appl. Phys.*, 1953, 24, 338.

2682. An investigation into methods of measurement of kinetic boundary friction.

P. G. FORRESTER AND A. A. MILNE. *Selected Government Research Reports. Vol. 11. "Lubricants and Lubrication," H.M.S.O.*, 1952, p. 208-230.

(Based on joint report by the N.P.L. and the Tin Research Institute, January, 1949).

2683. Plastic deformation of germanium and silicon.

C. J. GALLAGHER. *Phys. Rev.*, 1952, **88**, 721.

2684. X-ray studies of polycrystalline metals deformed by rolling. I. Examination of the harder metals, copper, nickel, and iron. II. Examination of the softer metals, tin, zinc, lead and cadmium.

P. GAY AND A. KELLY. *Acta Cryst.*, 1953, **6**, 165-177.

2685. Properties and composition of glass determined by flow measurements.

P. GILARD. *Engrs'. Dig.*, 1952, **13**, 346.

Considers the possibility of using birefringence measurements as a rapid means of assessing, without delicate equipment and at relatively low temps., the comp. of glass specimens.

2686. Temperature phenomena in the butter churning process.

P. GORDIENKO. *Molochnaya Prom.*, 1952, **13**, (9), 30.

A study of the churning of butter between concentric cylinders shows time required to form butter, passing through minimum with increasing clearance between cylinders. Some attempt is made to estimate thermodynamic efficiency of various churning processes but the proposed function remains unspecified.

G.W.S.B.

2687. Viscosity of iso-electric gelatin solutions.

J. C. GOSH AND B. B. GYANI. *J. Indian Chem. Soc.*, 1952, **29**, 615.

The viscosity is found to vary very little with shear. The high viscosity observed is due to hydration and structure.

2688. The phenomenological method in rheology.

A. GRAHAM. *Research*, 1953, **6** (3), 92.

The author discusses pros and cons for the use of mechanical models, the Nutting-Scott Blair equation and some accepted principles. A progressive method of building up a theory by direct reference to experimental evidence is described and is shown to lead to a particular differential equation.

E.W.J.M.

2689. Dynamic mechanical properties of the system polystyrene-decalin.

L. D. GRANDINE, JR., AND J. D. FERRY. *J. Appl. Phys.*, 1953, **24** (6), 679.

The dynamic rigidities and viscosities of solutions of polystyrene (number-average molecular weight 197,000) in decalin have been measured by three experimental methods over ranges of concentration from 10 to 62 per cent, of temperature from -5° to 50°C. , and of frequency from 30 to 2000 cps. Similar measurements were made on the undiluted polystyrene from 115° to 133°C. and 30 to 2800 cps. The data for the solutions, when reduced to a reference state of unit density and viscosity at a standard temperature, provide single composite curves for dynamic rigidity and viscosity. The distribution function of relaxation times calculated from these curves overlaps that previously derived from stress relaxation measurements on this system, and the combined function covers a range of time scale of ten powers of ten. It shows the three characteristic regions previously identified in the relaxation distribution function of polyisobutylene; there are no obvious anomalies associated with the fact that decalin is a very poor solvent for polystyrene. The data for the undiluted polymer, when reduced to a standard temperature, provide single composite curves for dynamic rigidity and viscosity. The temperature reduction factors provide apparent energies of activation for relaxation which agree with those for viscous flow obtained by Fox and Flory. The relaxation distribution function of the undiluted polymer is similar in shape to, but somewhat sharper than, those for other polymers in the transition from soft to glassy consistency. When reduced to a reference state of unit density and viscosity, the distribution function of the undiluted polymer lies near that reduced from data on solutions, but is considerably sharper than the latter.

A.

2690. The hydrodynamics of non-Newtonian fluids. III. The normal stress effect in high-polymer solutions.

H. W. GREENSMITH AND R. S. RIVLIN. *Phil. Trans. A.*, 1953, **245** (899), 399–428.

2691. Investigations on the part played by intermolecular forces in the mechanics of high-elastic deformations: VII. On the influence of molecular interaction on the resistance to fatigue of high polymers with a developed spatial structure.

V. E. GUL', D. L. FEDYUKIN AND B. A. DOGADKIN. *Kolloidnyi Zh.*, 1953, **15**, 11.

2692. An attempt to provide a general theory for the plasticity of ceramic mixes.

TH. HAASE. *Silikat Tech.*, 1952, **3**, 265.

Plasticity is defined as the capacity of a solid to react to external forces with permanent change of shape but without loss of coherence. There are two types of movement possible on an imaginary plane representing a section through a plastic mix and having a thickness of a few particles: a movement perp. to the plane, in which case the coherence of the material in the plane will be lost after the tensile strength σ_t is overcome; and a shearing movement in the direction of the plane, the coherence of the particles not being lost and the movement being resisted by the shear strength (γ). All other movements in relation to the plane in directions different from those above can be expressed as components of the main movements. The plasticity is then defined as the ratio σ_t/γ . After a discussion of the changes of plasticity with varying water content it is suggested that methods for measuring plasticity should be based on measurements of the tensile and shear strengths.

B.C.R.A.

2693. Forced oscillations with non-linear restoring force.

C. HAYASHI. *J. Appl. Phys.*, 1953, **24**, 198.

2694. Retardation of flow in narrow capillaries.

J. C. HENNIKER. *J. Colloid Sci.*, 1952, **7**, 443.

Certain anomalies in the rate of flow of Newtonian liquids in narrow channels can be explained either by slippage (surface fluidity) under conditions of one kind, or by retardation under others. Data are presented to show that slippage is unlikely. Retardation could be due to streaming potential or to mechanical restriction. The flow rate of distilled water in pores of 0.05μ in radius was found to be 20% less than that of a salt soln. The measured streaming potential was too small to account for the retardation. Bacteria and gas bubbles were excluded. A tentative explanation links the intense electric field existing in the electrical double-layer with the augmentation of the viscosity of liquids in the presence of strong fields.

B.C.R.A.

2695. Flow characteristics of fire-clay refractories at high temperatures.

P. G. HEROLD AND C. KNUDSEN. *J. Amer. ceram. Soc.*, 1952, **35**, 220, The effect of refractoriness, porosity, and lamination cracks on flow characteristics are described. It is shown that the increasing-load test is more rapid than the constant-load test for determining flow characteristics.

2696. Towards a uniform theory of relaxation phenomena.

E. HIEDEMANN AND R. D. SPENCE. *Z. Phys.*, 1952, **133**, (1–2), 109–23.

A functional theory of relaxation is discussed and also the behaviour of discreet and continuous relaxation spectra.

SCI. ABSTR.

2697. Quantum-mechanical treatment of viscosity coefficient of helium by use of a rigid sphere model with attractive force.

K. HIROTA. *Bull. Chem. Soc. Japan*, 1949, **22**, 16–20.

A rigid-sphere molec. model in which the inverse-cube law of attractive force applies

is adopted. This is used to calculate by quantum mechanics the viscosity coeff. of He. The divergence between theory and experiment is smaller at low temp. than in treatments postulating no attractive force. SCI. ABSTR.

2698. The low-temperature viscosity of glass.

L. C. HOFFMAN, T. A. KUPINSKI, R. L. THAKUR AND W. A. WEYL. *J. Soc. Glass Tech. (Trans.)*, 1952, **36**, 196.

By measurements of the time required for a glass fibre to elongate under a known load, the low-temp. viscosity values were obtained and are illustrated graphically for 106 glasses covering wide molecular comp. ranges. B.C.R.A.

2699. Evidence for collapse of lattice vacancy aggregates to form dislocation rings.

R. W. HOFFMAN, F. J. ANDERS AND E. C. CRITTENDEN, JR., *J. Appl. Phys.*, 1953, **24**, 231.

2700. Apparatus for measuring consistency and structure of butter.

F. HOFMANN, F. MOSIMANN AND W. OESCH. *Schweiz. Milchztg.*, 1953, **79**, 29.

Apparatus is described for measuring sectility (resistance to wire-cutting), breaking load under defined shear rate and bending consistency of butter. The latter follows Trouton's method using a beam supported at its two ends. An imitative machine is also described to measure "spreadability." No quantitative physical treatment is attempted. G.W.S.B.

2701. The plastic instability of plates.

H. G. HOPKINS. *Quart. Appl. Maths.*, 1953, **11**, 185.

2702. Measurement of the rheological and thixotropic behaviour of bentonite suspensions.

F. HÖPLER. *Kolloid Z.*, 1952, **128**, 87.

The distance travelled by a sphere, 2 cm. dia., in a hydrogel of a natural and a synthetic bentonite is measured. Ageing and regeneration of the gels are studied.

2703. On the rigidity of elasto-viscous liquids.

A. A. K. IBRAHIM. *J. Appl. Phys.*, 1953, **24**, 364.

An expression is derived for the modulus of rigidity of an elasto-viscous liquid, the behaviour of which is characterized by two relaxation times. S.T.

2704. Statistical thermodynamics of rubber elasticity.

H. M. JAMES AND E. GUTH. *J. Chem. Phys.*, 1953, **21**, 1039.

The basic concepts and procedures underlying the theory of rubber elasticity are analysed. The arguments advanced by Wall and Flory against the network theory of the authors are shown to be without foundation. The alternative theory which they advocate, and which is rather widely used, is criticised on two grounds; (a) it assumes a distribution of chain extensions that does not vary with network extension in the way the actual distribution functions can be shown to vary, and (b) the methods used to compute the numbers of network configurations from the distributions of chain extensions are invalid, except in the most trivial cases. The concept of "internal dilation entropy" is discussed and is shown to lack any physical basis. It is concluded that all the methods of calculation that lead to logarithmic terms in the network configuration entropy are incorrect, and that these terms, which affect the theory of swelling, should be discarded. A.

2705. The viscosity of aluminium and binary aluminium alloys.

W. R. D. JONES AND W. L. BARTLETT. *J. Inst. Met.*, 1952, **81**, 145.

2706. Strain-Ageing of mild steel.

W. R. D. JONES AND G. COOMBES, *J.I.S.I.*, May, 1953.

2707. The motion of a sphere moving parallel to a plane boundary.
F. C. KARAL. *J. Appl. Phys.*, 1953, **24**, 147.

The motion of a rigid sphere moving through an incompressible, homogeneous, nonviscous fluid in the presence of a rigid, infinite plane boundary is examined. The direction of motion of the sphere is assumed to be parallel to the plane boundary. It is assumed that the motion is irrotational and that the sphere velocity is small. An exact treatment is presented. Several curves of the pressure variation on the plane boundary are plotted for different values of the ratio of sphere radius to the perpendicular distance from the centre of the sphere to the plane boundary. A.

2708. Viscosity and rigidity of solutions of sodium thymonucleate.
S. KATZ AND J. D. FERRY. *J.A.C.S.*, 1953, **75** (7), 1589.

The viscosity is non-Newtonian at concentrations as low as 0.005 g/ml. The extrapolated viscosity is an exponential function of the reciprocal absolute temperature and the apparent heat of activation for viscous flow increases from 6.2 to 7.9 kcal with increasing concentration. The dynamic rigidity increases only slightly with increasing frequency or decreasing temperature.

The relaxation times (Maxwell) lie between 0.1 and 1 sec. The observed mechanical properties are attributed to orientation of rigid elongated particles which form no inter-connecting structure. E.W.J.M.

2709. On the viscosities of molten slags.

YASUJI KAWAI. *Science Reports, RITU, Japan. A., Dec.* 1952.

A study of the problem of the influence of MgO on the viscosity of blast furnace slag. MgO is similar to CaO in reducing the viscosity of slags. E.W.J.M.

2710. On the temperature dependence of the modulus of elasticity in high polymers.

E. KLEIN AND E. JENCKEL. *Z. Naturforsch.*, **7a**, 800-7 (Dec., 1952)

Deformation curves for linear and cross-linked polystyrene and linear PMA-ster are reported. An energetic and a statistical E -modulus are deduced; the latter is directly proportional to T (abs.) and the degree of cross-linking. This result leads to an analogy with the ideal gas law, $E_{\text{stat}} V = RT$ without additional numerical factor. SCI ABSTR.

2711. Diffusion in a fluid moving at uniform velocity in a tube.

A. KLINKENBERG, H. J. KRAJENBRINK AND H. A. LAUWERIER. *Ind. and Eng. Chem.*, 1953, **45** (6), 1202.

In one experimental technique eddy diffusion constants are derived from concentration patterns produced by a point source of solute on the axis of a packed tube. It was desired to include inequality of radial and axial diffusivity in the treatment and to compute the concentration curves. The concentration distribution was calculated by the method of the two-sided Laplace integrals. The results are presented in form of graphs covering variation of all three variables. The applicability of simplifications (absence of axial diffusion, equality of radial and axial diffusivity, diffusion in infinite space) was examined. The results should aid in evaluating data on diffusion, primarily eddy diffusion. The mechanism of axial eddy diffusion was analysed and the importance of this phenomenon is stressed. A.

2712. Explanation of the internal damping of solids by shear-viscosity and pressure-viscosity.

H. O. KNESER AND K. VOELZ. *Ann. Phys.*, 1953, **11**, (4-7), 377-82.

Some results of measurements point to the advisability of introducing a coefficient of the shear viscosity, independent of frequency, and a coefficient of volume viscosity. These coefficients might enable the damping to be compared for different forms of vibration. Volume viscosity for metals is probably zero. SCI. ABSTR.

2713. The production of large tensile stresses by dislocations.

J. S. KOEHLER. *Phys. Rev.*, Feb, 1952.

2714. Stress waves in solids.

H. KOLSKY. Oxford: Clarendon Press (1953) 222 pp. (*Monographs on the Physics and Chemistry of Materials*).

2715. Two-dimensional method of investigation of the viscous properties of plastic bodies.

A. A. KONSTANTINOV AND C. V. VINOGRADOV. *Doklady Akad. Nauk S.S.S.R.*, 1952, 86, 749.

A plastic body is driven through a capillary by means of a piston actuated by a compression spring. The experiments are interpreted in terms of effective viscosity and the velocity gradient.

2716. Direct determination of the flow curves of non-Newtonian fluids. II. Shearing rate in the concentric cylinder viscometer.

I. M. KRIEGER AND H. ELROD. *J. Appl. Phys.*, 1953, 24, 134.

(See Abstracts 2466 and 2604). Another method has been developed for obtaining the rate of shear vs shearing stress curves of non-Newtonian fluids from concentric cylinder viscometer data. The mathematical expression developed is a rapidly converging power series in $\ln s$, where s is the cup to bob radius ratio. An estimate of error shows that under favourable conditions only two terms of the series are significant, and that terms past the third will hardly ever be needed.

A.

2717. Apparatus for measuring the surface tension of cast iron and steel.

L. L. KUNIN AND I. A. KLYACHKO. *Zav. Lab.*, 1950, 750.

The gas-bubble method is applied in vacuo or in an inert atmosphere, up to 1600°C.

P.F.

2718. A micro viscometer of improved design.

F. M. LIDSTONE. *Chem. and Ind.*, 1952 (36), 873.

Two capillary viscometers are described and illustrated, one for all liquids down to viscosities as low as *c.* 30 centistokes and the second for liquids having viscosities < 30 centistokes. They are designed for use with oils or similar Newtonian liquids. B.C.R.A.

2719. The behaviour of ceramic casting-slips.

M. LINSEIS. *Sprechsaal*, 1952, 85, 321.

Experiments were carried out with four samples of a German kaolin using Bingham and Irvin viscometers. The results appear to agree with those given by American authors.

B.C.R.A.

2720. On unsteady flow of compressible viscous fluids.

G. LUDFORD, H. POLACHEK AND R. J. SEEGER. *J. Appl. Phys.*, 1953, 24, 490.

In order to solve the nonlinear equations of fluid dynamics, classical hydrodynamics introduced the concept of perfect incompressible fluids, viz., the perfect inviscid fluid and the perfect viscous fluid. The practical importance of considering compressibility nowadays has resulted in two new approaches from two distinct points of view. In the one case, compressibility is included in the discussion of a perfect inviscid fluid. As is well known, however, compressible effects include shock-wave phenomena, which are regarded in this instance as mathematical discontinuities. The goal then is to study the basic equations, allowing discontinuous solutions. The other approach retains the viscous terms together with the compressible ones. It is based upon the possibility of small coefficients producing large changes in the behaviour of the solutions. The present paper is written from this point of view. The consequent mathematical difficulties of solving the equations are avoided by the use of a particle model of the continuum. The resulting equations are put into finite difference form for solution on a digital calculator.

A.

2721. Viscoelastic properties as functions of the distribution of activation energies.

W. J. LYONS. *J. Appl. Phys.*, 1953, **24**, 217.

Assuming that the elementary molecular deformation process conforms to the Maxwell model and that the molecular elastic and viscous forces are functions of the free energy of activation, expressions are derived for the dynamic modulus and the dynamic viscosity. When certain assumptions are made about the distribution of relaxation times these expressions predict temperature and frequency dependencies in agreement with experiment. S.T.

2722. Viscosity studies of system $\text{CaO-MgO-Al}_2\text{O}_3\text{-SiO}_2$. III. 35, 45, and 50% SiO_2 .

J. S. MACHIN, T. B. YEE, and D. L. HANNA, *J. Amer. ceram. Soc.*, 1952, **35**, 322.

2723. The use of the moving plate viscometer for studying the flow properties of pastes and the sedimentation and caking of particles in suspension.

E. W. J. MARDLES AND E. B. CLARKE. *Selected Government Research Reports. Vol. 11. "Lubricants and Lubrication," H.M.S.O.*, 1952, p. 123-137. (Based on a R.A.E. Report, July, 1948).

2724. Temperature dependence of the elastic moduli and internal friction of silica and glass.

J. W. MARX AND J. M. SILVERTSEN. *J. Appl. Phys.*, 1953, **24**, 81.

2725. Oil flow in plain journal bearings.

S. A. MCKEE. *N.B.S. Tech. News Bull.*, 1952, **36** (4), 60.

Using the N.B.S. four-bearing friction machine it was found that the flow of oil was affected by the oil feed pressure and by the hydrodynamic-film pressure supporting the load which in turn are related to the bearing design and operation. E.W.J.M.

2726. The influence of particle shape on the technical properties of dusts.

R. MELDAU AND R. H. S. ROBERTSON. *Ber. d. deutsch. keram. Ges.*, 1952, **29**, 27-35.

Gel strength of a bentonite suspension is probably highest when particles are large, thin and monodisperse; gel structure takes time to develop. Viscosity of polydisperse suspensions is higher than that of large platelets alone. In dispersed kaolin suspensions solids content at equal Stormer viscosity (at "pour point") is linearly proportional to rugosity of particles (area/area of equivalent spheres). R.H.S.R.

2727. The fracture surface of finely milled mineral powders.

R. MELDAU AND R. H. S. ROBERTSON. *Tomind. Z.*, 1952, **76**, 365-368.

This is an electronoptical study of the Beilby layer of mineral particles all ground to same degree of fineness in agate mortar. Cleavage is not important in harder minerals. Depth of plastic flow of surface increases with decreasing hardness of mineral. R.H.S.R.

2728. The compression and bearing capacity of cohesive layers.

G. G. MEYERHOFF AND T. K. CHAPLIN. *Brit. Jour. Appl. Phys.*, **4** (1), 20.

2729. Preparation and properties of silica aerogel-thickened greases.

E. C. MILBERGER AND L. J. SWATIK. *Institute Spokesman*. 1953, **16** (10), 18.

2730. Viscosity of rosin sols in presence of basic dyes.

S. P. MITRA. *Z. phys. Chem.*, 1952, **199**, 196.

Small quantities of electrolyte reduce the viscosity, but an increase is observed when larger quantities are added. The adsorption of cations is considered to be responsible for the increase in viscosity.

2731. A test of the theory of secondary viscoelastic stress.

M. MOONEY. *J. Appl. Phys.*, 1953, **24** (6), 675.

Experimental data published by Garner, Nissan, and Wood on secondary stresses in a viscoelastic liquid have been analyzed in terms of the superelasticity theory of secondary stresses as developed by Mooney. The theory was slightly modified to be consistent with the reported viscosity rate of shear behaviour of the test liquid. With this modification the theory agreed within experimental error with observed normal stresses at various radii on a stationary circular plate mounted parallel to a rotating plate.

One reported qualitative experimental result is in disagreement with the theory, but this particular result is questioned. Other theories of secondary stress are briefly discussed. A.

2732. Structure of the liquid state and viscosity of hydrocarbons.

R. J. MOORE, P. GIBBS AND H. EYRING. *J. phys. Chem.*, 1953, **57** (2), 172-8.

Viscosities of anisometric molecules are considered in terms of possible liquid structures derived from molecular volumes and other physical properties. Observed discontinuities in the several properties with temperature are interpreted as changes in molecular packing in the liquid due to onset of specific molecular motions. At least three liquid "regions" are postulated: (1) at low temperatures the molecular motion is largely translational, (2) at intermediate temperatures rocking or "libration" is an added factor, and (3) at higher temperatures, free rotation of the molecules on their long axes takes place. Flow of liquids in these regions is a co-operative phenomenon, with low heats and negative entropies of activation flow. In the case of molecules whose irregular configuration precludes formation of the required regular lattice, flow is by "jumping" of individuals with consequent high heats and positive entropies of activation for flow. A.

2733. Temperature effects in thixotropic systems.

G. B. MOSES, A. F. SIRIANNI AND I. E. PUDDINGTON. *Can. J. Technol.*, 1953, **31**, (6), 121.

A temperature-dependent interparticle bonding in some grease-like systems is destroyed by high shear for long periods of time, particularly with sodium soaps. Recovery could be induced by heating. The effect of modifying the surface of the dispersed phase was studied. E.W.J.M.

2734. A theory of work-hardening of metal crystals.

N. F. MOTT. *Phil. Mag.*, 1952, **43**, 1151-78.

2735. Dislocations and the theory of solids.

N. F. MOTT. *Nature*, **171**, 234-7 (Feb. 7, 1953).

2736. The gas flow past slender bodies.

M. M. MUNK. *J. Appl. Phys.*, 1953, **24**, 584.

2737. On Bowden's stick-slip lengths of surface friction.

Y. NAKANO. *J. Fac. Sci. Hokkaidô Univ. II*, 1951, **4**, 87-9.

The frequency distribution of the Bowden stick-slip lengths was investigated in its dependence on the melting point by means of chlorides and oxides, since the melting points of these are lower and higher than that of the pure metal respectively.

SCI. ABSTR.

2738. Ultrasonic-wave study of swollen Buna-N rubber.

A. W. NOLLE AND J. F. MIFSOD. *J. Appl. Phys.*, 1953, **24**, 5.

2739. Internal friction in metals.

A. S. NOWICK. *Progress in metal physics, Volume 4*, 1-70 (1953). London: Pergamon Press.

2740. **Viscosity of sodium-calcium-aluminosilicate glasses in the interval of $10^{6.5}$ – 10^8 poises.**

M. V. OKHOTIN AND R. I. TSOY. *Glass and Ceramics*, Moscow, 1952, 9, (8), 3.

2741. **The elastic and viscous properties of emulsions and suspensions.**

J. G. OLDROYD. *Proc. Roy. Soc. A.*, 1953, 218, 122.

2742. **Relationship between relative viscosity and volume concentration of stable suspensions of spherical particles.**

D. R. OLIVER AND S. G. WARD. Letter in *Nature*, 171, 396–7 (Feb. 28, 1953).

2743. **Fundamentals of brittle behaviour in metals.**

E. OROWAN. *Symposium on Fatigue and Fracture of Metals.*, Mass. Inst. Techn. (June, 1950).

2744. **The initial yield of iron.**

H. W. PAXTON. *J. Appl. Phys.*, 1953, 24, 104.

2745. **The cleavage strength of polycrystals.**

N. J. PETCH, *J.I.S.I.*, May, 1953.

2746. **Mechanical investigations of elastomers in a wide range of frequencies.**

W. PHILIPPOFF. *J. Appl. Phys.*, 1953, 24, (6), 685.

A method has been found for measuring the shear moduli and losses of elastomers in a range of frequencies of about 1 to 10^6 , from 10 cps. down. This method provides for large cyclic shear stresses and deformations without employing resonance methods. Only one sample is needed for a complete study, the frequency of stress being the only variable. The method gives results that fit the "box-distribution function" developed by Kuhn and Kuenzle. Results for a series of elastomers show that such investigations are important in ascertaining the mechanical properties of elastomers in practice. A.

2747. **Measuring the plastic qualities of building limes.**

W. PIEPPENBURG. *Zement, Kalk, Gips*, 1952, 5 (2), 33–43.

It is suggested, in connection with a review of the German Standard, Din 1060, "Building Lime," that a measure of the plastic qualities—workability, plasticity, or "butteriness"—of the lime is important to the user. A number of suggested methods of measuring these or cognate properties, both for lime paste or "putty" and for sanded mixes, are reviewed. Mention is made of some A.S.T.M. methods and of the Emley plasticimeter. There are eleven references to the literature. The B.S. flow-table is likened to the German instrument (used to determine spread only): experiments at the Building Research Station with ultra-rapid film records of lime putty on the vibrating flow-table are also referred to. The composition and special plastic properties of lime suspensions are briefly discussed. Test methods include: A.S.T.M. suction method for retentivity of water; various determinations of spread of mortar, some combined with vibration; measurement of resistance to withdrawal of an embedded sphere; determination of resistance to deformation in the Brabender plastograph, at a standard flow-table consistence. Special importance is attributed to the apparent density of the powdered dry hydrated lime, and to the water-requirements of the paste when using the flow-table to determine spread; relations of these with other factors are shown in tables and discussed. B.S.A.

2748. **Temper-brittleness in high-purity iron-base alloys.**

A. PREECE AND R. D. CARTER, *J.I.S.I.*, April, 1953.

2749. Thixotropy.

J. PRYCE-JONES. *Kolloid Zeits.*, 1952, **129**, 96 (In English).

Thixotropy is discussed on the basis of the definition used by Freundlich and Peterfi. Gel-sol transformations are considered and defined by the presence or absence of a yield value. By means of a general diagram the degree of dispersion can be determined from rheological behaviour.

2750. Dynamic theory of yield.

K. E. PUTTICK AND M. W. THRING. *Iron and Steel*, 1952, **25**, 155-9.

2751. A survey of developments in rheology.

M. REINER. *Appl. Mech. Rev.*, 1951, **4** (4), 202-4.

A review of rheological development since its inception about a generation ago. Reference is made to the early work (1906) of Trouton on viscosity and the developments due to Bingham, Oldroyd and Reiner. Work on "non-Newtonian" fluids, Maxwell bodies and Burgers bodies is then reviewed and further developments on the classical viscous liquid and elastic solid including the concepts of cross viscosity and cross plasticity. The text contains thirty-eight references to Applied Mech. Revs. concerned with rheology and there is also a bibliography of thirty-five references to the literature. B.S.A.

2752. On the fine structure of clay minerals.

R. H. S. ROBERTSON. *Tonind. Z.*, 1951, **75**, 2-6.

In plots of "green compression strength" of synthetic moulding sands against moisture content, peak value is proportional to cation exchange capacity of calcium-saturated clays used. Plasticity (strain at breaking point of cylindrical test-piece) of moulding sand against moisture content shows unexplained inflexion in the curves at about 2% moisture. A.

2753. Fatigue of metals.

M. ROS. *Metallurgia Ital.*, 1951, **43**, 512-20.

The fatigue limit for different mono-axial stresses in relation to the notch coefficient, $\sigma_{\max} = (\text{max. stress in notch}) / (\text{mean stress in section})$, and the influence of stress gradient, notch size, and state of internal tension are examined. Results are given of tests on materials free from defects, almost homogeneous, and almost isotropic. B.S.A.

2754. Viscoelastic properties of dilute polymer solutions.

P. E. ROUSE, JR., AND K. SITTEL. *J. Appl. Phys.*, 1953, **24** (6), 690.

The viscoelastic properties of dilute solutions of chain polymers have been measured at frequencies in the range from 200 cps. to 60 kc. The data are compared with theoretical curves calculated from the steady-flow viscosities of the solution and solvent, the molecular weight and concentration of the polymer, and the absolute temperature; this calculation made use of equations obtained from a recently developed theory. The equations contain no adjustable constants. The theory is shown to be at least a good first approximation to the viscoelastic properties of the solutions studied.

The agreement of the data and the theory implies that, up to 60 kc. at least, the viscoelastic properties of dilute solutions of polystyrene and polyisobutylene are the result of the thermal motions of the segments of the polymer molecules. These segmental motions coordinate with one another to produce changes in the configurations of the molecules. The configurational changes have associated with them a series of relaxation times. These relaxation times are shown to depend upon molecular weight of the polymer, concentration, type of solvent, and viscosity of solvent. A.

2755. Molecular distribution functions in a one-dimensional fluid.

Z. W. SALSBERG, R. W. SWANZIG AND J. G. KIRKWOOD. *J. Chem. Phys.*, 1953, **21**, 1098.

Exact expressions are derived for the molecular distribution functions in a one-dimensional fluid whose particles interact with a nearest neighbour pair potential. The

pair distribution function for rigid spheres is found to be identical with Frenkel's result. The one-dimensional form of a new set of integral equations for the molecular distribution functions is examined. The superposition principle is found to be exact in a one-dimensional fluid with nearest neighbour interactions. A.

2756. On the development of plastic hinges in rigid-plastic beams.

M. G. SALVADORI AND F. DIMAGGIO. *Quart. Appl. Maths.*, 1953, **11**, 223.

2757. On viscosity measurement in the ultra-centrifuge.

H. K. SCHACHMAN AND W. F. HARRINGTON, *J. Amer. chem. Soc.*, 1952, **74**, 3965.

2758. The velocity and temperature dependence of rubber friction.

A. SCHALLAMACH. *Proc. Phys. Soc. B.*, 1953, **66**, 386.

2759. Material transfer in turbulent gas streams : concentric flow.

W. G. SCHLINGER AND B. H. SAGE. *Ind. and Eng. Chem.*, March, 1953, p. 657.

2760. Temperature gradients in turbulent gas streams : non-uniform flow.

W. G. SCHLINGER, V. J. BERRY, J. L. MASON AND B. H. SAGE. *Ind. and Eng. Chem.*, March, 1953, p. 662.

2761. Instruments for measuring plasticity in the rubber industry.

J. R. SCOTT. *J. sci. Instrum.*, 1953, **30**, 145-50.

2762. Plasticity of silicon and germanium.

F. SEITZ. *Phys. Rev.*, 1952, **88**, 722.

2763. Effects of rate of shear on inherent and intrinsic viscosities of polystyrene fractions.

L. J. SHARMAN, R. H. SONES AND L. H. CRAGG. *J. Appl. Phys.*, 1953, **24** (6), 703.

Fractions of polystyrene, varying in molecular weight from 0.3×10^6 to 10×10^6 approximately, were prepared by careful tertiary fractionation. Inherent viscosities were determined at various rates of shear in the approximate range $100-20,000 \text{ sec}^{-1}$, viscosity measurements being made at several different temperatures in benzene and toluene (good solvents for polystyrene) in butanone (an intermediate solvent) and in cyclohexane (a poor solvent). From these values intrinsic viscosities at various rates of shear were determined. These viscosity functions are sensitive to shear rate at high molecular weights; at a given temperature the shear effects are greater the higher the molecular weight and the better the solvent, and with increasing temperature they decrease in a good solvent and increase in a poor one. This behaviour is shown to be consistent with current ideas regarding the size and shape of polymer molecules in solution as affected by weight, temperature, and solvent power. It is concluded, among other things, that with flexible polymers (or polymer fractions) of very high molecular weight, measurements of intrinsic viscosity should be made in a poor solvent at a low temperature. A.

2764. Mixed boundary value problems in soil mechanics.

R. T. SHIELD. *Quart. Appl. Maths.*, 1953, **11**, 61.

A theory of two-dimensional strains in an "ideal" soil is developed. It is applied to the indentation of a semi-infinite material by a flat punch or footing, and to indentation by a lubricated wedge. R.R.

2765. Particle shape in thixotropic suspensions.

A. F. SIRIANNI, C. B. MOSES AND I. E. PUDDINGTON. *Can. J. Chem.* 1951, **29**, 166-72.

Several equations have been proposed that predict the shape of suspended particles when the viscosity of a suspension of known concentration is measured. These are not applicable to suspensions showing thixotropy, owing to the dependence of the measured

viscosity on the shear rate used. However, by using viscosity values that have been extrapolated to infinite rate of shear, good agreement has been found between the predicted and measured shapes for particles in thixotropic systems, and the method appears to be suitable for submicroscopic particles. A scheme is also proposed for comparing the degree of thixotropy of different systems. B.S.A.

2766. The elastic constants of Cu-4% Si.

C. S. SMITH AND J. W. BURNS. *J. Appl. Phys.*, 1953, **24**, 15.

2767. Creep and relaxation of high strength steel wires at room temperatures.

G. T. SPARE. *Wire and Wire Prod.*, Oct., 1952.

2768. A new device for the measurement of air flow.

K. SPINGLER. *Ziegelindustrie*, 1952, **5**, 462.

For use in kilns and tunnel dryers.

B.C.R.A.

2769. Singular surfaces and flow lines in the theory of plasticity.

T. Y. THOMAS. *J. Rational Mechs. and Anal.*, 1953, **2** (2), 339.

The author discusses theoretically the markings which appear on the surfaces of solids that have been strained to the yield point assumed to originate as the curves of intersections of the surface of the body and singular surfaces separating distinct regions within the body. Two such singular surfaces appear to be of particular significance, namely, the slip surface and the W surface which involves a weakened form of the condition of slip.

E.W.J.M.

2770. On the yielding of twisted steel bar.

N. TISHIHARA AND S. TAIRA. *Mem. Fac. Eng. Kyoto Univ.*, July, 1951.

2771. The influence of pressure on the viscosity of liquid helium I.

H. H. TIERKSTRA. *Physica*, 1952, **18** (11), 853.

The viscosity of liquid ^4He has been measured in a $5.8\ \mu$ diameter capillary at pressures from 5 to 50 Kg/cm^2 and temperatures between the λ -point and 4.2°K . Graphs relating temp. $^\circ\text{K}$ and η (μP) are shewn.

E.W.J.M.

2772. Exchange of liquid between paper pores.

D. TOLLENAAR. *Appl. Sci. Res.*, 1953, **A3**, 451.

The capillary rise of liquid in paper cannot be explained quantitatively by assuming uniform capillaries. The introduction of a distribution function for the capillary radii presents the possibility of calculating a correction term for the capillary pressure and the volume of liquid at any level.

A.

2773. The absorption of water by cellulose, and its dependence on applied stress.

L. R. G. TRELOAR. *Trans. Faraday Soc.*, 1953, **49**, 816.

2774. Solid solubility effect of metallic surface friction.

K. UMEDA AND Y. NAKANO. *J. Fac. Sci. Hokkaido Univ. II*, 1951, **4**, 70-86.

The temperature dependence of the metallic surface friction was studied experimentally for a number of metal pairs by the improved Bowden method. In particular, for metal pairs of limited solubility type the "solid solubility effect" embodied by the formula: $\mu\theta = (\alpha_{\text{eutec}} - \alpha_0)^k$ was found. Furthermore, similar phenomena are examined for metal pairs of simple eutectic, continuous solubility, intermetallic compounds, intermediate phase types and solidified mercury as a component. The results seem to favour the local melting theory of Bowden *et al.*

SCI. ABSTR.

2775. Plastic deformation of coarse-grained aluminium.

U. M. URIE AND H. L. WAIN. *J. Inst. Met.*, 1952, **81**, 153.