

THE BRITISH SOCIETY OF RHEOLOGY

President : DR. G. W. SCOTT Blair.

Hon. Sec.

DR. E. W. J. MARDLES,
ROYAL AIRCRAFT ESTABLISHMENT,
FARNBOROUGH, HANTS.

Hon. Editor

DR. V. G. W. HARRISON,
LYNDHURST, LINKS WAY,
LITTLE BOOKHAM, SURREY.

Hon. Treas.

DR. J. G. OLDROYD,
Y BWTHYN,
ALLENBY ROAD,
MAIDENHEAD, BERKS.

Bulletin No. 29

December, 1950

Price to non-members, 5s.

EDITORIAL

Committee has decided that in future summaries of papers presented at the Society's meetings shall be printed in the Bulletin, either in advance or in the issue immediately following the meeting. These summaries will be of some five hundred words in length and will thus convey more information than is possible in an abstract; on the other hand, they will not be so long as to prejudice the paper's chances of publication in full in another journal. As explained in previous issues of the Bulletin, publication of full-length papers is beyond our resources. The Committee, however, agrees that material presented at Society's meetings should not be lost and the arguments advanced by some of our correspondents carry considerable weight. The proposed 500-word summaries are an attempt to meet an evident need and we hope that, while not straining the Society's resources unduly, they will at least enable authors promptly to publish any new facts or theories in outline and to establish priority, leaving them free to publish in full elsewhere—perhaps after more mature thought and consideration of criticisms which the preliminary note may have aroused.

Publication of our Annual Conference proceedings in book form presents steadily increasing difficulties. The unpleasant fact is that sales at a reasonable price of a few hundred copies of a highly specialised and composite book incorporating mathematical symbols and diagrams can no longer recover the costs of publication, and it appears that future books can be issued only if the Society accepts part or all of the financial risk involved. There is a rather remote possibility that the Society may be able to undertake publication of the next volume, but only on condition that sales are guaranteed and sufficient to cover the cost of printing. Readers' attention is drawn to a note on this subject appearing elsewhere in this number.

The number of abstracts received per quarter shows a tendency to increase. This is due in part to a steady increase in the number of authors. Every quarter sees the addition of more than a hundred new names to our card index of authors. More than half of these are accounted for by authors who, in groups of threes, fours or even fives, publish in one glorious burst and for ever after hold their peace; nevertheless, there is a substantial minority of new authors showing clear signs of becoming regular contributors to the rheological literature. This promises well for the future of our science. On the other hand, increase in the number of abstracts is due also to a welcome increase in the number of our abstractors and consequent better coverage of journals. By no means all journals are yet covered. But the more important available literature is now

abstracted conscientiously and well by our own abstractors. This work makes substantial demands on their time and energy. It is of course voluntary and unpaid, and abstractors' only reward is the sincere thanks of the present Editor and Committee and the knowledge that they are helping the science in which they are interested.

V. G. W. HARRISON.

THE BRITISH RHEOLOGISTS' CLUB

ACCOUNTS FOR THE YEAR ENDING 30th SEPTEMBER, 1950

(a) GENERAL ACCOUNT

										<i>Receipts</i>		
										£	s.	d.
Balance at beginning of year	—	—	—	—	—	—	—	—	—	94	17	11
Subscriptions	—	—	—	—	—	—	—	—	—	266	0	0
Donations	—	—	—	—	—	—	—	—	—	4	0	
Royalties—	—	—	—	—	—	—	—	—	—	15	0	
Sale of books	—	—	—	—	—	—	—	—	—	4	13	0
Refunds	—	—	—	—	—	—	—	—	—	16	10	2
Receipts at Annual Conference	—	—	—	—	—	—	—	—	—	74	7	0
										£457	7	1
										<i>Expenditure</i>		
										£	s.	d.
Postage and receipt stamps	—	—	—	—	—	—	—	—	—	23	11	6
Stationery and printing	—	—	—	—	—	—	—	—	—	174	1	10
Subscriptions refunded	—	—	—	—	—	—	—	—	—	3	0	0
Secretarial help and Committee expenses	—	—	—	—	—	—	—	—	—	10	16	2
Expenses connected with Annual Conference	—	—	—	—	—	—	—	—	—	80	4	6
Expenses connected with other meetings	—	—	—	—	—	—	—	—	—	13	18	6
Sundries	—	—	—	—	—	—	—	—	—	5	2	
Balance at end of year	—	—	—	—	—	—	—	—	—	151	9	5
										£457	7	1

(b) INTERNATIONAL UNION OF RHEOLOGY ACCOUNT

										<i>Receipts</i>		
										£	s.	d.
Donation	—	—	—	—	—	—	—	—	—	50	0	0
Transfer	—	—	—	—	—	—	—	—	—	20	6	0
										£70	6	0
										<i>Expenditure</i>		
										£	s.	d.
Printing	—	—	—	—	—	—	—	—	—	3	19	11
Balance at end of year	—	—	—	—	—	—	—	—	—	66	6	1
										£70	6	0

J. GARDNER OLDROYD,
Hon. Treasurer.
6 December, 1950.

Audited and found correct.
A. DE WAELE,
Hon. Auditor.
December 19th, 1950.

"RECENT ADVANCES IN RHEOLOGY"

The Society has for sale at 10/- each a limited number of copies of the proceedings of the 1949 (Bristol) Conference. The book contains the text of the papers presented at Bristol and covers a wide range of subjects. Members wishing to purchase one are asked to communicate with the Hon. Secretary.

PUBLICATION OF CONFERENCE PAPERS

Publication of future Conference papers is presenting a serious problem. The Society may be prepared to take over publication risks provided a sufficient number of members promise to buy copies on publication. The Society is not in a position to stand a serious financial loss and before making such a venture it would be necessary to know in advance whether the sales would cover the cost of printing. It will greatly help the Committee if members willing to guarantee to buy at least one copy of the Conference proceedings as they appear would notify the Hon. Treasurer,—provided always that the cost of such proceedings do not exceed 10/- and that they appear within twelve months of the date of the conference to which they relate.

"PHYSICS OF LUBRICATION" CONFERENCE

We understand that the papers presented at the joint conference with the Institute of Physics at Manchester will be published in the early spring at a cost of about 15/- (paper covers).

FUTURE EVENTS.

The following general meetings are being arranged, and particulars and confirmation of dates will be circulated later:

Discussion on New Developments in Viscometry, at the University, Birmingham, 11th May, 1951.

Summer Visit. To be announced later.

Conference on The Rheology of Surface and Thin Films, and Annual General Meeting at the Washington Singer Laboratories of the University College of the South West, Exeter, 27th to 29th September, 1951.

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.

1845. **The anisotropy of Young's modulus of ferro-magnetic monocrystals.**
N. S. AKULOV, I. P. MAZIN AND YA. E. FELTSHEIN. *Dokl. Akad. Nauk, SSSR*, 1950, 71 (5), 851. *In Russian.*

Shows the method for the determination of the elastic modulus for monocrystals on the basis of measurements conducted on polycrystalline textured specimens and its application in the study of elastic properties of monocrystals in Ni.

SCI. ABSTR.

- 1846 **Cohesion and fracture in metals.**

N. P. ALLEN. *Institution of Metallurgists*, Jan. 1950, The Fracture of Metals, pp. 5-28.

Theories for the fracture of metals are reviewed. The Taylor dislocation and the Griffith crack are explained, and plastic and brittle fractures and combinations of these are discussed.

J.I.S.I.

1847. **High temperature hardness testing. Some recent Russian work.**
ANON. *Metallurgia*, 1950, 42 (251), 207.

Usual method of testing hardness with Brinell apparatus for temp. up to 500°C. with diamond or Pobedite (Russian sintered carbide) indenters. Brinell machine with metallo-ceramic indenter for temp. up to 900°, without vacuum or protective media used in Russian research. Chemico-thermal diffusion treatment forms protective film on ball. 5 mm. dia. ball used at 750 kg. load for hardnesses below 300 HB, 250 kg. above 300 HB. Basic metals of alloys tested : tungsten, molybdenum, chromium, cobalt, nickel, iron. Chromium alloys hardest at temp. up to 800°C. (335 HB); nickel alloys 140 HB, cobalt 180 HB, iron 100 HB at same temp.; all about 120 points less than at room temp. "Hot" tests quicker and more reliable in estimating effect of additional constituents and heat treatment than room temp. measurements.

I.D.I.B.

1848. **Determination of elastic constants in single crystals with especial reference to silver chloride.**

D. L. ARENBERG. *J. Appl. Phys.*, 1950, 21, 941.

Letter. The ultrasonic pulse method has been applied to the determination of the various elastic constants of silver chloride crystals.

A.G.W.

1849. Liquid helium films II. The flow of the film.

K. R. ATKINS. *Proc. Roy. Soc., A*, 1950, **203**, 240.

The rate of flow of the He II film has been found to vary slightly with the height of the film and the pressure head. Most of the variation can be ascribed to changes in the thickness of the film, but a small residual variation at small pressure heads suggests that at least part of the flow is subject to frictional retardation. Measurements of the damping of the film oscillations enable a small upper limit to be put on the frictional retardation of the remaining part, but a similar method applied to flow through wide capillaries indicates that in this case most of the flow is opposed by frictional forces. The results are discussed in conjunction with the measurements of Allen and Missener on flow through capillaries and an attempt made to formulate some of the general features of the flow of the superfluid component.

AUTHOR.

1850. The viscosity of linseed oil lithographic varnish films during oxidation drying.

W. H. BANKS AND P. B. G. UPTON. *J. Oil Col. Chem. Assoc.*, 1950, **33** (363), 397.

Measurements of the changes in viscosity of a bodied linseed oil film during drying, using a rolling ball technique, are described. The viscosity shows negligible change for a period which is a considerable fraction of the drying time. Number average molecular weight changes during the drying process are consistent with the condensation of oxygen activated molecules to form a cross linked polymer in which the functionality of the active units is not in excess of three.

AUTHORS.

1851. Influence of hydrogen on the elasticity and inelasticity of iron and steel.

P. BASTIEN AND P. AZOU. *C.R. Acad. Sci., Paris*, 1950, **231**, 147. *In French*.

It is shown that H has only a very slight effect on the elastic and inelastic properties of Fe and very soft steel. The modulus of elasticity is decreased slightly and the damping capacity is similarly increased.

SCI. ABSTR.

1852. Bentonite suspensions.

W. E. BERGMAN AND H. B. FISHER. *Ind. & Eng. Chem.*, 1950, **42**, 1895.

Aqueous drilling muds based on bentonite are prepared with addition of sodium hydroxide, quebracho, sodium chloride, or sodium carboxymethyl cellulose. The properties studied are gel strength, stormer viscosity, pH, and water loss, and the effects of ageing on these properties are also considered. It is shown that, while the caustic and quebracho treatment effectively controls viscosity and gel strength in muds free from sodium chloride, they lose this property once the concentration of the latter salt increases beyond 1%. In such regions an additional component—sodium carboxymethyl cellulose—must be used to facilitate control of rheological properties.

F.H.

1853. On the correlation of the directional properties of rolled sheet in tension and cupping tests.

L. BOURNE AND R. HILL. *Phil. Mag.*, 1950, **41**, 671.

Plastic anisotropy in rolled sheet is examined. The earing positions are correlated with the strain-ratios measured in tension tests at various orientations to the direction of rolling. The materials used are copper giving four ears at 45°, brass giving four ears at 50°, and brass giving six ears at 0° and 60°. A theory of plastic anisotropy due to Hill is found to be in good agreement with the experimental data for materials producing four ears. The theory is extended to describe more complex states of anisotropy.

AUTHORS.

1854. Viscosity-temperature dependence.

A. V. BRANCKER. *Nature*, 1950, **166**, 905.

Graphs relating $\log \eta$ and T^{-1} or $\log \log (\nu+c)$ and $\log T$, (A.S.T.M. chart) deviate from linearity over wide temperature ranges particularly at low temperatures. It is concluded that existing methods of representing viscosity temperature data are not entirely satisfactory. The equation $\eta = a\eta/T + b$ where η is in poises and a and b are constants, gave a closer relation: deviations appeared near b.p. but not at low temperatures.

E.W.J.M.

1855. Frictional relaxation oscillations.

J. R. BRISTOW, R. C. PARKER AND D. HATCH. *Proc. Phys. Soc., Lond.*, 1950 B, **63** (371), 964.

Dr. Bristow makes the point that generally during the frictional generated relaxation oscillation cycle the two surfaces are never at rest relative to each other. He refers to his own observation that during the "stick" part of the cycle the dragged elastically restrained surface never catches up with the dragging surface.—In this connection Dr. Parker and Mr. Hatch state the behaviour of a soft metal hemisphere in contact with a hardened flat non-metal surface under the influence of increasing frictional force. Relative movement is accompanied by an increase in the real area of contact, and when this area cannot grow further any additional increase in the tangential force gives rise to slipping on a macroscopic scale. If the soft metal hemisphere is elastically constrained and the glass friction element is moved forward at a low uniform velocity, Parker and Hatch say that at the moment of movement the two surfaces appear to move altogether for only a very short time after which the relative velocity will gradually increase up to the point of macroslip.

R.S.

1856. Graphical symbols for instrumentation.

B.S. 1646: 1950.

The system of instrument symbols described in this British Standard provides a means of graphical representation suitable for use in any engineering or process-line diagram. It is also suitable for use in engineering and layout drawings. The notation used with the symbols provides a general indication of the kinds of instruments and control represented. Systems for the numbering of instruments are not dealt with in this standard. Diagrams are included to illustrate the application of this system, but the symbols are not primarily intended for use in electrical wiring diagrams, nor are they intended to detail any particular type of instrument or control.

D.C.B.

1857. Long-period, high-sensitivity, tensile creep testing.

B.S. 1686: 1950.

Specifies the essential requirements for testing machines and methods of test to be employed in order to measure tensile creep (total plastic) strains down to 0.001 (0.1 per cent) and in periods up to 10,000 hours. It is applicable to standard tests on specimens from bars, plates, sections, sheets and components.

Clauses deal with the size of the test specimen, testing machine, thermocouples, temperature indicators, heating apparatus, temperature control, extensometer, extensometer check, thermocouples (calibration), heating-up and soaking periods, loading, temperature and creep readings, and presentation of results. An appendix sets out the fixed temperature points required for the calibration of base-metal and precious-metal thermocouples.

D.C.B.

1858. Medium-sensitivity tensile creep testing.

B.S. 1687 : 1950.

Specifies the essential requirements for testing machines and methods of test to be employed in order to measure tensile strains of 0.01 (1.0 per cent) or greater, in periods up to 10,000 hours. It is applicable to standard test on specimens from bars, plates, sections, sheets, and components.

Clauses deal with the size of the test specimen, the testing machine, temperature measuring equipment, heating apparatus, temperature control, extension measuring apparatus, temperature measurement, heating-up and soaking periods, loading, temperature and creep readings, and presentation of results. An appendix sets out the fixed temperature points required for the calibration of base-metal and precious-metal thermocouples.

D.C.B.

1859. Determination of time to rupture under stress.

B.S. 1688 : 1950.

Specifies the essential requirements for testing machines and methods of test to be employed in order to measure the times to rupture, with or without measurement of creep strain, under constant tensile loads and at constant temperatures. It is applicable to standard tests on specimens from bars, plates, sections, sheets and components.

Clauses deal with the size of test specimens, the testing machine, temperature measuring equipment, heating apparatus, temperature measurement, heating-up and soaking periods, temperature readings, time recordings and presentation of results. An appendix sets out the fixed temperature points required for the calibration of base-metal and precious-metal thermocouples.

D.C.B.

1860. Transitions in high polymeric materials.

R. BUCHDAHL AND L. E. NIELSEN. *J. Appl. Phys.*, 1950, **21**, 482.

Experimental results for dynamic modulus of elasticity, damping, specific heat, thermal expansion etc. are reviewed in order to establish that a thermodynamic transition is involved. It is suggested that the molecular basis of the transition is modification of the "hindered" rotation.

A.G.W.

1861. A non-destructive mechanical test for animal fibres.

H. M. BURTE. *J. Appl. Phys.*, 1950, **21**, 494.

Non-destructive measurement of the force-extension curve can be used to follow the course of the interaction between salt solutions and wool fibres. Two processes appear to occur, firstly hydration or dehydration until the fibre is in equilibrium with the activity of water in the salt solution and, secondly, slow absorption of salt ions on the fibres. Similar results are obtained for the interaction of fibres and aqueous solutions of large organic molecules.

A.G.W.

1862. Some notes on the analysis of redundant systems by means of the conception of conservation of energy.

T. M. CHARLTON. *J. Franklin Inst.*, 1950, **250** (6), 543.

The principles of analysis of conservative redundant deformable systems are considered with regard to conditions for equilibrium and geometrical compatibility to secure unique solutions. Energy methods of analysis are approached directly through conservation of energy.

K.H.S.

1863. The viscosity and friction of soft solids.

F. CHARRON. *C. R. Acad. Sci., Paris*, 1950, **231**, 646.

The expression $X = f + \eta \, du/dz$ is supposed for the shearing of soft solids such as a lubricating grease between two parallel planes, distance z apart at rate of movement u of one plane, where X is the force per unit area, f a coefficient of friction and η a coefficient of viscosity. Microscopic observations with petroleum jelly indicated that wall effects played an important effect and it is proposed to determine the values of f and η for different pressures.

E.W.J.M.

1864. Design and construction of equipment for a small stress-rupture creep laboratory.

F. C. CHILD. *Metallurgia*, 1950, **42**, 37.

An account is given of experience in the development of a creep-testing lab. for life-to-rupture tests on materials at 900°C. using miniature creep-testing machines, and details are given of the equipment finally installed. Although designed for high-temp. testing, the apparatus has given satisfactory performance, with only minor alterations, at temps. as low as 400°C. Temp. control of $\pm 1^\circ\text{C}$. at 900°C. can be achieved over periods of up to 1,000 hr. with a temp. gradient of less than 1°C .

B.C.R.A.

1865. Scheme for analyzing capillary measurements on non-Newtonian liquids.

O. H. CLARK AND M. L. DEUTSCH. *J. Appl. Phys.*, 1950, **21**, 713.

Simple relations are derived between the observed quantities and viscosity and shear rate, and the application to Bingham bodies and high rates of shear considered.

A.G.W.

1866. Fracture by fatigue.

H. L. COX. *Institution of Metallurgists*, Jan., 1950, The Fracture of Metals, pp. 42-67.

The nature of fatigue is discussed with many references to work carried out at the National Physical Laboratory. The subject is dealt with under the following headings: Introduction; The S-N Curve; Propagation of the Crack; Initiation of the Crack; Size Effect; Imperfection of Structure; Hypothesis as to the Nature of Fatigue; Conclusion.

J.I.S.I.

1867. The surface chemistry of proteins, Part 2. The viscosity, elasticity and thickness of adsorbed films.

C. W. N. CUMPER AND A. E. ALEXANDER. *Trans. Faraday Soc.*, 1950, **46**, 243.

The adsorption at the oil-water interface of the proteins, pepsin, insulin and β -globulin has been studied as a function of protein concentration, nature of interface, pH, ionic strength, temperature and time by means of interfacial tension and interfacial viscosity measurements. The interfacial viscosity was determined by oscillating a platinum needle in the interface and an elasticity index (directly proportional to the contribution of the film to the restoring torque on the needle) was obtained from the same experiment. By assuming that the surface viscosity of an adsorbed film is independent of the interfacial energy, and that the structure of spread monolayers and adsorbed films are essentially the same it was possible to calculate the thickness of the surface-denatured protein present at the interface.

G.S.

1868. Flow characteristics of organopolysiloxane fluids and greases.

C. C. CURRIE AND B. F. SMITH. *Ind. & Eng. Chem.*, 1950, **42**, 2457.

Some of the rheological properties of organopolysiloxane fluids and greases are described. Data are presented to show that methylpolysiloxane fluids exhibit either

Newtonian or pseudoplastic flow depending on molecular weight and that the rate of shear has little effect on the calculated viscosity-temperature slope. The existence of thixotropy at high shear rate is established. The rheological behaviour of the siloxane greases is determined by both the concentration of soap and the type of organopolysiloxane fluid. The type fluid is the major factor in the temperature dependence of siloxane greases under shear.

AUTHORS.

1869. The viscosity of sulfur vapor.

G. A. DALIN. *J. Phys. Colloid Chem.*, 1950, **54** (8), 1215.

The viscosity of sulphur vapour at the boiling point (445°C.) was determined, using the capillary method with short tubes and low rates of flow. The experimental value obtained, 197 micropoises, agreed closely with average values calculated for a mixture of octatomic, hexatomic and diatomic molecules.

G.E.B.

1870. Use of micro-hardness instrument PMT-2 designed by M. M. Krushchov and E. S. Berkovich for study of minerals.

C. D. DMITRIYEV. *Zapisk Vsesoiuzn Mineralog Obshchestva*, 1949, 2nd ser, **78** (4), 241. *In Russian*.

Some literature on micro-hardness testing reviewed, in particular work by M. M. Khrushchov and S. B. Talmage. Some tests were made according to Talmage's scale of 7 groups to final limits of micro-hardness numbers in different groups, extent of overlapping and whether hardness could be measured in mineral particles of about 0.02 mm. size. Results for loads from 5 to 200 g. were as follows:—

No.	Mineral	Hardness No. (kg./sq.mm.)
Talmage Group		limits
1	Argentite	10- 30
2	Galenite	70-105
3	Chalcopyrite	180-250
4	Tetrahedrite	180-275
5	Nickelin	390-520
6	Magnetite	480-740
7	Ilmenite	505-690

Tests were made with different crystal orientations, and averages of 5 to 10 tests in each case were recorded. Data also given for another group of 7 minerals: (1) argentite, bismuth, (2) native copper, galenite, (3) bismuthin, (4) chalcopyrite, sphalerite, (5) pyrrhotite, (6) ilmenite, magnetite, (7) arsenopyrite. This shows no overlapping; hardness range of group 7 is 810 to 1250 kg./sq.cm. With regard to minimum size, some data are given; in some cases particles down to 0.02 mm. size and even less were tested. Other properties such as elasticity, plasticity and brittleness were determined on the PMT-2 instrument. Shape of impression varies strongly with anisotropy and elastic properties of minerals and differences in composition (mentioning in case of metals work of H. O'Neill and Brit. standards for Brinell and diamond pyramid hardness). Some typical forms illustr. and described, showing differences in different faces of same crystal (examples: ilmenite (pinacoid), calcite (rhombohedral), bismuth, fluorite etc.; irregular forms of antimonite, bismuthin, and jamesonite, tested under high loads). Plastic deformation results from high loads and extends far beyond boundaries of impression; patterns (figures) of compression or stress are formed. Literature noted, and examples given for copper, ilmenite, bismuth, and calcite. Twinning of impression, when observed through microscope with crossed nicols may, in case such as ilmenite, be accompanied by slip. This occurs in 3 forms (a) parallel to pinacoid edge, (b) hexagonal prism, and (c) rhombohedron. With hematite, isomorphous with ilmenite, under load of 100 to 200 g. on rhombohedron side (1011) scarcely noticeable lines appear

forming angle 60° and 120° in examining thin polished sections; various examples given and compared. In regard to cracks appearing under brittle fracture, pointed out that nature of brittleness appears very different from microhardness point of view than from scratch testing according to Mohs. Many minerals regarded as brittle appear under limited loads as plastic, and impressions obtained perfectly clear; examples from quartz, calcite. Some results of tests tabulated showing minimum loads under which first crack appears, typical cases, and degree of plasticity or brittleness; another table gives details of Mohs' hardness and values obtained by new method, impression forms, stress figures, loads used, and degree of brittleness or plasticity, for large number of minerals.

I.D.I.B.

1871. Dynamic impact strength of panels.

A. DOSOUDIL. *Svensk Papperstidning*, 1950, 53 (19), 609. *In German*.

The author is convinced that the mechanical resistance of panels to be used as walls cannot be satisfactorily judged from the testing of small specimens. He thinks it necessary to examine the panels as such, placed on or fastened to a frame. He emphasizes the importance of subjecting them to a dynamic test. For this purpose he has developed a special falling apparatus by which the energy necessary to break through the panels can be measured. The paper is a short report on the experiments still in progress and a number of photographs showing the broken panels of various descriptions. The last figure presents a diagram based on the preliminary results, which shows how the dynamic strength depends on the thickness of the various materials.

AUTHOR.

1872. The flow properties of elastic dispersions.

W. J. DUNNING AND D. PATTERSON. *Trans. Faraday Soc.*, 1950, 46, 1095.

The flow properties of dispersions of latex rubber in Aroclor 4465 (a "liquid" with a viscosity of about 10^{10} poises) have been studied. The form of the compression-time curves and the order of magnitude of the strain relaxation time agree with the theory of Frölich and Sack for the flow properties of elastic spheres dispersed in a Newtonian liquid.

AUTHORS.

1873. Evaluation of empirical viscosity measurements for varnishes.

M. R. EUVERARD. *A.S.T.M. Bull.*, 1950, 169, 67.

This paper is a report on the activities of Group 18, Sub-Committee 9 of A.S.T.M. Committee D.1, on paints, varnish, lacquer and relative products and deals with the industrial measurement of viscosity by a wide range of efflux viscometers and Gardner-Holdt viscosity tubes. In all some 40 instruments have been investigated and correlation data is scheduled including viscosity factors providing approximate values in centistokes when the cup reading is above the minimum time in seconds indicated. A more detailed comparison of 29 of these viscosity measuring devices is provided followed by details of replies received from a questionnaire which was circulated to a number of paint and varnish manufacturers and institutional and raw material representatives. It is observed from this survey that the Gardner-Holdt viscosity tubes and the Ford type cups are preferred by the majority, the Gardner-Holdt tubes being used for transparent varnishes and the Ford cups for non-transparent varnishes and enamels.

D.C.B.

1874. The determination of the plasticity of soil by the Vasiliev cone.

I. S. FEDEROV. *Pochvovedeniye*, 1949, 11, 675.

A method is described for the determination of the lower boundaries of viscosity and of plasticity. Soil in the air-dry condition is crushed, sieved (-1 mm.) added to water and stirred. The soil thus prepared is placed in a mould and compacted, its surface being levelled with a knife. A standard cone is then released electro-magnetically

from a height of 34 cm. and falls on to the sample. If the cone penetrates a depth of 10 mm. it can be considered that the plasticity limit has been reached. If the cone does not reach a depth of 10 mm., then the material is taken out of the mould, more water is added and the test is repeated. If the cone penetrates more than 10 mm., the moisture content is reduced until the penetration is exactly 10 mm.

B.C.R.A.

1875. Conversion tables for Vickers and Rockwell C hardness.

G. FINKE. *Stahl & Eisen*, 1950, **70** (13), 568. *In German*.

Conversion tables and curves for these two hardness scales have been empirically determined and often show discrepancies (*cf* W. Hengemuehle *Stahl & Eisen* 1942, **62**, 321). In order to calculate such discrepancies or errors H. Meincke (*Arch. Metallkde*, 1949, **3**, 354; *Bibl. Ind. Diamond Appl.*, 1950, **7**, 504) has proposed following formula relating the two scales:

$$HRC = 25 (1 - \sqrt{P/HV}) (4.65 - (P/HV))$$

for *HV* equal to or greater than 225. Since, up to hardness of about 400 *HV*, Vickers hardness is practically same as that obtained on Brinell scale, this equation applies also to Brinell scale in hardness range 225 to 400 *HV*. Diagram shows application of this formula to some known conversion curves. Deviation does not appear to be very serious but said to be worth noting. Based on this formula Meincke has constructed hardness conversion tables for *HV* (Vickers) and *HRC* (Rockwell C). Deviations from usual tables are about 6% for polished surfaces 8% for matt plated surfaces, and 10% for certain other cases.

I.D.I.B.

1876. Theory of relaxation phenomena in solids.

B. N. FINKELSHTEIN AND N. S. FASTOV. *Dokl. Akad. Nauk, SSSR*, 1950, **71** (5), 875. *In Russian*.

The theoretical investigation of these phenomena was hitherto based on a formal extension of the elastic theory by introducing terms depending on time into the generalized Hooke equation, or on Boltzmann's theory of the elastic after-effect. The present attempt is based on general thermodynamical considerations by a method first used by L. I. Mandelstam and M. A. Leontovich (*J. Exp. Theor. Phys.*, 1937, **7**, 438) in the theory of sound absorption in liquids. If the stressed state in an elastic body is propagated at a finite velocity, there is at any time a deviation from the statistical equilibrium throughout the body. The deformation process becomes hereby irreversible and the dissipated elastic energy is converted into heat. The instantaneous deviation of the state of the body from the statistical equilibrium may be characterized by the relaxation tensor ξ_{ik} . This representation is used in the paper for the special case of isothermal changes of state. The free energy of the isotropic elastic body may then be represented by a linear combination of the quadratic invariants of the elastic tensor ϵ_{ik} and relaxation tensor ξ_{ik} . The resulting elastic waves are found. Their propagation velocity appears as a monotonic function of the frequency, on which also depends their absorption.

SCI. ABSTR.

1877. Meyer analysis of metals.

H. M. FINNISTON, E. R. W. JONES AND P. E. MADSEN. *Nature*, 1949, **164**, 1128.

From equations connecting the load on a ball pressed into a plane surface for the determination of hardness with its diameter and the recovered diameter of the impression, it is made clear that the Mayer hardness *Pm* is a function of the shape of the impression. It is therefore decided that the ultimate ball hardness *Pu* when the ball is pressed up to its equator is the best value to represent the hardness of a metal in a given condition. Here $Pu = (4aD^{n-2})/n$ where *a* is a constant for the metal, and also depends on the size of the ball, *D* is the diameter of the ball, and *n* is the Meyer index; for metals in general *n* is greater than 2. All previous work has been done on cubic

metals and it has been found that Pu increases as n decreases; however, with magnesium, uranium, tin, zinc, and gallium, whose structures are not cubic, the correlation is positive, and the earlier interpretation of $(n-2)$ as a measure of the work-hardening capacity of the metal should be reconsidered. This belief is substantiated by an examination of the relation between r , the coefficient of correlation between n and Pu , and the expansion anisotropy which is a measure of the compression anisotropy. It is found that, whereas cubic materials are isotropic in this respect, the non-cubic materials show a strong positive relation between r and the anisotropy factor A_a , defined as $a \text{ max.} - a \text{ min.} / a \text{ mean.}$

J.I.S.I.

1878. The limiting hydrostatic tension of water near 0°C.

J. C. FISHER. *J. Appl. Phys.*, 1950, **21**, 1069.

Letter. The drop in the limiting tension below 5°C. is related to the nucleation of the vapour phase by ice nuclei.

A.G.W.

1879. Some recent investigations in the theory of hydrodynamic stability.

J. R. FOOTE AND C. C. LIN. *Quart. Appl. Maths.*, 1950, **8**, 265.

Consideration is given to the stability of two-dimensional flow systems involving free boundary layers, such as jets, wakes and mixing region between two streams. It is shown that in such systems (unlike those involving fixed boundaries) the effect of viscosity is to be taken into account as a second approximation to the results obtained from the inviscid fluid theory. The inviscid fluid approximation is used in discussion of the stability of symmetrical and unsymmetrical wakes and jets, and of zonal winds in the atmosphere.

R.R.

1880. Second-order transition temperatures and related properties of polystyrene. I. Influence and molecular weight.

T. G. FOX, JR. AND P. J. FLORY. *J. Appl. Phys.*, 1950, **21**, 581.

Dilatometric and viscosimetric data for fractionated polystyrenes have been obtained over a wide temperature range. Empirical expressions have been derived for the influence of molecular weight on the various properties and attempts have been made to provide a theoretical basis.

A.G.W.

1881. Impact resilience as a brittleness test for polyvinyl plastics.

G. FRIEDLANDER. *Anal. Chem.*, 1950, **22**, 1545.

The paper deals with Lupke impact resilience of plasticized polyvinyl chlorides. The impact resilience temperature curve passes through a minimum which defines the transition from ordinary to rubberlike elasticity. The position of this minimum with regard to temperature is characterized by the percentage concentration and type of plasticizer used. At temperatures lower than the resilience minimum—i.e. in the absence of rubberlike elasticity—polymer compounds which give rise to high resilience are not capable of large viscous deformation during the short time of impact. In this temperature region impact resilience can be used to classify them according to their tendency toward brittleness. Merits of the method are discussed and compared with other brittleness tests.

AUTHOR.

1882. Volume changes in the stretching of vulcanized natural rubber.

G. GEE, J. STFRN AND L. R. G. TRELOAR. *Trans. Faraday Soc.*, 1950, **46**, 1101.

Measurements are presented of the volume changes accompanying small ($> 100\%$) elongations of vulcanized natural rubber completely free from undissolved particles.

The small expansions found agree with those calculated from the known compressibility of the rubber and the hydrostatic component of the stretching force. It is pointed out that this volume change mechanism applies generally to any isotropic body, and does not contribute significantly (in rubber) to the tensile stress.

AUTHORS.

1883. Polymeric additives for synthetic ester lubricants.

F. J. GLAVIS. *Ind. & Eng. Chem.*, 1950, **42**, 2441.

Interest in ester lubricants justifies a study of polymeric additives for these fluids. Data on a single polymer blend in di-2-ethylhexyl sebacate are used to demonstrate the various interpretations possible in discussing viscosity-temperature properties. Viscosity-temperature effects are discussed for blends of representative ester lubricants and a commercially available viscosity index improver. Viscosity increase and viscosity index improvement are then demonstrated for blends of acrylic polymers and polyesters of high molecular weight in various ester types, including inorganic esters, glycol ether esters, glycol diesters, alkyl acylated ricinoleates, aryl dibasic acid diesters, aliphatic dibasic acid diesters, and polyesters of low molecular weight.

AUTHOR.

1884. Note on the rheological properties of elasto-plastic materials.

K. GOLDSMITH. *J. Appl. Physics*, 1950, **1**, 107.

It is shown that the flow properties of some elasto-plastic materials can be expressed by an empirical equation. Three constants, derived from this equation, are a measure of these properties.

B.C.R.A.

1885. The effects of rate of loading on fracture of materials.

C. GURNEY. *Institution of Metallurgists*, Jan., 1950: The Fracture of Metals, pp.101-116.

Methods of testing at high rates of strain are described. The author's apparatus is one in which the test piece is attached to an elastic weigh-bar carrying four wire resistance strain gauges with a cathode-ray oscilloscope in the circuit. At the lower end of the test piece is attached a hanger carrying rubber pads. By dropping a weight on to the hanger, a specimen can be broken at a constant rate of loading in a period of 10^{-4} sec. The time to fracture can be increased by increasing the number of rubber pads. Results with this and other apparatus are discussed in three groups dealing respectively with the effect of the rate of loading on (a) the proof or yield strength, (b) the ultimate stress, and (c) deformation at fracture. Finally the theory of tensile impact is considered.

J.I.S.I.

1886. Viscosimetric measurement of streptococcal antihyaluronidase. Comparison with titers obtained by turbidimetry.

T. N. HARRIS, W. B. ABRAMS AND S. HARRIS. *J. Infect. Dis.*, 1950, **86** (2), 122.

A capillary is fitted beneath a vertical pipette and the viscosity of hyaluronic acid found by timing the drainage of a known volume. The method is quicker and needs smaller samples than the standard Ostwald viscometer.

F.A.G.

1887. Abrasive wear of metals.

R. D. HAWORTH, JR. *Metal Progress*, 1949, **55**, 842.

The effects of different abrading materials, speed, pressure, impact, moisture, and heat on the wear of metals, especially cast iron and steel, are discussed. Some of the factors affecting the performance and extent of abrasive wear of metals are reviewed and include particle size, the hardness of the abrasive and the roundness of angularity, the effect of speed in dry and wet abrasion, corrosion, and resistance to sliding abrasion.

J.I.S.I.

1888. **A theory of the plastic bulging of a metal diaphragm by lateral pressure.**
R. HILL. *Phil. Mag.*, 1950, **41**, 1133.

Explicit formulae are obtained for the stresses in a metal diaphragm which is bulged plastically by lateral pressure. The predicted influence of work-hardening on the shape of the profile, and on the relation between polar strain and curvature, agrees well with experimental data. A simple expression is developed for the instability strain.

AUTHOR.

1889. **A quantitative comparison of flow and deformation theories of plasticity.**

P. G. HODGE, JR. AND G. N. WHITE, JR. *J. Appl. Mech.*, 1950, **17**, 180.

The stresses and displacements in a partly plastic, infinitely long, hollow cylinder are obtained according to the flow type of stress-strain law of Prandtl-Reuss and to the deformation law of Hencky. In both cases the Mises yield condition is used and the compressibility of the material is taken into account. It is shown that under these assumptions the two theories yield substantially the same results for this particular problem, but that one theory or the other may be preferable for computing purposes in certain cases. The results are compared with those of other investigations in which different combinations of stress-strain law, yield condition, compressibility, and end loading were assumed.

AUTHORS.

1890. **On Young's modulus of elasticity of single crystals of nickel and cobalt.**
K. HONDA AND Y. SHIRAKAWA. *Sci. Rep. Res. Inst. Tohoku Univ., Ser. A*, 1949, **1**, 9.

The moduli have been determined by the microscopic measurement of the depression of the mid points of crystals treating them as small beams under load. The following results were obtained for Ni single crystals: $E_{[100]}$, $E_{[110]}$, $E_{[111]}$; the 3 principal elastic parameters (assuming the volume compressibility), and the 3 rigidity moduli computed from these parameters. For Co single crystals: E for axes parallel and perpendicular to the hexagonal axis; the principal elastic parameters (assuming the linear compressibility), and the 2 rigidity moduli from these values. It is shown that the relation between the elastic constants (C_{ik}), $C_{12}=C_{44}$ (Ni and Co) and $C_{11}=3C_{12}$ (Co) do not hold as they do in various other metals.

SCI. ABSTR.

1891. **Improved miniature penetrometer cones for determination of lubricating grease consistency.**

B. W. HOTTEN AND G. M. KIBLER. *Anal. Chem.*, 1950, **22**, 1574.

Two modifications of an improved method of measuring the consistency of small samples of lubricating grease are described. The penetrometer cones used have the same shape as the A.S.T.M. cone, but their diameters and moving weights and the diameters of the sample cups have been reduced in a proportionate manner, so that the shear rates of the cones falling through the grease samples are the same as those occurring when the full-sized A.S.T.M. cone is used. As a result, rectilinear relationships between reduced-scale cone and A.S.T.M. cone penetrations are obtained with small fractions (one fifteenth for the half-scale cone and one sixtieth for the quarter-scale cone) of the sample required by the latter method.

AUTHORS.

1892. **The use of metals at low temperature.**

S. L. HOYT. *Metal Progress*, 1949, **55**, 821.

A discussion is presented on the factors which control the low-temperature behaviour of ferritic steels and other metals. The metallurgical and mechanical factors of low-

temperature brittleness are examined. These factors, together with the size and design of the part, affect the choice of steels for low temperature service and their treatment.

J.I.S.I.

1893. On the atomic theory of elasticity.

K. HUANG. *Proc. Roy. Soc. A*, 1950, **203**, 178.

A scheme has recently been developed to present the general theories in lattice dynamics without specific assumptions about the atomic interactions. The present note aims at clarifying some basic points in using this scheme, as well as giving the correct expressions for the elastic constants (the available results given in previous work are shown to be correct only for central forces in spite of the use of the general scheme). The fact is emphasized that neither the potential energy of a homogeneous deformation from a reference configuration, nor the complete stresses in the configuration can in general be represented in the general scheme. Hence, for instance, the elastic constants cannot be deduced by straightforward means, nor the equilibrium conditions (vanishing stresses) imposed; the latter itself being necessary for the definition of the usual elastic constants. A different technique is shown to be necessary for discussing such problems; one result obtained is that only five of the stresses in an arbitrarily chosen reference configuration can be explicitly represented, namely, all the anisotropic stresses. After introducing the condition that these stresses should vanish, the expressions for the elastic constants can be obtained, which are, however, to be used subject to the condition that the remaining stress, namely, an isotropic pressure, vanishes. Only when the general theory is applied to a concrete case, can the latter condition be explicitly introduced by the use of the given interaction. The results are illustrated by the special example of central forces in the last section. The Cauchy relations follow as an incidental result; the assumptions upon which the relations rest are clearly exhibited in the simple derivation.

AUTHOR.

1894. Rockwell C hardness on cylindrical steel specimens.

F. W. HUSSEY. *Autom. Ind.*, 1950, **103** (5), 47.

Experiments to determine deviation of apparent from true hardness in tests on curved steel surfaces in hardness range 20 to 65 Rockwell C; 80 specimens tested, 8 size groups, $\frac{1}{4}$ to $1\frac{1}{4}$ in. dia. in 10 heat ranges: non-shrinkable deep oil-hardening steel composed of carbon, manganese, phosphorus, sulphur, silicon, nickel, chromium, molybdenum, tungsten and vanadium tested on Rockwell hardness tester. Deviations of hardness values measured on curved surfaces from those obtained on flat areas are greatest at lower end of hardness scale, for smaller dia. ($\frac{1}{4}$ to $\frac{7}{8}$ in.); curved surface hardness approaches that of plane surface at higher values or for harder material.

I.D.I.B.

1895. Impulse-phase method of determining the mechanical parameters of resin-like materials.

M. A. ISAKOVICH. *Ź. Exp. Theor. Phys., USSR*, 1950, **20**, 371. *In Russian.*

The widely used resin-like materials of modern technology (natural and artificial rubbers and plasticized artificial resins) all imitate the mechanical characteristics of natural rubbers, i.e. the small value of their shear modulus and their high internal viscosity. The shear modulus of these substances is thousands of times greater than the bulk modulus, which is of the same order as that of water. The elastic parameters of these substances vary within wide limits, depending on chemical composition, technology of production, temperature and frequency of the external force. The theory of a measuring method of the elastic parameters is developed, and a testing method based on it described. This works with short wave-trains, of acoustic waves set up in an impulse tube filled with water, in which the sample is immersed. It is shown theoretically that the determination of the wave modulus can be used to find the shear modulus of

the material, which is confirmed by the actual test results. The rather laborious theoretical evaluation of the test results is simplified by using a graphical method.

SCI. ABSTR.

1896. A peculiarity of the mechanism of plastic deformation of ice.

K. E. IVANOV AND V. V. LAVROV. *J. Tech. Phys., USSR*, 1950, **20** (2), 230. *In Russian.*

It is shown that the plastic deformation curve of ice, just as those hitherto investigated of NaCl, brass, Zn and Cd crystals, and also metals in semi-crystalline state, has a marked stepped character. This applies for the first and subsequent stressings as well, which furnish families of curves of essentially identical character. The difference from curves of metals consists in the dimensions of the steps, which for metals is 10μ , for ice $50-100\mu$. The experiments were made at -3°C ., the repeated stress being applied to the same specimen after a 21 hr. rest.

SCI. ABSTR.

1897. The paste index of waxes.

L. IVANOVSKY. *Paint, Oil Col. J.*, 1950, **118** (2718), 816.

A penetrometer method, using tubular plungers with tapered cutting edge, is described for measuring the hardness of pastes of wax and wax mixtures in relation to the solvent used. Information on the structural system of the pastes may be obtained by a study of their behaviour after working and on ageing.

D.L.T.

1898. Turbulence in apparatus for measurement of streaming double refraction.

H. G. JERRARD. *J. Appl. Phys.*, 1950, **21**, 1007.

The different apparatus used by some thirty investigators, who have induced double refraction in a liquid contained in the annular gap between two concentric cylinders, are examined with particular reference to the onset of turbulence. In the case where the outer cylinder alone rotates, curves are given which easily enable the critical gradients corresponding to the dimensions of the apparatus used to be found. The results of the examination are so tabulated that present and future workers in this field can quickly decide on the significance of the measurements obtained by any of the investigators. An explanation is put forward of the surprising fact that with either the inner or outer cylinder rotating measurements of double refraction apparently show no very sharp break between regions of laminar and turbulent flow. The value of making simultaneous measurements of streaming double refraction and viscosity is pointed out and the advantages of using an apparatus with rotating outer and stationary inner cylinder are briefly summarized. Mention is made of optical design.

AUTHOR.

1899. Non-Newtonian surface viscosity. Change of phase produced by a velocity gradient.

M. JOLY. *J. Phys. Radium*, 1950, **11**, 171. *In French.*

Eyring's theory of viscosity is modified by introducing a relaxation time corresponding to changes of stresses in viscoelastic bodies with any form of boundary conditions. If stress and double refraction and their time derivatives are also linearly related, the standard photoelastic techniques can be used to determine the directions and difference in magnitude of the time-dependent principal stresses, even though the principal stress axes do not coincide with the polarizing axes and both vary with time. When viscoelastic models are used in photoelastic studies, the time variation of the stress distribution in the model represents a first approximation to the dependence of the stress in the elastic prototype on Poisson's ratio.

SCI. ABSTR.

1900. On the discontinuous elongation of aluminium crystal. I.

T. KAWADA. *J. Phys. Soc. Japan*, 1950, 5, 60.

Extension is performed at constant strain rate with stress recorded by a spring leaf, the movement of which produces a capacitance change and, eventually, an oscillograph deflection. This is photographed. The deflection leaf movement ratio was usually set at about 8,000. Commercial Al at 200°C. gave a smooth curve. Single crystals gave fluctuations of amplitude $<0.5\mu$ up to 10% extension for all orientations. These are to be distinguished from "discontinuous jumps." A 4-crystal specimen gave a smooth curve below the critical shear stress and also above about 10% extension (with the exception of a few groups); in between, jumps were observed.

SCI. ABSTR.

1901. On the discontinuous elongation of aluminium crystal. II.

T. KAWADA. *J. Phys. Soc. Japan*, 1950, 5, 64.

A more detailed account of work on coarse-grained polycrystals (see preceding Abstr.). From 0 to 100°C., there were fluctuations only; from 100 to 350°C. jumps occurred, but with decreasing magnitude as the temperature increased; above 350°C. the curves were smooth. As the strain rate decreased, jumps were slightly more frequent and of greater magnitude. Different relative orientations of the members indicated a reduction in the number of jumps as the orientation of neighbours became closer. In view of previous results, an attempt was made to find the minimum grain size for which jumps occur: such a border-line specimen is discussed, and it is suggested that the discontinuous jumps must be associated with the distortion near the grain boundary. The number of jumps was not proportional to the number of grain boundaries. The duration of jumps were random, from 25 to 80 msec, and were independent of the jump magnitude. 99.99% Al showed no discontinuities for any kind of specimen (including single crystal), hence impurities are said to be necessary for their occurrence. Results on Al-Zn and Al-Sn alloys are briefly stated.

SCI. ABSTR.

1902. On the discontinuous elongation of aluminium crystal. III.

T. KAWADA. *J. Phys. Soc. Japan*, 1950, 5, 68.

A discussion of experimental results (see preceding Abstr.) based on dislocation considerations and their interaction with the grain boundary.

SCI. ABSTR.

1903. New method for bulk modulus determination.

S. L. KERR, L. H. KESSLER AND M. B. GAMET. *Trans. Amer. Soc. Mech. Engrs.*, 1950 (Nov.), p. 1143.

The literature is reviewed and a new apparatus described the error of which is estimated not to exceed 2% at the highest test pressure of 1500 lb./sq. in. Results for water, petrol and three crude oils are quoted. At pressures near 300lb./sq. in. the bulk modulus of water is 3.0×10^5 . The modulus of the oils drops with increasing temperature. The results are compared with those of other workers and are used in an examination of surge conditions in pipe lines.

V.G.W.H.

1904. Interpretation of fracture markings.

J. A. KIES, A. M. SULLIVAN AND G. R. IRWIN. *J. Appl. Phys.*, 1950, 21, 716.

This paper presents a study of the sequence of events by which cracks "grow." A careful investigation was made of the origin, development and characteristic pattern of level-difference markings left by rapidly moving fractures in a wide variety of materials. Characteristic markings indicating discontinuous propagation are found in fractures of plastics, polycrystalline and single-crystal materials, coal, mica, photographic film from

which the emulsion was stripped, etc. Thus, the continued occurrence of essentially discontinuous initiations which comprise fracturing becomes clear. These considerations are sufficient to explain a number of well-known fracture markings and to clarify what is meant by brittleness and fracture velocity.

AUTHORS.

1905. Note on the use of Reiner's equation for recognition of pseudoplastics from their flow curves.

V. O. KRAKAUER. *J. Appl. Phys.*, 1950, **21**, 850.

A method is described which has been found useful to determine by application of the Reiner equation whether certain flow curves obtained with a concentric cylinder rotational viscometer indicate pseudoplastic or Bingham body types of flow.

AUTHOR.

1906. Hardness testing and its application to plastics.

E. KRUSE. *Schweizer Archiv.*, 1950, **16** (8), 225. *In German.*

The various hardness tests such as Rockwell, Vickers and Knoop do not properly agree with each other. Between usual hardness values linear relationships exist, but under prevailing test conditions variations up to 20% may be observed. Desirable to co-ordinate various test methods, with particular ref. to proper definition of hardness, but without losing particular advantages of each system. Differentiation should be made between plastic and elastic deformation. Optical properties of plastics require special hardness tests, whereas rigid plastics can be treated as metals: for more elastic materials another definition should be applied. Hardness tests of metals at high temp. give a good idea of softening phenomena which then occur. Suggested that light should fall obliquely onto specimen.

I.D.I.B.

1907. Functional selection of synthetic lubricants.

R. G. LARSEN AND A. BONDI. *Ind. & Eng. Chem.*, 1950, **42**, 2421.

The basic principles are summarized which guide the selection of synthetic lubricants for specific application in lubricating practice. The physical and chemical properties of the commercial and potential lubricants characterizing many chemical classes have been assembled in a single table, permitting quick selection of suitable compound classes for a given application. The use of this information is illustrated by a few typical lubricating problems which cannot altogether satisfactorily be solved by the use of conventional petroleum fractions. Consideration has also been given to economic factors such as raw material cost, which may often be as important an element in lubricant selection as the technical requirements; so far, these factors have retarded the application of synthetics in uses where products based directly upon petroleum fractions are satisfactory.

AUTHORS.

1908. The rheological properties of dielectric polymers.

W. LETHERSICH, *Brit. J. Appl. Phys.*, 1950, **1**, 294.

The rheological properties of a number of dielectric materials which are used for electrical insulants and constructional materials have been studied. These included ebonite, polythene, perspex and polystyrene. Static long time tests had indicated that considerable creep takes place in the few seconds between loading the specimen and observing the strain. Dynamic tests have therefore been made with an apparatus designed to measure the strain a few milliseconds after applying the stress. The results obtained indicate that the rheological properties can be expressed in terms of a distribution of mechanical relaxation times. This distribution is hyperbolic for a range of times from 10^{-3} to 10^7 secs. and enables creep and dynamic measurements to be correlated.

A.G.L.

1909. Theory of the mechanical properties of hot plastics.

S. J. LORING. *Trans. Amer. Soc. Mech. Engrs.*, 1950, **72**, 447.

A theory of the mechanical behaviour of materials, such as hot plastics, which exhibit large strain elasticity and stress relaxation, is developed. The theory is applied to obtain general solutions for steady state flow in channels and in tubes. Comparison with experiment shows encouraging agreement with the theory.

SCI. ABSTR.

1910. The mechanism of softness in paper.

L. M. LYNE. *Paper Maker*, 1950, **120** (4), 260.

The four main physical properties contributing to the softness of paper or any other material are stated to be: density, rigidity, compressibility or resilience, and surface smoothness. The dependence of these properties on the mechanical entanglement of the fibres and on the fibre-to-fibre bonds is discussed. The testing equipment available for the appraisal of softness is reviewed with particular reference to the Clark tester.

V.G.W.H.

1911. Some theoretical considerations of dynamic-property data on textile specimens.

W. J. LYONS. *J. Appl. Phys.*, 1950, **21**, 520.

The interpretation of results for the dynamic elastic properties of nylon monofilaments is discussed, together with a short note of similar work for cotton cord.

A.G.W.

1912. On Young's modulus and its temperature coefficient of the alloys of cobalt, iron and chromium, and a new alloy "Co-elinvar."

N. MASUMOTO AND H. SAITO. *Sci. Rep. Res. Inst. Tohoku Univ., Ser. A*, 1949, **1**, 17.

Using the direct bending method, the least value of the modulus (E) obtained was 14.9×10^5 kgm cm⁻² with an alloy of 60% Co, 32% Fe, 8% Cr, and the greatest value 24.4×10^5 kgm cm⁻² for 75% Co, 10% Fe, 15% Cr. Temperature coefficients of E , e , are negative over the greater part of this range, but as the % Co is reduced, e passes through zero and becomes positive to reach a maximum value of $+82.0 \times 10^{-5}$ for 53% Co, 37% Fe, 10% Cr. The Co-Fe-Cr alloys of small e have been called "Co-elinvar."

SCI. ABSTR.

1913. Adhesion of solids and the effect of surface films.

J. S. MCFARLANE AND D. TABOR. *Proc. Roy. Soc., A*, 1950, **202**, 224.

Earlier experiments have shown that the friction between metals is due to the shearing of junctions formed by adhesion or welding at the points of intimate contact. This suggests that when the load is removed the junctions should remain and an appreciable normal force should be needed to separate the surfaces. Experiments show that with clean hard surfaces in dry air the adhesion is negligibly small. In moist air appreciable adhesion may be observed, and it is shown that this is due to the surface tension of a thin film of adsorbed water. The surface-tension forces due to thin films of liquid trapped between solid surfaces may be very large. Under certain conditions the viscosity of the liquid may also be important. The absence of adhesion between clean hard surfaces is not due to the non-formation of metallic junctions. Experiments show that it is due to the released elastic stresses which break the junctions one by one as the load is removed. With very soft metals, such as Pb or In, where the effect of released elastic stresses is very much less important, marked adhesion is observed in air, if the surfaces are freed of grosser contaminants. This adhesion provides direct evidence for the formation of metallic junctions by a process of cold welding or pressure welding at the points of contact. If the surfaces are covered with oxide films of appreciable

thickness, the amount of metallic interaction is diminished with a corresponding reduction in the adhesion. Lubricant films have a similar effect, and in general those materials which are most effective in reducing the adhesion are also most effective, as boundary lubricants, in reducing the friction.

AUTHORS.

1914. Relation between friction and adhesion.

J. S. MCFARLANE AND D. TABOR. *Proc. Roy. Soc. A*, 1950, **202**, 244.

Simultaneous measurements have been made of the friction and adhesion of steel sliding on In in air. The results show that both the normal and tangential stresses play a part in the deformation of the metallic junctions formed at the interface. When the surfaces are first placed in contact, a minute tangential force is required to initiate relative motion between the slider and the In surface, since the junctions are already plastic under the applied load. As relative motion proceeds, the region of contact grows with a corresponding increase in the tangential force and the adhesive force. An upper steady state is reached where the tangential force increases more rapidly than the rate of growth of the region of contact and sliding on a macroscopic scale occurs. The detailed behaviour of the junctions during the early stages of the sliding process may be expressed quantitatively in terms of von Mises's criterion for plastic deformation under combined normal and tangential stresses, and there is good agreement between the theoretical relation and the experimental observations. The results emphasize the reality of the cold welding process which occurs at the points of intimate contact when metal surfaces are placed together. The metallic junctions so formed are responsible both for the friction and the adhesion observed. Lubricant films diminish the amount of metallic contact and so lead to a reduction in the friction and adhesion.

AUTHORS.

1915. The ultrasonic degradation of polymers.

H. W. MELVILLE AND A. J. R. MURRAY. *Trans. Faraday Soc.*, 1950, **46** (11), 996.

The ultrasonic waves are produced by driving a quartz crystal with the output from a valve oscillator. To follow the degradation reaction the viscometric method is employed as a preliminary to osmotic measurements.

R.S.(abr.).

1916. Polyalkylene glycol synthetic lubricants.

W. H. MILLETT. *Ind. & Eng. Chem.*, 1950, **42**, 2436.

The properties of polyalkylene glycol synthetic lubricants are briefly reviewed. Recent developments have included the formulation of a series of greases which incorporate the desirable features of the base liquids and the preparation of a new series of fluids having viscosity indexes ranging from 160 to 180. Data from laboratory bench wear tests, performance tests in hydraulic equipment, and industrial and automotive gear installations show that the polyalkylene glycol lubricants are characterized by excellent wear resistance.

AUTHOR.

1917. Nuclei of strain in the semi-infinite solid.

R. D. MINDLIN AND D. H. CHENG. *J. Appl. Phys.*, 1950, **21**, 926.

Theoretical. Stress functions are given for forty nuclei of strain in the semi-infinite elastic solid.

A.G.W.

1918. Thermoelastic stress in the semi-infinite solid.

R. D. MINDLIN AND D. H. CHENG. *J. Appl. Phys.*, 1950, **21**, 931.

Theoretical. The solution of the elasticity equations for the centre of dilation in the semi-infinite solid is introduced into Goodier's theory of thermoelastic stress. It is shown that the problem of potential to be solved is identical with that for the solid

of indefinite extent. The results are applied to the case of an expanding (or contracting) spherical inclusion embedded in an elastic body near its surface.

AUTHORS.

1919. The hydrodynamics of drops of a suspension falling into the pure dispersion medium.

L. M. MOROZ, AND Y. I FRENKEL. *Kolloidnyi Zhurnal*, 1949, **11** (3), 179.

When a cloud of droplets of a suspension falls into the pure dispersion medium, that cloud behaves as a drop of a foreign liquid falling collectively with a velocity exceeding many times the rate of fall of a single grain of the suspension. The stability of shape is conditioned by the turbulence with which such a drop is enveloped.

P.M.

1920. Use and properties of non-fat dry milk solids in food preparation. I. Effect on viscosity and gel strength. II. Use in typical foods.

L. M. MORSE, D. S. DAVIS AND E. L. JACK. *Food Res.*, 1950, **15** (3), 200, 216.

I. Flour pastes are studied using a Stormer rotation viscometer and a Bloom penetrometer for thin and thick pastes respectively. Pastes using fresh, whole milk were also tested for comparison purposes. The addition of non-fat dry milk solids increases viscosity and gel strength. Empirical information enables the effects of addition of any specified quantity of dry milk solids to specified quantities of flour to be roughly predicted. Tap water gives higher gel strengths than distilled water. The addition of sucrose decreases the gel strength of thick pastes but increases the viscosity of thin pastes. NaCl, though increasing the viscosity of thin pastes, has little effect on gel strength. Somewhat complex effects of changes in pH are also discussed.

II. The above experiments are extended to include various sauces, soups, puddings, waffle mixes etc. to which dry milk solids are added. As well as the Stormer and Bloom instruments, a pipette and a falling ball viscometer were also used. Milk solids were successfully used to fortify all the products studied.

G.W.S.B.

1921. Structural guides for synthetic lubricant development.

C. M. MURPHY AND W. A. ZISMAN. *Ind. & Eng. Chem.*, 1950, **42**, 2415.

General structural guides for the development of synthetic lubricant fluids are presented. To attain small temperature coefficients of viscosity, flexible long-chain structures with small coefficients of expansion are required. Of the various hydrocarbons, the n-alkanes have the better viscosity indexes. The alkyl polyethers and methyl silicones have even better viscosity indexes than the n-alkanes. The perhalocarbons, because of their rigidity and high thermal expansion, have very poor viscosity indexes; this is a fundamental limitation. Branching, or other hindrance to close alignment, is the most reliable method for obtaining freezing point depressions. Boundary lubricant and rust-inhibition properties are related to the ability of the molecules either to form condensed physically adsorbed films or to react chemically with the boundary material. It is not possible to obtain the optimum bulk and surface properties in the same molecule. The properties of hydrocarbons, ethers, polyethers, thioethers, mono-, di-, tri-, and tetraesters, silicones, perhalocarbons, and amides are discussed in relation to these guides.

AUTHORS.

1922. An X-ray study of thermally induced stresses in microconstituents of aluminium-silicon alloys.

J. P. NIELSEN AND W. R. HIBBARD, JR., *J. Appl. Phys.*, 1950, **21**, 853.

The changing width of high angle Debye X-ray diffraction lines from eutectiferous aluminium-silicon alloys during thermal cycling as measured by a recording Geiger counter spectrometer is interpreted in terms of stresses resulting from the difference in thermal expansion of the microconstituents.

AUTHORS.

1923. A new ultrasonic method for determining elastic constants.

B. A. RAMACHANDRA. Letter in *Curr. Sci.*, 1950, **19**, 148.

The crystal is excited by an X cut quartz plate 2 mm. thick and the ultrasonic wave is transmitted into a liquid trough. Near a natural frequency of the plate, transmission max. in the diffraction pattern are found and the differences between max. nearly correspond to the longitudinal fundamental of the crystal; thus the velocity and hence the corresponding modulus is calculated. To excite shear waves a Y cut quartz plate is used.

SCI. ABSTR.

1924. Stress analysis for compressible viscoelastic materials.

W. T. READ, JR. *J. Appl. Phys.*, 1950, **21**, 671.

Mathematical methods of stress analysis are presented for linear, compressible, viscoelastic, or anelastic materials such as metals at high temperatures or high polymers with small strains. Fourier integral methods are used to show that static elasticity solutions can be used to determine the time dependent stresses in viscoelastic bodies with any form of boundary conditions. If stress and double refraction and their time derivatives are also linearly related, the standard photoelastic techniques can be used to determine the directions and difference in magnitude of the time dependent principal stresses, even though the principal stress axes do not coincide with the polarizing axes and both vary with time. When viscoelastic models are used in photoelastic studies, the time variation of the stress distribution in the model represents a first approximation to the dependence of the stress in the elastic prototype on Poisson's ratio.

AUTHOR.

1925. Mechanical models for the representation of visco-elastic properties.

Brit. J. Appl. Phys., 1950, **1**, 332.

Letter from Prof. M. REINER criticising Dr. Roscoe's paper on this subject (*Brit. J. Appl. Phys.*, 1950, **1**, 171) and a reply from Dr. Roscoe.

A.G.L.

1926. Notes on extrusion.

Z. RIGBI. *Brit. Plastics*, 1950, **23** (256), 100.

Some general principles and factors governing the extrusion process are discussed. The shape of nozzle for optimum working is related to the rheological properties of the material and generalized recommendations are made.

C.C.M.

1927. Plasticity of wool.

O. RIPA AND J. B. SPEAKMAN. *Nature*, 1950, **166**, 570.

The slow extension under constant stress in water of wool fibres and human hair has the characterisation of a first-order reaction. The product C of slope of line, plotting $E-E_t$ where E_t is extension at time t , against t , and sulphur content is practically constant but C was found to be different for hair than that for Lincoln wool. Determinations of C for different types of wool may be a measure of important characteristics.

E.W.J.M.

1928. Physiological and histological phenomena of the bovine estrual cycle with special reference to vaginal-cervical secretions.

D. B. ROARK AND H. A. HERMAN. *University of Missouri Agricultural Experiment Station Research Bulletin* 455, Feb., 1950.

A very small section of this paper concerns the variation of flow elasticity of bovine cervical secretions with time during oestrus. For 668 cows the average recoil in the oestroscope during the first six hours of oestrus was 17.64 mm. This fell gradually to 16.00 mm. at 19-25 hrs. after the beginning of oestrus.

F.A.G.

1929. **Velocity distribution and fluid friction in smooth concentric annuli.**
R. R. ROTHFUS, C. C. MONRAD AND V. E. SENEAL. *Ind. & Eng. Chem.*, 1950, 42, 2511.

The isothermal flow of air at room temperature through two smooth, horizontal, concentric annuli has been studied by measurement of point velocities and static pressure differentials. Data are presented for various Reynolds numbers in the viscous, transition, and lower turbulent flow ranges. Velocity distributions and pressure losses in viscous flow are in agreement with theoretical relationships. Both viscous and turbulent flow patterns are believed to exist simultaneously in the transition range. The radius of maximum velocity in fully developed turbulence appears to be predicted by viscous flow equations. Turbulent flow friction factors are affected by radius ratio and are higher than those calculated from hydraulic radius. The outer pipe common to both annuli has been operated without a core. Velocity profiles and pressure drops are in satisfactory agreement with data of other investigators. Friction factors in annuli have been correlated by the hydraulic radius concept applied to the portion of the fluid section outside the radius of maximum velocity. Turbulent flow velocity profiles in the annuli have been correlated with open pipe data through a geometrical modification of the u^+ , y^+ relationship.

AUTHORS.

1930. **Determination of residual stresses of quenching origin in solid and concentric hollow cylinders from interferometric observations.**

A. W. SAENZ. *J. Appl. Phys.*, 1950, 21, 962.

The theoretical method has been tested for glass, for which certain applications in practice may be of importance.

A.G.W.

1931. **Mechanical methods of testing lubricants.**

R. SCHNURMANN. *Trans. Instrum. and Measurements Conference, Stockholm*, 1949, p. 154.

A review dealing with the physical requirements for hydrodynamic and boundary lubrication and the testing of lubricants. Among the subjects discussed are the temporary reduction of viscosity by shear, permanent viscosity reduction by mechanical degradation, dependence of temp. coeff. of viscosity on rate of shear, the force of friction as a function of load, correlation of frictional force, temperature rise, wear and load, and the mechanism of lubricated friction under "extreme pressure" conditions. One-point *ad hoc* tests of lubricants are deprecated; there is no definite "breakdown load" for any lubricant and the term "film strength" has no physical meaning.

V.G.W.H.

1932. **Dry friction and its role in technology.**

V. S. SHCHEDROV. *Nauka i Zhizn*, 1949, (5), 22. *In Russian.*

Discussion of friction generally with historical notes. Dry friction then defined and exemplified, including cases where impossible to use lubricant, e.g. at very low temp. Zhukovski work in Russia cited, with frictionless pendulum and stretched threads illustrating so-called Zhukovski effect, explicable on assumption that friction force always inversely proportional to velocity. This effect useful in graphic depiction of energy law. Author claims that all important results in connection with study of dry friction were obtained by Soviet scientists; but, even here theory has developed very slowly in recent years, and merely leads up to the law of Amonton which claims relation between friction and pressure, i.e. coefficient of friction, independent of contact areas. Generally friction theory has not kept pace with other branches of Russian science and technology. Two early theories of friction dating from 17th century described and illustr., one mechanical and other molecular; both inadequate. Effect of surface roughness, pressure, and speed of movement discussed. Dry friction increases with smoothness of surface. Author claims to have further developed molecular theory on basis of experiments. Friction arises not only from mutual pressure of two surfaces

but also owing to discontinuity of surface fields of force. Movement of one field in other involves work and generates heat. By analogy of movement of magnetic needles according to position of magnet poles (north and south) molecules are said to act in similar manner when forming part of sliding contact surface; and this again confirms statement that the smoother the surface the greater friction. Molecular explanation of friction, though better than mechanical, leaves outstanding such questions as friction increase with roughness of surface in cases, e.g. of coarse finish or machining; and increase and then decline of coeff. of friction with increasing speed. Answers to queries on friction sought in new mechanico-molecular theory of I. V. Kragel'skii, which takes into account micro points of real contact—not whole surface—amounting to only about 0.00002 to 0.0001 of total visible surface. Molecular interaction involves mechanical deformation near surface.

I.D.I.B.

1933. The influence of stress upon the electrode potential and polarization of iron and steel in acid solutions.

M. T. SIMNAD AND U. R. EVANS. *Trans. Faraday Soc.*, 1950, **46**, 175.

Experiments are described to discover how far internal stresses (present, for example, in cold-rolled metal) affect the true electrode potential of iron and steel.

G.S.

1934. On the effective range of stress hardening.

A. SLIBAR AND F. VITOVEC. *Schweiz. Arch. angew. Wiss. Tech.*, 1950, **16**, 80 *In German*.

The hardening is assumed to be due to the interference of crystallites with one another; the latter depends on the angle (θ) between the crystallographic axes of the crystallites and their separation. The limitation of the deformation of a single crystallite by its neighbours is shown to be a function of the crystallite dimensions, and for face-centred cubic materials, using experimental results, the mean θ is calculated to be 0.57×10^{-5} radians.

SCI. ABSTR.

1935. Determination of internal stresses of the second type.

P. SKULARI. *Druhý Dracovní Sjezd Horních a Hutních Inženýrů*, 1947, May, pp. 127-144. *In Czech*.

The author, in a paper before the 1947 Convention of the Czech Mining and Metallurgical Engineers, classifies internal stresses into three different types: The first type is that inside the individual crystals, the second is that occurring between individual crystals owing to their non-uniform size, and the third is that between individual crystallites. A method is described by which the second type can be determined quantitatively by X-ray diffraction. This method is based on the relation between the width of the interference lines K_{21} , the change in the Bragg angle, and the change of the lattice constant resulting from internal stresses of the second type. For calculating these stresses the author has modified the Cagliotti-Sachs equation, which defines the relation between the change in lattice constant and the internal stress. It was found that, for low-carbon steels, the optimum annealing conditions were 460°C. for 1 hr. and cooling in air.

J.I.S.I.

1936. Equation of state for high polymers.

R. S. SPENCER AND G. D. GILMORE. *J. Appl. Phys.*, 1950, **21**, 523.

In a former paper the authors suggested the following equation of state ($P + \pi$) ($V - \omega$) = RT , where π is the internal pressure (or cohesive energy density) and ω is the volume at absolute zero. It was found that this equation was in good agreement with data on the thermal expansivity and isothermal compressibility of polystyrene. The present paper reports isothermal compression measurements on polymethyl methacrylate, polyethylene, cellulose acetate-butyrate, and ethyl cellulose at temperatures

within the fabrication range. The above equation of state is shown to apply equally as well to these thermoplastics as to polystyrene and values are given for the constants. The usefulness of this relationship is illustrated in a brief discussion of some phases of the injection moulding process.

AUTHORS.

1937. Behaviour of granulated polymers under pressure.

R. S. SPENCER, G. D. GILMORE AND R. M. WILEY. *J. Appl. Phys.*, 1950, **21**, 527.

In such fabricating processes as extrusion and injection moulding it is frequently necessary to force a granular polymer through a channel. Frictional forces between polymer and channel walls lead to a drop in pressure through the granular material. Simultaneously, the applied pressure causes a compaction of the granules. Assuming that the granular mass has certain fluid-like properties, a simple theoretical expression for pressure transmission is derived. Comparison with data on saran powders and granular polystyrenes shows good agreement between theory and experiment. The effect of lubrication is also shown. The compaction of granular polystyrene follows the same pattern as that observed in the earth's crust. The porosity decreases exponentially with increasing pressure. The "compressibility coefficient" for the porosity of granular polystyrene is comparable with that given for clays and shales.

AUTHORS.

1938. Dialkyl tetrachlorophthalates as plasticisers.

J. K. STEVENSON, L. E. CHEYNEY AND M. M. BALDWIN. *Ind. & Eng. Chem.*, 1950, **42**, 2170.

A series of dialkyl tetrachlorophthalates has been investigated for use in plasticising vinyl chloride—vinyl acetate copolymers. These esters are flame-resistant and exhibit little tendency to migrate. Their influence on properties such as tensile strength, elongation, hardness, stiffness, and "stiffness temperature" are studied.

F.H.

1939. The elastic constants of sodium tartrate and Rochelle salt.

R. V. G. SUNDARA RAO. *Proc. Indian Acad. Sci., A*, 1949, **30**, 173.

The constants were determined by the ultrasonic method. The results are discussed along with the existing data on Rochelle salt.

AUTHOR.

1940. Testing materials at high temperature.

F. G. TATNALL. *Mechanical Engineering*, 1949, **71**, 906.

An illustrated review is presented of current methods of testing materials at elevated temperatures, including short-time stress-strain tests, stress-rupture tests, creep tests, relaxation tests, and fatigue tests.

J.I.S.I.

1941. The swelling of cross-linked amorphous polymers under strain.

L. R. G. TRELOAR. *Trans. Faraday Soc.*, 1950, **46**, 783.

The equilibrium swelling of vulcanized natural rubber in benzene and heptane was investigated experimentally as a function of the state of strain. Three types of strain were examined, i.e. simple elongation, 2-dimensional extension and uni-directional compression. The swelling ratios were determined either from measurements of linear dimensions, or by weighing, precautions being taken to ensure uniformity of the strain over the measured region. Measurements of swelling ratios were reproducible to about 1%, and the swelling process was completely reversible (with respect to strain variations). Changes in swelling ratios of up to 50% were observed, the swelling increasing under tensile stress and falling under compressive stress. The results were accurately accounted for by the author's extension of the Flory-Rebner statistical theory, using two independent parameters—one of the μ -value in the Flory-Huggins equation

for the free energy of mixing, which was obtained from vapour pressure data, and the other, the degree of cross-linking which was determined from the swelling of the unstrained rubber. It is concluded that for good swelling agents this theory is applicable to a homogeneous strain of the most general type.

AUTHOR.

1942. Creep-time law for zinc crystals.

E. P. T. TYNDALL. *J. Appl. Phys.*, 1950, **21**, 939.

Letter. Under certain conditions of orientation the law $S = At^M$ has been found to hold for zinc single crystals, where S is the non-elastic strain occurring in time t .

A.G.W.

1943. Stress conditions in adhesion.

U. S. BUREAU OF STANDARDS. *Mechanical World*, Oct. 20th, 1950, 371.

This paper is a shortened version (also appearing in *Mechanical Engineering*, September 1950) of a report by G. M. Kline and F. W. Reinhart of the U.S. National Bureau of Standards in a paper contributed to the wood industries division of the American Society of Mechanical Engineers. Analysis of the factors responsible for the production of stress concentrations in rigid bond conditions includes :

1. Stress-strain characteristics of adherend.
2. Stress-strain characteristics of adhesive.
3. Dimensional changes in setting of adhesive.
4. Dimensional changes under service conditions.

D.C.B.

1944. The elastic and rheological properties of papermaking fibres.

J. A. VAN DEN AKKER. *Paper Maker*, 1950, **120** (4), 263.

A general discussion of the problems to be met with in developing an analytical approach to the subject, with particular reference to fibre-to-fibre bonds, the bonded area, stress and strain in the fibres, shear stress in the fibre-to-fibre bonds and the flexural rigidity of the fibres.

V.G.W.H.

1945. Chemicals used in red-lime muds.

O. W. VAN DYKE AND L. M. HERMES, JR. *Ind. & Eng. Chem.*, 1950, **42**, 1901.

The effect of additions to quebracho, sodium hydroxide and lime on the viscosity of clay suspensions has been studied. Strong indications were found that a powerful dispersing effect results from the combination of these three additives when in certain proportion and this is thought to explain the resistance to the viscosity increase of red-lime muds during drilling.

F.H.

1946. A new method of measuring the elastic constants of solids.

K. VEDAM. *Curr. Sci.* (India) 1950, **19** (7), 205.

Comment on note by B. Ramachandra Rao : " A new ultrasonic method for determining elastic constants." When method used to determine elastic constants of some optical glasses, certain difficulties experienced. Glasses were rectangular blocks ($3 \times 3 \times 2$ cm.), thickness not varying by more than 0.003 cm. from 2 cm. Piezo-quartz used was x-cut crystal ($20 \times 20 \times 1.5$ mm.). Many spurious maxima were observed over and about true maxima, intensities of latter practically of same order as true ones, making distinction impossible. Also reproduced in energy transmitted by sample, and hence recorded also. Using H. Straubel x-cut plate to some extent eliminates spurious maxima : results obtained agree with values found by E. Hiedemann's method. If y-cut plate used, same difficulties again arise : not possible to measure constant C_{12} .

I.D.I.B.

1947. **A parallel plate viscometer for printing inks.**

A. VOET AND J. S. BRAND. *Amer. Ink Mkr.*, 1950, **28** (a), 28.

A drop of printing ink of standard volume is compressed between the platens of a parallel plate viscometer and the diameter of the drop observed as a function of time. A plot of log diameter against time is linear and the line constants are shown to be related to plastic viscosity (measured in a rotation viscometer) and the "length" of the ink. The ultimate diameter of the drop is used to estimate the yield value.

C.C.M.

1948. **The propagation of plastic deformation in solids.**

T. VON KARMAN AND P. DUWEZ. *J. Appl. Phys.*, 1950, **21**, 987.

The stress wave caused by a longitudinal impact at the end of a cylindrical bar has been analysed in the case where the impact velocity is large enough to produce plastic strain. The theory gives a method for computing the stress distribution along the bar at any instant during impact. It is shown that for a given material there is a critical impact velocity such that when subjected to a tension impact with a velocity higher than the critical, the material should break near the impacted end with negligible plastic strain. An experimental investigation was made concurrently with the theoretical study. Some of the most significant experimental results are presented in this paper.

AUTHORS.

1949. **On the negligible changes produced in the stress-strain curve by immersion of a copper single crystal in mercury.**

J. B. WACHTMAN, JR. *J. Appl. Phys.*, 1950, **21**, 943.

Letter. The Frank theory of the reflection of dislocations at the surface of a single crystal has been tested by measurement of the stress-strain curve for copper single crystals immersed in mercury. Under these conditions the reflection of the dislocations might be expected to be suppressed. No significant difference was however observed in the curve obtained.

A.G.W.

1950. **An electronic integral-transform computer and the practical solution of integral equations.**

H. WALLMAN. *J. Franklin Inst.*, 1950, **250** (1), 45.

This device solves in about 1/10 second the integral transforms $F(x)$ of $f(t)$ with kernel $K(x, t)$. Display is graphical on a cathode ray tube screen. Special cases of the general equation are the Fourier and Hilbert transforms and the convolution integral. The instrument also allows the expansion in about 1/10 second an arbitrary function in terms of Laguerre, Legendre and Tschebyscheff polynomials. Solution of a family of simultaneous linear algebraic equations. Solution of non-linear integral transforms is also possible after slight adaption of the instrument.

K.H.S.

1951. **Viscosity of liquids. at high rates of shear.**

A. F. H. WARD, S. M. NEALE AND N. F. BILTON, *Nature*, 1950, **166**, 905.

It was found with a mineral oil (S.A.E. 30 Spec) using a high speed rotational viscometer that the anomalous fall in viscosity increased with rate of shear (for values up to about $2 \times 10^5 \text{ sec}^{-1}$) but a rise in temperature produced a very marked decrease in the anomaly.

E.W.J.M.

1952. **Studies of the viscosity and sedimentation of suspensions. Part I. The viscosity of suspensions of spherical particles.**

S. G. WARD AND R. L. WHITMORE. *Brit. J. Appl. Phys.*, 1950, **1**, 286.

The absolute validity of the relationships obtained by various workers using a wide variety of materials for the viscosity of a suspension of smooth spherical particles

is criticised. The present paper describes experiments made with suspensions of methyl methacrylate polymer spheres in an aqueous solution of lead nitrate and glycerol of viscosity about 6 centipoises. These suspensions are claimed to be free from defects noted in earlier work: the suspension remains stable and unflocculated for as long as a week and the particles possess low density, small water absorption and almost perfect sphericity. A rising-sphere type of viscometer was used for the measurements and after correcting for wall effects, etc. an accuracy of $\pm 2\%$ is claimed. It is shown that the viscosity of such suspensions is a function of the size distribution of the particles, decreasing with increasing size range to a constant value. It is pointed out that when the suspensions consist of dielectric particles in a non-polar liquid, electrostatic charges of the particles may affect the measurement of viscosity. In these experiments a falling sphere viscometer was used.

A.G.L.

1953. Studies of the viscosity and sedimentation of suspensions. Part 2. The viscosity and sedimentation of suspensions of rough powders.

S. G. WARD AND R. L. WHITMORE. *Brit. J. Appl. Phys.*, 1950, 1, 325.

Continuing the work on the viscosity of suspensions of smooth spheres of methyl methacrylate polymer in aqueous solutions (Abstr. 1952) the authors have studied the behaviour of suspensions of similar powders made up of irregularly shaped particles with rough surfaces. In contrast to the results obtained for suspensions of spheres, the relative viscosity of suspensions of rough irregularly shaped particles at a given concentration depends upon the sizes of the particle, increasing with decreasing average particle size. This increase is attributed to the increase in effective volume of the particles due to suspending liquid being held in the surface irregularities. There is no evidence of adsorption of the liquid on the surfaces and the layers can be so thick that any theory of chemical binding of the liquid to the surfaces is ruled out. The thickness of the layer depends on the degree of surface roughness but not on the viscosity of the liquid, and for a given material, the thickness of the layer is substantially constant above a certain particle size, below which it decreases continuously although the ratio of thickness of surface layer to particle size increases continuously with decreasing size. Size distribution of the particles has little effect on the viscosity of the suspension.

A.G.L.

1954. The effect of cold-work distortion on X-ray patterns.

B. E. WARREN AND B. L. AVERBACH. *J. Appl. Phys.*, 1950, 21, 595.

With modern experimental technique, it is possible to measure a peak shape with sufficient accuracy to justify an interpretation based on the precise shape of the reflection. By measuring several orders of a given plane it is theoretically possible to obtain a distribution function of the strains.

A.G.W.

1955. Effective stress and effective strain in relation to stress theories of plasticity.

G. N. WHITE, JR. AND D. C. DRUCKER. *J. Appl. Phys.*, 1950, 21, 1013.

Theoretical.

A.G.W.

1956. X-ray diffraction by elastically deformed crystals.

J. E. WHITE. *J. Appl. Phys.*, 1950, 21, 855.

Experimental and theoretical results are given concerning the relation between integrated intensity of X-ray diffraction and strain for the case of static bending. In addition a qualitative study has been made on similar lines for vibrating crystal line plates.

A.G.W.

1957. **Autopneumatic apparatus for measuring stress relaxation.**

C. S. WILKINSON, JR. AND S. D. GEHMAN. *Anal. Chem.*, 1950, **22**, 1439.

An apparatus for measuring stress relaxation in rubber under compression is described. Expansion of a Sylphon bellows by air pressure compresses small cylindrical test pieces. As stress in the samples decreases owing to relaxation, air is automatically released through an ordinary tyre valve, thus maintaining the force at a magnitude just sufficient to keep the sample at a constant compressive strain. The force, which is a function of the air pressure within the bellows, is calculated from readings indicated by an accurate Bourdon-type gauge directly connected to the bellows. The amount of compression is indicated by a dial micrometer connected to one end of the bellows. The apparatus is compact, simple, and completely self-contained. Reliability of results is improved by use of test pieces of low shape factor, recesses in platens for ends of samples, and cyclic preloading of samples before starting the test. Accuracy of the instrument was checked by comparing results with those obtained using a resistance wire strain gauge. Experiments upon GR-S and Hevea compounds showed that the rate of stress relaxation was not appreciably affected by the degree of compression over a fairly wide range. Over the range from -20° to 212°F . somewhat greater rates of stress relaxation were observed for extreme high and low than for intermediate temperatures. The effect of temperature upon initial stress was also observed. Tests were made upon compounds of several types of GR-S and Hevea to determine the effect of cure upon the rate of stress relaxation. In all instances longer cures gave lower rates of relaxation. Examples illustrate the usefulness of the apparatus in comparing particular gasket-type compounds. Extensive tests were made to study possible correlation between stress relaxation results and compression set results. For some compounds, such a correlation may exist.

AUTHORS.

1958. **An improved instrument for the evaluation of the physical properties of high polymer composition.**

J. WILLIAMSON. *Brit. Plastics*, 1950, **23** (256), 87.

An instrument is described for measuring the modulus of rigidity by torsion of a flat strip of material whose thickness might be as low as 0.01 inch. It was designed to study the temperature dependence of the modulus of rigidity of high polymers and several curves are shown.

C.C.M.

1959. **The fluidity of different steels.**

J. E. WORTHINGTON. *British Iron & Steel Research Association*, Conference on Foundry Steel Melting, Sept. 22-23, 1949, pp. 59-66.

The fluidity of steels is discussed and curves are presented to show the effects of increasing amounts of carbon, chromium, nickel, molybdenum, aluminium, and titanium on the fluidity at different temperatures. Chromium increases the fluidity of steel at all temperatures below about 1560°C . Steels containing 1% and 3% have approximately the same fluidities in the 1450 - 1600°C . range. Molybdenum, as well as aluminium and titanium, decrease the fluidity.

J.I.S.I.

1960. **Viscosity of metallic liquids.**

T. P. YAO AND V. KONDIC. *Nature*, 1950, **166**, 483.

Deviations from the expression $\eta = A \exp B/RT$ were found for pure tin, lead and some binary alloys, marked changes in viscosity occurring a few degrees above the m.p. A correlation of viscosity and constitution of tin/zinc mixtures was observed.

E.W.J.M.