

BRITISH RHEOLOGISTS' CLUB

BULLETIN No. 18



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FARNBOROUGH,
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LONDON, S.W.6.

Bulletin No. 18.

March, 1948.

Price to non-members, 5/-

CLUB NOTES.

International Rheological Congress, Holland, 1948.

The following circular letter has been received :

Communication Nr. R C 3

DELFT (Holland), February 1948.

Julianalaan 134

(Postbox 66).

Dear Colleague,

Without doubt you will have heard about the International Rheological Congress, which will be organized at Scheveningen (The Hague) from Tuesday September 21st till Friday September 24th, 1948.

The Congress will be devoted to :

- a. Theoretical Problems.
- b. Fundamental Experimental Methods.
- c. Rheological Properties of Various Systems.
- d. Rheological Problems in Biology.
- e. Industrial Applications.

Plasticity of crystallized materials, soil mechanics and geophysical problems will be excluded, as in the course of 1948 other international congresses will pay attention to these subjects.

From the attached programme it will appear that, apart from general lectures, great attention will be paid to sectional meetings for the discussion of special subjects.

The Organizing Committee has the honour of cordially inviting you to participate and if possible to present a paper before one of the sections.

It is intended that in the sectional meetings every speaker will give only a short account of his paper or mention the most important points, so that ample time will be available for discussion. The time to be allotted to each paper, inclusive of discussion, will be at most 30 minutes.

Manuscripts in English or French must be received before May 1st, 1948. A maximum space of 2,500 words (space for formulae and diagrams included) should not be exceeded, and the organizing Committee must, as a consequence of present restrictions, reserve the right to limit the number and to cut down papers, as the Proceedings will be limited to 500 pages.

Preprints of all papers will be forwarded to participants at least a month in advance of the Congress. Discussional remarks will be included in the final edition of the Proceedings.

Owing to a generous support from the side of the Dutch industry and from some Dutch Scientific Societies, it will be possible to keep the congress fee for participants at f. 15,—(about £1 8s. or \$6.50), which will also cover the cost of the preprints. It does not, however, include the price of the excursions, nor that of the final edition of the Proceedings. The latter can be fixed only when all papers have been received; subscription to them will be possible after announcement.

The Organizing Committee will help participants in obtaining hotel accommodation at Scheveningen and moreover will attempt to find accommodation in private quarters, if so desired. Further particulars and information about price will be given on request.*

THE ORGANIZING COMMITTEE

J. M. Burgers, Chairman; R. Houwink, First Secretary (for the Rheological Committee of the Royal Netherlands Academy of Sciences, Amsterdam).

H. C. den Daas, Assistant Secretary, Treasurer.

H. Kramers (for the Netherl. Physical Society).

A. van Rossem (for the Society for Materials).

R. N. J. Saal (for the Section Oil Technics of the Royal Institution of Engineers).

A. J. Staverman (for the Netherl. Chemical Society).

PROGRAMME (provisional)

TUESDAY, SEPTEMBER 21ST, 1948:

Morning: (a) Opening by the President.

(b) General Lecture: H. S. GREEN (Edinburgh) on Recent Developments in the Theory of Viscosity.

Afternoon: (a) Communications from the Joint Committee on Rheology of the I.C.S.U.

(b) General Lecture: J. M. BURGERS (Delft) on Nomenclature.

(c) General Lecture: F. R. EIRICH (Brooklyn) on Fundamental Experimental Methods.

WEDNESDAY, SEPTEMBER 22ND:

Morning: Sectional Meetings.

Afternoon: (a) General Lecture: Ch. SADRON (Strasbourg): Viscosité des Solutions Macromoléculaires étendues.

(b) General Lecture: not yet decided, an invitation has been sent to a Russian Scientist.

THURSDAY, SEPTEMBER 23RD:

Morning: (a) Sectional Meetings.

(b) General Lecture: M. REINER (Tel Aviv) on Relations between Stress and Strain in Complicated Systems.

Afternoon: (a) General Lecture: K. WEISSENBERG (Manchester) on Abnormal Substances and Abnormal Phenomena of Flow.

(b) General Lecture: G. W. SCOTT BLAIR (Reading, England) on Psycho-Physical Aspects of Rheology.

Evening: Informal dinner and evening entertainment (with ladies).

FRIDAY, SEPTEMBER 24TH:

Morning: (a) Sectional Meetings.

(b) General Lecture: A. L. COPLEY (New York) on Rheological Problems in Biology.

Afternoon: (a) General Lecture: R. HOUWINK (Delft) on Rheology in Industry.

(b) Communications from the Joint Committee of the I.C.S.U.

* For people with simple tastes the cost is expected to be about 23/- per day for hotel and meals.—EDITOR.

SATURDAY, SEPTEMBER 25th ; MONDAY, SEPTEMBER 27th :

Excursions, if sufficient interest is shown, or further discussions in specialized groups.

During the Congress an exhibition of rheological equipment will be organized.

International Geological Congress.

DATE AND PLACE OF THE EIGHTEENTH SESSION OF THE CONGRESS

1. The Eighteenth Session of the International Geological Congress will, as announced in the Third Circular, be held in London from **August 25th to September 1st, 1948**, on the invitation of the Geological Society of London. The Headquarters and Office of the Session are in the building of the Geological Survey and Museum, Exhibition Road, South Kensington, London, S.W.7.

The principal meetings of the General Assembly of the Congress will be held in the Royal Albert Hall. The Council, Sections and Commissions of the Congress will meet in the Lecture Theatres of the Royal Geographical Society and of the Imperial College of Science and Technology. All these buildings are in the vicinity of the Headquarters of the Congress.

American Rheology Bulletin.

It is with regret that we learn that our "opposite number," the *American Rheology Bulletin*, is to be discontinued. British Rheologists have found much to interest them in the Bulletin and we are glad to learn that its demise is no more than a matter of organization and that the information which we used to find within its pages will now reach us through other publications.

Vacancies for Rheologists.

A FOOD MANUFACTURING COMPANY (Home Counties) invites applications for the following vacancies in its Research and Development Department : (1) Senior Chemist or Physicist with First Class degree, post-graduate research work at both University and in industry, and a good knowledge of the theory and practice of rheology. The position is definitely not administrative and calls for a really high grade experimentalist. Age not over forty. Initial salary £1,600 upwards ; (2) Research Chemist or Physicist having First Class Honours Degree, at least two years academic or industrial post-graduate research experience, and a sound knowledge of rheology. Age not over thirty. Initial salary not less than £750. Applications for both these posts should be sent in confidence, giving particulars of age, education, and post-graduate experience, to the Hon. Editor.

LONDON FIRM manufacturing specialized cereal products requires rheologist to investigate drying of gluten and similar problems. Honours Degree in Chemistry or Physics, and research experience essential. Salary will depend on qualifications and experience, but would start at not less than £700. Applications to the Hon. Editor.

National Institute for Research in Dairying.

Physicist with Honours Degree and one or two years' post-graduate experience, preferably in a biological field, required at once to investigate in collaboration with senior rheologist physical properties of bovine secretions. Salary up to £390, depending on qualifications and experience. Further particulars obtainable from the Secretary, N.I.R.D., Shinfield, Berks.

Correspondence.

To Dr. E. W. J. Mardles, Royal Aircraft Establishment, South Farnborough, Hants.

Dear Sir,

I have recently been reading "Essays in Rheology," and am taking the liberty of writing to ask whether you can give me any information on a question to which I have never been able to find a satisfactory answer. It may be that the answer is familiar to you, or you may be able to refer me to a book which gives me the answer.

Broadly the question is this: does a liquid possess a property analogous to what is sometimes referred to as "stiction" or static friction between solid bodies? In all methods (known to me) of measuring viscosity it appears to be implicit that no such property exists in a fluid, and my experiments on the subject appear to confirm this. But two experiences (one of which is well known, the other being less well known) suggest the contrary.

As regards the well known experience, I will cite one example among many. A hydraulic valve of the tapered rotary plug type has combined with it means for maintaining a film of lubricating grease between the plug and its seating. If the valve is allowed to remain undisturbed for some days or weeks, it is found that a very considerable effort is required to turn the plug, but as soon as the "seizure" has been overcome, the plug can be rotated quite easily. The usual explanation is that while standing undisturbed the plug gradually forces out the film of grease allowing the surfaces of the plug and seating to come together and cohere, thus making it difficult to turn the plug until the cohesion has been broken. But this to my mind is not convincing, as I do not think it would be possible for the weight of the plug to force out the final mono-molecular layer of the grease. A similar condition also occurs between, for example, the big ends of the connecting rods of an engine and the crankshaft, necessitating a very large effort for starting an engine which has been standing for a time.

The other experience is perhaps more interesting, and I was prompted to write this letter to you on reading the part of the above Essays (page 83) dealing with the dragging of anchors (see particularly lines 16-19, page 84). I have a small hydraulic jack which sometimes behaves as follows: suppose the jack to be supporting a load and it is required to lower the load very slowly. This is effected by giving a very small opening movement to the controlling valve. The jack ram will then descend slowly through a short distance and then it will stop. To get continued descent of the ram a slightly greater opening must then be given to the valve, and after moving a little further the ram will again stop. So far I have failed to find any satisfactory explanation of this effect, and it seems to be related to the effect noticed in connection with the dragging of anchors. The same effect is experienced in powerful compressed air or hydraulic presses, where a hydraulic device is used for controlling the rate of motion of the press. This device consists of a cylinder in which slides a piston. Both ends of the cylinder are filled with oil, and the two ends are interconnected by a passage in which is located a micrometer valve for controlling the rate of displacement of oil from one end of the cylinder to the other. With a very narrow annular orifice in the valve, flow will continue for a time and then stop, causing the piston to come to rest. It has been found, however, that if instead of a valve in which there is a very narrow gap of relatively large diameter a valve is used with a small hole and relatively big gap, the trouble usually disappears.

The facts above mentioned seem to suggest that a very thin film of oil possesses an abnormal resistance to movement and moreover in the second instances mentioned this resistance develops after motion has been initiated. But I can find no satisfactory explanation. It may be that you know the answer, and if so I would be very grateful

for any explanation you might be able to give me. I may say that my interest in the question is purely scientific, and arises incidentally out of a study of the properties of liquids which has occupied my mind a good deal in recent years.

Yours faithfully,

J. D. MORGAN.

[The Hon. Editor would be glad to receive any suggestions which members may have to offer].

Reply to letter by D. C. Drucker and W. Prager. (American) Rheology Bulletin, 18, 3-4, 1947.

We are interested to have this contribution to the discussion on nomenclature, and should like to make the following comments on the points raised.

1. *Traction and Stress.* The suggestion made is an equally valid alternative, for which there is much to be said. The important point is that one or other of these alternatives should be agreed on and consistently employed.

2. The statement in the paper that stress is not a function of the material was a mistake, and should not appear in the final publication.

3. This is true, and is a point in favour of the alternative terminology proposed under (1) above.

4. The omission was due to a printer's error.

5. We see no objection to defining components of strain in the way suggested to make them correspond to the components of a particular form of tensor. The forms given in the paper have the backing of a recognized authority, but are admittedly somewhat arbitrary.

L. R. G. TRELOAR,

for British Rheologists' Club.

New Members.

Mr. H. F. Bamford,
Messrs John Mackintosh & Sons, Ltd.,
Caley Branch, Norwich.

Monsieur Marcel Louis,
Ecole Nationale du Pétrole,
4, Place de Bir-Akheim,
Reuil (S. et O.), France.

Mr. A. J. Kent,
c/o Mrs. Manning,
11 Bromley Road,
Parsons Heath,
Colchester, Essex.

Mr. R. W. Whorlow,
44 Lower Road,
Kenley, Surrey.

Mr. A. P. Feldman,
14 Woronzow Road,
London, N.W.8.

Dr. Robert Roscoe,
Physics Department,
King's College,
Newcastle upon Tyne, 1.

Chief Interests.

Foods (chocolate and confectionery).
Viscometry.

Representing Institut du Pétrole, Paris,
France.

Thermoplastics, tackiness and extrusion.

Rubber technology.

Metals.

Viscometers and thixotrometers.

Dr. A. R. Lee,
Road Research Laboratory,
Harmondsworth, Middlesex.

Dr. A. A. Houghton,
Mars Limited,
Trading Estate, Slough, Bucks.

Dr. T. S. E. Thomas,
Messrs. Powell Duffryn Research
Laboratories, Ltd.,
140 Battersea Park Road,
London, S.W.11.

Mr. R. E. Gibson,
60 Girdwood Road,
London, S.W.18.

Madame Alma Dobry-Duclaux,
Institut de Biologie physico-chimique,
13 rue Pierre Curie,
Paris 5, France.

Dr. B. A. Toms,
c/o Messrs. Courtaulds, Ltd.,
Research Laboratory,
Maidenhead, Berkshire.

Bituminous road materials.

Bakery and confectionery materials.

Metals and ceramics.

Clays, sands, particle packing and mathematical theory.

Rheology of macromolecular solutions.

Elastico-viscous properties of solutions of linear polymers.

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.R.R.A.	British Refractories Research Association.
I.D.I.B.	Industrial Diamond Information Bureau.
Nickel Bull.	Nickel Bulletin.
P.A.T.R.A.	Printing and Allied Trades Research Association.
Sci. Abstr.	Science Abstracts.
B.S.A.	Building Science Abstracts.

832. Organic Plastifiers in the Production of New Ceramic Materials.

I. D. ABRAMSON. *Proc. Acad. Sci. U.R.S.S.*, **53**, 335, 1946.

Refractory oxides have not been widely used in the U.S.S.R., despite their valuable properties, because they do not yield readily to normal processes of shaping. The energy of wetting of minerals by liquids depends on the molecular nature of the surfaces, and the setting and spreading of the liquid is influenced by surface micro-relief. Adsorbed films alter the properties of particle surfaces and increase the property of cohesion, reducing frictional forces which act between particles of loose material. Many organic substances forming similar films have been found suitable as activators for non-plastic materials, and according to the nature of the mineral powder they may be hydrophilic, as in the case of proteins, or hydrophobic, for example, resins or high-molecular hydrocarbons of the paraffin series. The mineral material needs stabilizing by heat treatment before addition of the plasticiser. The author claims that by his method products of complex shape have been made from alumina and thoria. Special agents were used, capable of sucking away the liquid fractions formed by the plasticiser, to prevent rupture of the wall of the article when the products of decomposition of the organic substances through heat are given off; certain loose materials, chemically inert under heat treatment, proved to be satisfactory. Shrinkage of sintered corundum test-pieces cast from organic slip was 17.3%; this reduction of shrinkage in firing with organic plasticisers was due to previous structural compacting of the alumina by firing, to transform it from γ - to α -form. Uncompacted alumina with the same plasticiser yielded shrinkage values similar to those found by other research workers.

B.R.R.A.

833. The Effect of Solvent-type and Temperature on the Specific Viscosities of polystyrene solutions.

T. ALFREY, J. D. JUSTICE, and S. J. NELSON. *Trans. Faraday Soc.*, **42B**, 50, 1946.

The viscosities of polystyrene solutions in mixed solvents are measured, and interpreted in terms of the effect of interaction energies between polymer and solvent on the form of the statistically-kinked chains.

L.R.T.G. (see Abstr. 520, etc.).

834. Tensile Properties of Rolled Silver Chloride.

B. M. AXILROD and J. J. LAMB. *J. Appl. Phys.* **19**, 213, 1948.

Specimens of rolled AgCl sheet prepared from a single crystal gave tensile strengths of 2500 and 1500 lb./in.² at 25 and 93° C. respectively, with corresponding elongations of 15 and 40%. The figures obtained after annealing at 200° C. were considerably higher. Stress-strain diagrams are included in the paper.

L.R.G.T.

835. Sorption, Swelling and Elastic Constants of the Cell Wall Material in Wood.

W. W. BARKAS. *Trans. Faraday Soc.*, **42B**, 137, 1946.

Thermodynamic relations are given connecting the change in liquid content in the anisotropic swelling of a gel with the change of stresses applied to it. From these it is possible to determine the stresses indirectly, from data on sorption and swelling in the presence of restraints.

The method is applied to the derivation of the elastic constants of spruce wood allowed to swell in suitably arranged clamps.

The relation between plasticity and sorption hysteresis is discussed.

L.R.G.T. (see Abstr. 363).

836. The Melt Viscosity of Shellac and its Constituents.

S. BASU. *Indian J. Phys.*, **21**, 7, 83, 1947.

Viscosity measurements indicate that the molten shellac resins are molecularly aggregated due to the presence of a large number of active polar groups in them. The rôle of the hydroxyl and carboxyl groups in the "micelle" formation was studied by protecting the polar groups by esterification and acetylation and examining their effect on the energy of activation.

E.W.J.M.

837. The adhesion of Animal Glue to Synthetic Resin Adhesives.

BATTELLE MEMORIAL INST., *Summary Report to Book Manufacturers' Inst., Inc.*, Sept. 5, 1947.

A procedure (based on A.S.T.M. 816-44T) is described for determining the adhesion of synthetic resin adhesives used for gluing-off to lining-up glue, using a Scott tensile testing machine. Examination of the glued area after failure of the adhesive to bond indicated a non-uniform distribution of the adhesive forces at the interface. The same type of rupture pattern is found to occur when the crash and liner are stripped away from a book processed with such a combination of adhesives. A logical interpretation of these phenomena, which is supported by experimental results in tests on books, is based on the fact that as water is removed from the glue film, the forces of attraction between the glue particles increase. As a result, the glue film begins to contract, and a tension is eventually established between the glue and the glue-resin interface. As the moisture content of the glue is further reduced, and the volume occupied by the glue film correspondingly decreases, stress factors are set up and the bond begins to fail or advances along the path to failure. Such progress towards failure not only reduces the attractive force per unit area of the interface but also promotes an unusual distribution of the force applied in testing procedures. The effect of impurities in the glues of lower grades on the adhesion of the glue to a resin surface is, therefore, to reduce the force of cohesion of the glue and thereby reduce the tension in the bond at the interface. The test method described will serve as a reliable guide in selecting the proper lining-up glues to be used in combination with certain adhesives.

P.A.T.R.A.

838. High-Pressure Gear Pumps.

T. E. BEACHAM. *Proc. Inst. Mech. Engrs.*, **155**, 417, 1946.

Displacement pumps of the rotary gear type are used in aircraft for pressure feeding of oil and fuel to the engine, for operating hydraulic gun turrets, undercarriage systems, etc., particularly where the viscosity of the liquid prevents the use of centrifugal pumps, or where piston pumps are too heavy or costly. The main problems are those of the load distribution on journal bearings, internal leakage and wear. The journal loads are affected by the number of teeth and by the width/diameter ratio

of the gears. The proportion of internal leakage to the liquid displaced depends largely on the factor pressure/speed viscosity. Small amounts of wear, mostly originating from impurities in the liquid, reduce the volumetric efficiency considerably. Gear design and other criteria for optimum operation are discussed at length. P.F.

839. A Study by a Double-refraction Method of the Development of Turbulence in a Long Circular Tube.

A. M. BINNIE and J. S. FOWLER. *Proc. Roy. Soc. A*, **192**, 32, 1947.

The flow in a long glass tube of a very weak solution of benzopurpurin water was examined. Two kinds of turbulent entry were used: with one, laminar flow at a Reynolds number of $\sim 1,900$ was observed at cross-sections > 120 dia. from the entry; with the other the corresponding distance was 90 dia. The nature of the breakdown of laminar flow at a cross-section was found to depend upon the kind of entry and upon the distance of the cross-section from the inlet. The development of complete turbulence at various cross-sections was also investigated. SCI. ABSTR.

840. An Interpretation of the Sigma Phenomenon.

R. C. L. BOSWORTH. *Phil. Mag.*, **38**, 592, 1947.

A theory of anomalous viscosity (the " σ phenomenon") is developed. The viscosity of the liquid varies with the radius of the containing vessel; it is suggested that this is evidence for a slip at the walls analogous to that occurring in the low pressure molecular flow of gases, due to the transport of momentum by a carrier passing to the wall without making a collision. Suitable carriers of momentum in the case of 2-phase systems showing the σ -phenomenon may be found in the acoustical vibrations into which the Debye theory resolves the thermal molecular energy.

SCI. ABSTR. (see Abstr. 429).

841. Measuring the Wet Strength of Papers.

W. BRECHT. *Svensk Papperstidning*, Spec. Issue, June, 63, 1947; *Can. Pulp & Paper Assoc., Condensed Trans.*, **10**, 93, 1947.

The wet strength of paper should refer to its mechanical strength in a condition of wetness brought about by water. The absolute wet strength is expressed by the value found in the specific tests (breaking, load bursting resistance, etc.). The relative wet strength represents the percentual relation of the measured value to the value of the paper in air-dry condition. If not otherwise mentioned, the absolute and relative wet strengths refer to those of finished paper, which has been treated with water for the test. In order to differentiate between this common wet strength and the strength of a paper which is still wet from sheet formation, *i.e.*, not having been dried before, it is suggested that it be called the "initial wet strength." Since the values found for all these wet strengths will be dependent on the water content, the latter should be mentioned in the result. The author developed new measuring procedures, which are described in great detail in the original article, and which may be summarized as follows: for measuring the ordinary wet strength, the moisture content and the breaking load (tear test) of the air-dry paper were determined. The paper was then cut into strips of certain lengths and these were dipped for various periods into distilled water at 20°C .: (1) 1 sec., (2) 5 sec., (3) 10 sec., (4) 1 min., (5) 10 min., (6) 1 hr., (7) 5 hr., (8) 10 hr., (9) 24 hr., (10) 100 hr. After being removed from the water, the strips (6 for each test) were put on to blotting paper of always the same quality, under which a glass plate of the same size is put. The strip is covered with another piece of blotting paper and a glass plate, and the plate is loaded so that it exerts a constant pressure to the foundation (10 g./cm.^2). After 30 sec. 3 of the strips are tested in the tearing apparatus for breaking load, and on 3 strips the moisture content is determined by weighing and drying. The average of the three tests is

taken. From the values curves are drawn. The water content and strength are drawn as ordinate values linearly over the logarithmically divided abscissa defining the steeping period. The author compared four different papers with each other and gave the results in a diagram. He also used the new procedure for testing when measuring the wet strength increasing property of "Polymim P." It was found that the thickness greatly influences the results if the steeping period was brief. At a longer steeping period also thick paper becomes saturated completely and the results of thin and thick paper become equalized. If the values for the same water content are compared, the relative wet strength of a paper is quite independent of the thickness. Measuring the initial wet strength is of importance in many cases for determining the maximum speed of the paper machine. P.A.T.R.A.

842. **Properties of Liquids at High Sound Pressure.**

H. B. BRIGGS, J. B. JOHNSON, and W. P. MASON. *J. Acoust. Soc. Amer.*, **19**, 664, 1947.

Under steady-state conditions, light liquids filled with air cavitate when the negative acoustic pressure reaches the atmospheric pressure. When degassed, their natural cohesive pressure becomes effective and they will withstand a negative acoustic pressure up to a value equal to the sum of the cohesive pressure—tensile strength—and the ambient pressure. Viscous liquids have a higher cohesive pressure and a proportionality has been established between log (viscosity) and the cohesive pressure. The amount of power that a liquid can withstand increases markedly as the pulse length is shortened. An explanation of these phenomena is attempted on the basis of Eyring's theory of viscosity, plasticity and diffusion. On this theory natural holes exist in the liquid into which molecules can jump, leaving holes behind them. A jump occurs when the molecule has accumulated enough heat energy to surmount an activation potential barrier of energy value E_0 . Cavitation appears to be the result of coalescing of the natural holes in the negative pressure phase of the cycle. Since a molecule has to jump from a hole in order that this can coalesce with another hole, the cavitation pressure $\propto$ the activation energy which in turn $\propto$ viscosity. The increased power-transmitting capacity for short pulse lengths is a result of the finite time taken for the small holes to grow in size to a large enough hole to cause rupture of the liquid. SCI. ABSTR. (see Abstr. 713).

843. **Recovery and Crystallization Viewed as Processes of Dissolution and Movement of Dislocations. III. Dissolution and Movement of Dislocations during Heat Treatment.**

W. G. BURGERS. *Proc. K. Ned. Akad. Wet.*, **50**, 719, 1947.

The microscopic process corresponding to macroscopic recovery is the mutual dissolution of dislocations of opposite sign, accompanied by the displacement of groups of dislocations of the same sign to positions where they minimize the lattice stress. Further decrease of lattice stress must be by boundary movement, which is a process of grain growth (recrystallization). Boundaries between crystals having nearly the same orientation are particularly stable. The processes of grain growth in Al sheet are discussed. SCI. ABSTR.

844. **Recovery and Recrystallization Viewed as processes of Dissolution and Movement of Dislocations. Occurrence of "Stimulated" Crystals.**

W. G. BURGERS. *Proc. K. Ned. Akad. Wet.*, **50**, 858, 1947.

The observations of Sandee on stimulated crystals explain the increase with time of the rate of nucleus formation in rolled Al sheet [Anderson and Mehl, *Amer. Inst. Min. Met. Engrs. Tech Publ.*, 1805, 1945]. SCI. ABSTR. (see Abstr. 682, 683).

845. Flow of Boiling Water through Nozzles, Orifices and Pipes.

J. G. BURNELL, *Engineering*, p.572., 12th December, 1947.

A knowledge of the laws of flow of hot water at or near the b.p. (saturated water) is necessary for problems such as, for example, those relating to the passage of condensate through piping and traps draining a series of heaters connected in cascade for the regenerative heating of feed water by means of steam bled from the various stages of large steam turbines. Rateau (1902) showed how flow through a nozzle can be calculated by use of the entropy-temperature diagram. W. T. Bottomley (*Trans. N.E.C. Inst.*, **53**, 65, 1936) extended Rateau's work and formulated expressions covering the flow of saturated water in pipes. For flow through nozzles, his measured maximum discharges obtained under a very slight head, just sufficient to prevent entrained steam passing, are from four to five times as great as would be expected from ordinary thermodynamic theory and an extraordinary self-regulation was observed over the whole range of flow.

M. W. Benjamin and J. G. Miller (*Trans. A.S.M.E.*, July, 1944) reported that with flow through a sharp-edged orifice no critical-pressure condition is evident and the weight of mixture passing the orifice may be reduced approximately to 40% by passing 4% steam.

The author studied the flow of saturated water through nozzles and combinations of nozzles and pipes with pressure up to 40 lbs./sq. in.; the results are shown graphically and the method of computing the theoretical discharge is given in an appendix. The coefficient of discharge of a nozzle (0.6 for cold water) was found to vary from 1 to 4 or 5 and this variation is considered to be due to the fact that with falling pressure no vaporization occurs, neither does the temperature drop until the exit pressure falls to about two-thirds of the initial saturation pressure when sudden vaporization occurs.

H. L. Callendar (Properties of steam) interpreted his experiments on the total heat of water as showing that water always contains its own volume of vapour in solution (high energy vapour molecules are present of the same density in both liquid and vapour). Nozzles appear to be capable of dealing with a variation in flow of at least 4 or 5 to 1 with the same initial pressure without flooding and without passing any appreciable amount of initial steam; they therefore should be satisfactory substitutes for ball float traps. If there is no sensible loss of heat during flow and no lag in the flashing of the water, the energy liberated by fall of pressure in the pipes will be that due to adiabatic expansion (the reheating effect being negligible) and this work must be absorbed in overcoming pipe friction and in the increased kinetic energy of the fluid at the exit. Burnell shows from his data that the increased discharge due to static head on the nozzle and undercooling of the condensate, tend further to increase the discharge capacity of a nozzle which in turn increases the range of self-regulation of the nozzle, because any flooding of the tubes will increase the head and at the same time undercool the condensate. Supersaturation of rapidly expanding steam continues until condensation finally takes place on nuclei of paired molecules; bubbles controlling the limit of superheating in boiling water are many times larger than the nuclei. Burnell from his experiments concludes that steam and water move at different velocities in the tube.

E. W.J.M. (see Abstr. 438).

846. Stand Oil Formation, Especially with the aid of SO₂.

D. CANNegiETER. *Verfkroneik*, **19**, 126, 1946.

During stand oil formation, the viscosity of the oil increases logarithmically with time. The value of the constant in the $\log \eta$ —Time—equation is increased by SO₂.

P.G.M.

847. Drilling Fluids.

W. T. CARDWELL. *Chem. Industries*, **61**, 988, 1947.

A short general description is given of the composition of drilling fluids. Attention is directed to the incorporation of weighting agents, starch, swelling clays, and to emulsion and non-aqueous systems. F.H.

848. Determining the Elasticity and Compressibility of Blankets for Newspaper Presses.

G. CARLSSON. *Grafiska Forskningslaboratoriet Meddelande* No. 15, 43, 1947.

The compressibility and the elasticity of a number of newspaper press blankets have been determined. It was found that felt blankets have less elasticity than blankets with one or more layers of rubber. It is recommended that felt blankets be avoided unless the stereos are particularly uneven. P.A.T.R.A.

849. Aluminium Stearate Gels in Light Hydrocarbon Oils.

C. M. CAWLEY, J. H. G. CARLILE, J. G. KING, and F. E. T. KINGMAN. *J. Inst. Petrol.*, **33**, 649, 1947.

An account is given of the preparation and properties of aluminium stearate dispersed in benzene, cyclohexane, petrol, etc. The phenomenon of anomalous viscosity and its temperature coefficient are considered, a $\frac{5}{32}$ in. diameter steel ball, falling through 5 cm. of the sample and a plastometer with tube 3 in. and $\frac{1}{16}$ in. bore, being used. The presence of small amounts of water was found to decrease the apparent viscosity of the system considerably. The systems gave little indication of structural breakdown with mechanical disturbance. E.W.J.M.

850. The Viscosity of Liquids under Shock Loading.

F. CHARRON. *C.R. Acad. Sci.*, **225**, 919, 1947.

The author describes experiments using a ballistic viscometer (a capillary tube fitted with a piston operated by a pendulum) to answer the query communicated to the "Groupement des Recherches Aéronautiques" (G.R.A.) as to whether the increase in viscosity of a lubricant with pressure is instantly attained at the point of sudden application of the load. Formulae are worked out relating the rate of volume change of the oil to the load, viscosity, etc. The first results indicate differences in behaviour obtained with glycerol, the viscosity of which differs little with pressure, and with a commercial oil. With the latter the viscosity increase was not apparently attained instantly at the point of application of the load. E.W.J.M. (see Abstr. 532).

851. New Investigations on the Spread of a Liquid Jet in a Stationary Liquid.

D. CITRINI. *Energia Elett.*, **24**, 177, 1947.

Previous investigations (*Energia Elett.*, **23**, 133, 302, 1946) are briefly reviewed. Velocity measurements with Pitot tubes at various points of the jet issuing from a 34 mm. dia. horizontal tube under pressures varying between 30 and 85 cm. water show that the characteristic of velocity distribution in the transverse sections is not in accord with the theory based on efflux from a point source. Axial velocity decreases exponentially, the cross-section of the jet increases parabolically. Apparatus is described, the procedure is discussed and the results are exhibited in tables and graphs showing max. velocities, characteristics of distribution, transverse dimensions, for various pressures. The conclusions are discussed in great detail. SCI. ABSTR.

852. Laboratory Testing of Rubber Torsion Springs.

D. H. CORNELL and J. R. BEATTY. *Trans. A.S.M.E.*, 799, 1947.

The cylindrical rubber torsion spring consists of three essential members—an intermediate member of flexible rubber, securely bonded to two rigid cylindrical metal shells, forming concentric inner and outer members. If such a spring is stressed in torsional shear, many advantages are realized, such as versatility of design, no static friction, inherent stability, elimination of serious stress concentrations, and elimination of lubrication needs. Laboratory tests have been performed to establish the load-deflection modulus, creep, and fatigue properties of rubber torsion springs. Other work has been done to a limited degree to investigate the effect of temperature on all of the properties mentioned. Such a programme necessitated the development of test methods for these particular investigations. Methods have been developed to find accurately and conveniently the static and dynamic moduli of any rubber torsion spring if its physical dimensions and the fundamental data of the rubber are known.

AUTHORS' ABSTR.

853. Application of the Principles of Clay Chemistry ; Problems Encountered when Drilling in Trinidad Clays.

H. C. H. DARLEY. *J. Inst. Petrol.*, 33, 219, 1947.

In order to maintain the characteristics necessary for drilling, a high degree of dispersion of the clay particles is required. "Sticky" drilling is accompanied by low rates of penetration. Experiments with clay base starch muds and starch-brine silicate and starch-aluminium sulphate drilling fluids are discussed.

E.W.J.M. (see Abstr. 5).

854. Construction of a New Helicoidal Viscometer for the Study of Dilute Solutions.

M. R. DARMOIS. *C.R. Acad. Sci.*, 225, 678, 1947.

The author desired to use capillaries sufficiently large (0.5 to 0.7 mm. diameter) to avoid obstructions with the use of solutions of sodium alginate. By using the form of a helix with vertical axis, a long capillary could be used. The volume of liquid to be measured was taken as 10 cc. and the height of the viscometer was 15 cm.

E.W.J.M.

855. Rheology of Surface Coatings.

P. H. DEWEY. *Paper Mill News*, 70, 114, 116, 118, 124, 1947.

Various types of viscometers in common use are discussed from the viewpoint of the measurement of thixotropy characteristics, and the rotational viscometer developed by the Interchemical Research Laboratories is described and illustrated. Flow curves are given for lithographic varnishes and for the effect of increasing pigment concentrations, and a generalized curve is given for a thixotropic plastic material. The application of rheology to the study of floating or flooding (*i.e.*, the complete separation of one pigment from another at the surface of a dried film) and the effect of surface-active agents on the flow properties of pigments are discussed. P.A.T.R.A.

856. Constant-Modulus Spring Alloy.

S. DINERSTEIN. *U.S. Pat.* 2,419,825.

A corrosion-resisting spring alloy claimed to have a high elastic limit and a constant modulus of elasticity over a range of more than 110° F. (the lower limit being below 0° F.) is made from an alloy containing nickel 35, chromium 9, manganese 1.5, silicon 1, tungsten 0.3, carbon (as chromium carbide) 0.06, beryllium 0.5 per cent., with a trace of calcium, remainder iron. Solution-treatment of the alloy is at a temperature above 1700° F. (925° C.), followed by rapid cooling, and ageing is carried out at a temperature below 1340° F. (725° C.).

NICKEL BULL.

857. **Particle Swelling and the Viscosity of Suspensions.**

F. EIRICH and J. SVERAK. *Trans. Faraday Soc.*, **42B**, 57, 1946.

Suspensions of soft, flexible cellulosic fibres were prepared, and the viscosities measured in a Couette viscometer. The intrinsic viscosities were lower than for previously studied rigid fibres having the same length-diameter ratio. The experiments permit the assignment of an effective "axial ratio" for the hydrodynamic ellipsoid equivalent to the flexible fibre.

Comparisons with theoretical formulae, and the study of the effect of concentration, indicate that the curled fibres are effectively "free-draining" and give information on the extent of the disturbance of the flow pattern in the vicinity of the fibres.

L.R.G.T.

858. **The Effect of Temperature on the Thermal Conductivity and Viscosity of Liquids.**

R. EISENSCHITZ. *Proc. Phys. Soc., Lond.*, **59**, 1030, 1947.

The theory of Brownian movement is applied to the "cell model" of liquids. The Smoluchowski equation for the density distribution is solved under conditions corresponding to laminar flow and conditions corresponding to inhomogeneous temperature. The flow of momentum and the flow of energy are calculated. The result indicates that the viscosity $\propto \exp(1/T)$ and that the thermal conductivity $\propto T$.

SCI. ABSTR.

859. **The Visco-elastic Behaviour of Cordite. Part I: Plastic Flow in Compression at High Stresses.**

D. D. ELEY and D. C. PEPPER. *Trans. Faraday Soc.*, **43**, 559, 1947.

The rate of plastic flow in compression, ϕ , has been examined over the temperature range 17–70° C., and the stress range 6 to 161 kg. cm.⁻². At low stresses, *i.e.*, below a certain stress f_0 (which is a function of temperature), the dependence of ϕ upon f is of the form to be expected from Eyring's theory of flow, *viz.*, $\ln \phi = \text{const.} + b f$ where b is a constant. At higher stresses, $f > f_0$, it is found that $\phi = A(f - f_0)$ where A is a constant, independent of stress, and a function of temperature. On certain assumptions a "viscosity coefficient" in poises, may be calculated from A . This result at high stresses is not easily reconcilable with Eyring's theory. Whether the deficiency lies in the theory of flow, or the model to which the theory is applied, must be left an open question at present.

AUTHORS' ABSTR.

860. **Part II: the Plastic and Elastic Extension of Cords at Low Stresses.**

D. D. ELEY and D. C. PEPPER. *Trans. Faraday Soc.*, **43**, 568, 1947.

The total extension is expressed as the sum of three terms, representing (a) rapid elastic, (b) delayed elastic and (c) plastic components. Of these (a) is probably related to the orientation of short segments of the cellulose chains, (b) is related to the orientation of long chains, and is characterized by a retardation time which is sensitive to temperature and stress, and (c) is similarly sensitive. The experimental data on the stress and temperature dependence of the rates of deformation are interpreted on the basis of the Eyring theory. Both (b) and (c) yield activation energies of about 30 k. cal., and this figure applies also to the phenomena of rupture.

L.R.G.T.

861. **Part III: the Plastic and Elastic Torsion of Cords at Low Stresses.**

D. D. ELEY and D. C. PEPPER. *Trans. Faraday Soc.*, **43**, 583, 1947.

The phenomena encountered in torsional strain are compared with the phenomena in extension, discussed in part II.

L.R.G.T. (see Abstr. 267, 691).

862. Statistical Aspects of Fracture Problems.

B. EPSTEIN. *J. Appl. Phys.* **19**, 140, 1948.

The mathematical basis of theories relating strength of brittle materials to dimensions is discussed quite generally. The problem is equivalent to the statistical determination of the distribution of the smallest value in samples of size n drawn from a population described by a probability function $f(x)$. It is claimed that the statistical analysis accounts well for many of the experimental observations in the literature.

L.R.G.T.

863. Falling Ball Viscometer.

P. J. FRANKLIN. *Amer. Ink Maker*, **25**, 73, 1947.

A falling ball viscometer suitable for translucent and opaque liquids such as rotogravure and aniline inks has an electronic timer consisting of pulse sharpening and trigger circuits—the passage of the ball through two coils around the viscometer tube is used to trigger a radio frequency oscillator, starting and stopping a timing device.

P.A.T.R.A.

864. A New Sandpaper Abrasion Tester.

F. M. GAVAN, S. W. EBY, and C. C. SCHRADER. *A.S.T.M. Bull.*, p. 23, 1946.

The requirements of a good abrasion test are specified and some types of abrasion testers in use are briefly described. It is noted that the one fault common to all of them is that contamination of abrasive and sample occurs during the tests. A description is then given of an abrasion machine employing a continuously changing abrasive surface and in use since 1941 for testing various flooring materials, synthetic resins, painted surfaces, metals, etc. Essentially the apparatus comprises two independent units: (1) a vertical track which carries the specially prepared specimens around to meet the abrasive, (2) a carriage which rests on roller bearings and has means for keeping a strip of sandpaper in continuous motion while abrading the samples. The directions of motion of the sandpaper and samples are opposite and contact between the two is maintained by dead weights attached to the carriage by a cable-spring-pulley device. Standard comparison specimens of zinc are tested with each run; the sandpaper is shown to give always reasonably consistent results, the abrasive action being constant.

B.S.A.

865. Report on the Fracture of Metals, Part 1.

M. GENSAMER, E. SAIBEL and J. T. RANSOM, *Welding J.*, **26**, Suppl. p. 443. 1947.
M. GENSAMER, E. SAIBEL, and R. E. LOWRIE, Part II. *ibid.*, p. 472.

Part I. A survey of current knowledge of the laws and fundamental mechanism of fracture was requested by the U.S. Bureau of Ships some years ago, in order to form a basis for a programme of long-range research designed to elucidate the effects of factors operating in the fracture of ship structures, armour plate, ordnance material, etc.

The results of the survey are expressed in terms of flow- and fracture-strength concepts, and the effects, on these quantities, of combined stresses, strain and strain-anisotropy, non-uniform and cyclic stressing, temperature, strain-rate, composition and metallurgical structure, are discussed.

The survey indicates that very little work has been done on fracture-strength, due mainly to experimental difficulties. Fracture-strength appears to be much more structure-sensitive than flow-strength, and is therefore considered to be more important in controlling ductility or capacity to deform and absorb energy without fracture. On this account the writers recommend an extensive investigation of this property.

Part II. The supplementary survey of recent work in the field of fracture of metals, constituting Part II, was requested by the Office of Naval Research, to bring up to date the survey made for the Bureau of Ships in Part I. The discussion does not represent a complete review of all recent work but comprises rather a selected group of the more important and basic new results of research in this field.

The concepts of flow- and fracture-strengths are again used as a framework, to compare the effects of such variables as stress-system, testing-environment, temperature, composition and metallurgical structure, prior strain-history, non-uniform stress and strain and the combined effects of temperature and strain-rate. New developments in the theories of fracture and of plastic flow are also discussed.

The final section of the report contains a statement of new problems which, in the light of the summary data presented, are deemed to be of importance in determining the fracture-behaviour of metals. Suggestions made for future research include proposals for :

(1) Investigation of the contention that fracture-strength should be decreased in triaxial tension, as a test of the micro-crack theory of fracture.

(2) Investigation of the local ductility exhibited by iron and steel when broken at low temperatures.

(3) Study of the effect of distribution of deformation upon resistance to fracture.

NICKEL BULL.

866. **How to Determine the Desirable Rheological Properties of Coatings.**

H. GREEN. *Paper Trade J.*, **125**, 49, 1947.

The measurement of flow properties or "consistency" is discussed, together with the various types of instruments which are used. It is stressed that the measurements so obtained must be applied to each scientific problem on a trial-and-error basis to determine the relationship between instrument values and product characteristics. Definitions are given of : dilatancy, hysteresis loop, plasticity, plastic viscosity, rate of shear, pseudoplastic, thixotropy, up-and-down-curves, viscosity and yield value.

P.A.T.R.A. (see Abstr. 697, etc.).

867. **The Effect of the Adhesive on the Quality of Paperboard. I : Measurement of the Glue-line Strength of Corrugated Board.**

R. E. GREEN, R. H. SAMS, and J. H. WILLS. *Paper Trade J.*, **125**, 57, 1947.

The glue-line strength is one of the most direct measures of the quality of corrugated paperboard. Early methods of measurement of the flute bond strength of corrugated board are briefly reviewed. Revised equipment (a Thwing-Albert electro-hydraulic tensile strength tester) and a recommended procedure are described for the separation of a chosen liner by a tensile pull on steel pins inserted in alternate flutes. The method requires to be tested thoroughly before any recommendation for standardization can be suggested. The equipment is easy to use and provides automatic records or indicated readings as desired. There is very little chance for error by the operator if standard conditioning and a standardized technique are used for samples. The data it can provide need to be tested for correlation with other data and with box performance before the question of the relative importance of the tensile bond strength and the column compression or other tests can be decided. P.A.T.R.A.

868. **Stiffness Tester.**

W. GURLEY and L. E. GURLEY. *Chemical & Engineering News*, **25**, 2847, 1947.

A motor driven stiffness tester measures the stiffness or absence of it of practically any thin flexible sheet material, and its capacity is from light tissue paper or thin

cloth up to the heaviest single sheet boxboards in common use. It can also measure such product finishings as varnish, paste, lacquer, glue, wax, paraffin, water-proofing, glycerin, oil or other plasticizers. The tester has a balanced pointer which pivots in jewel bearings, and moves parallel to a sine scale mounted on the base. It is loaded below the centre with weights of 5, 25, 50 or 200 g., fastened 1, 2 or 4 in. from the pivots. The arm carrying the sample being tested is moved by a small-g geared synchronous motor which is controlled by a reversing switch on the base. P.A.T.R.A.

869. Mercury-balance Method for the Measurement of Gel Strength.

W. J. HAMER. *Paper Ind. & Paper World*, **29**, 843, 1947.

This procedure, which gives the strength or "yield value" and resistance to deformation of the material under study, essentially involves the determination of the shearing force necessary to fracture the gel as given by the weight of mercury required to pull a standard disc from the gel in which it is embedded. The method and apparatus used are described and illustrated. P.A.T.R.A. (see Abstr. 765).

870. Dust Electrostatics.

J. W. HANSEN. *Physical Review*, **72**, 741, 1947.

The Hopper and Laby apparatus has been redesigned to study the charge on dust particles in the size range of 50 to 1 micron in diameter.

Using sulphur dust in a sulphur coated tube and finely ground quartz in a quartz tube, it is claimed that a dust can become highly charged by frictional contact with a surface of the same material. Charges of both signs exist simultaneously in the same cloud and the charge per particle varies over a wide range. A relation seems to exist between the size of the particle and the charge which it carries, large charges occurring on large particles. R.S.

871. Photo-elastic Apparatus, Technique and Materials.

A. W. HENDRY. *J. Inst. Civ. Eng.*, **27**, 85, 1946-47 (Abstr. only).

The paper gives a detailed description of the apparatus and technique employed for photoelastic testing in the Engineering Department of Aberdeen University. The apparatus includes a photoelastic polariscope and a mica plate compensator; transparent synthetic resins, e.g., "Catalin," are used for making the photoelastic models. Experimentally determined data on the mechanical and optical properties of "Catalin" relevant to its use for photoelasticity, are given also. It was found that the creep in "Catalin" could be reduced and its elastic moduli increased by heating it in a metal container at 80° C. for 20-30 hr. and then cooling slowly for 6-8 hr. The creep, however, did not appreciably distort the photoelastic fringe pattern.

B.S.A. (see Abstr. 609).

872. The Structure and the Mechanism of Deformation in Cellulose Gels. Part I : General Picture of a Molecular Network.

P. H. HERMANS and D. VERMAAS. *Trans. Faraday Soc.*, **42B**, 155, 1946.

In their elastic behaviour, swollen cellulose gels present certain resemblances to and also certain differences from rubbers. A study of their double refraction as a function of elongation, interpreted on the basis of statistical theory, leads to the conclusion that the chains are relatively stiff, corresponding to random chains of only 1 or 2 freely-rotating links. L.R.G.T.

873. Part II : Application of the Theory to Short Chains.

J. J. HERMANS. *Trans. Faraday Soc.*, **42B**, 160, 1947.

An attempt is made to apply the theory of rubber elasticity to a network of chain-molecules containing only a small number of equivalent freely-rotating links, corresponding to cellulose. Although this is obviously only a first approximation, the elastic properties and swelling of cellulose gels can be fairly well accounted for in this way.

L.R.G.T. (see Abstr. 233, 463).

874. Deformation and Swelling of Polymer Networks Containing Comparatively Long Chains.

J. J. HERMANS. *Trans. Faraday Soc.*, **43**, 591, 1947.

The problem of the calculation of the elastic properties of a network of long-chain molecules is considered from the standpoint of statistical thermodynamics. The author's treatment differs from the Kuhn-Wall approach in dispensing with assumptions regarding the deformation of the individual molecular chains, and permits of direct application to relatively stiff chains (*e.g.*, cellulose).

The question of swelling is also discussed.

L.R.G.T.

875. The Falling Sand Abrasion Tester.

C. C. HIPKINS and R. J. PHAIR. *A.S.T.M. Bull.*, p. 18, 1946.

The falling sand abrasion tester consists of a straight smooth bore metal tube 36 in. long and 0.75 in. internal diameter through which, by means of a fitted funnel, nearly spherical particles of sand (20-30 mesh) are allowed to fall on to the surface of the coated specimen until the film is worn away revealing a small area of the base metal. The amount of sand required is the measure of abrasion resistance. This report describes and discusses the results of a series of tests made to standardize the apparatus and procedure and to show that uniform and reproducible results may be obtained. In the apparatus as finally designed for standard testing, the sand on reaching the bottom of the tube scatters to strike a surface on the specimen about 1 in. wide and $1\frac{1}{4}$ in. long. Five litres of sand should flow through the apparatus in 52-59 sec. The area of maximum abrasion should occur on the centre line through the longer axis of the abraded pattern and within $\frac{9}{16}$ to $\frac{11}{16}$ in. from the top edge. A worn spot $\frac{5}{8}$ in. in diameter is taken as the abrasion end point. There is no need for a control to start and stop the sand flow. The coated specimen is fixed at an angle of 45° to the vertical so that the opening of the tube is directly above the area to be abraded and about 1 in. distant.

B.S.A.

876. A Method for the Determination of Viscosity at Low Rates of Shear.

A. K. HOLLIDAY. *Trans. Faraday Soc.*, **43**, 630, 1947.

The method employed depends on the measurement of the velocity of a spherical iron particle in a magnetic field. The dependence of velocity on applied force is investigated, for a number of liquids, both Newtonian and non-Newtonian, and the results compared with equations derived theoretically.

L.R.G.T.

877. The Flow of Metals at Elevated Temperatures, I-II.

J. H. HOLLOMAN and J. D. LUBAHN. *Gen. Elect. Rev.*, **50**, 28, 44, 1947.

Derives a general equation relating stress, strain, strain rate and temperature in plastic flow of metals under simplified conditions, from which the complete creep behaviour could be determined from the results of a small number of tensile tests. Supporting experimental evidence is presented for a wide range of conditions. The equation is regarded as a mechanical equation of state, its form being independent of past history in absence of phase changes.

SCI. ABSTR. (see Abstr. 611).

878. **Some Remarks Concerning the Viscosity of Liquid Hydrogen and Deuterium in Connection with the Theory of Ewell-Eyring.**

A. VAN ITTERBEEK and O. VAN PAEMEL. *Physica, 's Grav.*, **8**, 522, 1941.

The relation between viscosity and density given in the previous abstract has no physical significance because the range of viscosities covered is not sufficient for establishing a linear relationship. Attention is drawn to a formula of Ewell and Eyring: $\eta = 1.09 \cdot 10^{-3} M^{\frac{1}{2}} T^{\frac{3}{2}} e^{E_a/RT} / (V^{\frac{2}{3}} E_v)$ based on the "hole" theory of liquids, M =molecular weight, V =molecular volume, E_a =activation energy for the formation of holes of the size of the molecule, E_v =latent heat of evaporation. Ewell and Eyring give figures for E_v/E_a which do not agree with the authors'

measurements on H_2 and D_2 . By assuming instead $E_a = \int_v^{2V} a/v^2 dv$, where a is the van der Waals constant, the authors are able to obtain fair agreement for liquid hydrogen and a number of other liquids. SCI. ABSTR.

879. **Determination of the Viscosity of Liquid Hydrogen and Deuterium.**

A. VAN ITTERBEEK and O. VAN PAEMEL. *Physica 's Grav.*, **8**, 133, 1941.

Measurements of the viscosity of liquid H (14.70° – $20.37^\circ K$), D (18.74° – $23.65^\circ K$) and O (68.70° – $90.25^\circ K$) by the oscillating disc method. It was found that the viscosity η can be related to the density ρ by the expression $1/\eta = a + b\rho$ where a and b are independent of temperature. a is approx. $\propto 1/(\text{mol. weight})$. This relation also holds for CO, N_2 , C_2H_6 , for which data are given in the literature.

SCI. ABSTR. (see Abstr. 777).

880. **The Fluidity of Steel.**

R. JACKSON, D. KNOWLES, T. H. MIDDLEHAM, and R. J. SARJANT. *J. Iron Steel Inst.*, **157**, 1, 1947.

The work described covered study of the fluidity-temperature relationships of four steels:—(1) 2 per cent. copper steel; (2) nickel-silicon steel of the 4-1 per cent. type; (3) a low-carbon steel; and (4) a 13 per cent. manganese steel. All were melted in high-frequency furnaces with acid and with basic linings.

The investigations were made with the primary object of comparing the results obtained by the spiral type of test (TAYLOR, ROMINSKI and BRIGGS, *Trans. Amer. Foundrymen's Assocn.*, **49**, 1, 1941) with earlier work by the present authors, in which the Ruff test had been employed.

The data reported lead to the conclusion that, although the type of fluidity-temperature relation is of approximately the same form in the two cases, the spiral test is the less subject to error and gives more consistent results than the Ruff test. Temperature measurements were made by both optical and quick-immersion-couple methods.

A wide discrepancy was observed between individual American data and the spiral test results obtained by the present authors on similar steels, although the order of merit of fluidity was the same in both series of tests. It is considered that these differences are due to the method of temperature-measurement used by Taylor and his co-workers, by which errors of at least $25^\circ C$. ($45^\circ F$.) might be introduced.

Attention is drawn to comparison between steels of similar composition made in furnaces having (1) acid or (2) basic linings. Whereas it is an accepted fact in foundry circles that acid steel is more fluid than basic steel, the present report indicates that while this relation may hold when temperatures are obtained by visual means, the converse applies if true temperature is considered.

It was observed that in some cases a change of fluidity in the steel was accom-

panied by changes in emissivity, but since available data do not permit satisfactory correlation between the two properties, it is not yet clear whether the particular examples given are indicative of a more general law or are merely fortuitous.

NICKEL BULL.

881. Study of Thixotropy Using a Co-axial Cylinder Viscometer.

F. KAUER and B. PERSOZ. *C.R. Acad. Sci.*, **225**, 236, 1947.

Using a 7% bentonite water suspension at 27° C., measurements were made of the initial couple required to initiate rotation in the system after standing. Several hysteresis cycles are shown on diagrams relating speed of rotation and couple in dynes per cm².
E.W.J.M. (see Abstr. 561).

882. Rheological Measurements with Some Solutions of Tar and Tar Residues.

F. KAUER and H. A. SACK. *C.R. Acad. Sci.*, **226**, 337, 1948.

Experiments using a Couette type of viscometer are described. Non-Newtonian flow was observed with the raw dehydrated tar which showed shear hardening when diluted with a non-solvent to the point of coagulation.

In solution in aniline and other aromatic liquids both the tar and tar residues behaved in a strictly Newtonian manner.
E.W.J.M.

883. Testing Refractory Materials in Torsion.

E. K. KELER. *Ogneupory*, **11**, 31, 1946.

An apparatus is described whereby the behaviour of refractories in torsion at high temperatures can be measured. Tests on firebrick, semi-silica, and magnesite are described, using three different procedures: (a) constant load, uniform rate of temperature rise; (b) constant load, temperature raised in stages; (c) varying load, temperature raised in stages. Using procedure (a), a sharp inflexion is found in the strain-temperature curve given by the semi-silica material at a temperature corresponding to the quartz inversion. This is attributed to a momentary weakening of the quartz crystals while undergoing atomic regrouping.
B.R.R.A.

884. Some Investigations on Flow of Gases at Critical Velocities Exceeding the Speed of Sound.

I. A. KIBEL. *Bull. Acad. Sci. U.R.S.S., Dep. Sci. Tech.*, 253, 1947.

The difficulties of theoretical analysis of aerodynamic problems at ultrasonic speeds are explained and different approaches based on the behaviour of non-compressible fluids and of adiabatically compressible moving gases are discussed. It is shown that at critical speeds the air flow round wings possesses discontinuities (vortices).
SCI. ABSTR.

885. End-effect in Rotational Viscometers.

C. H. LINDSLEY and E. K. FISCHER. *J. Appl. Phys.*, **18**, 988, 1947.

A comprehensive experimental examination is made of the effect of ends in the concentric cylinder viscometer. Parameters considered are (1) radius of the inner cylinder, (2) clearance between cylindrical surfaces, (3) separation between bottom surface and cup, and (4) viscosity.

The end-correction increases with radius and with clearance. For separations at the bottom greater than 1 cm., and for viscosities greater than 1 poise, the end-effect is nearly constant. The method of trapping air underneath the inner cylinder has very little effect on the end correction.
L.R.G.T.

886. Precision Determination of Stress-strain Curves in the Plastic Range.

J. R. LOW and F. GAROFALO. *Proc. Soc. Exp. Stress, Anal*, **4**, 16, 1947.

In this paper a method is described for the determination of simple tension stress-strain curves in the plastic range with high precision. The apparatus used consisted of a ring dynamometer to measure loads and a straight beam "clip-gauge" to measure strain; in both instruments SR-4 strain gauges were used indirectly to indicate load and strain values. The clip gauge had a maximum capacity of 0.7-in. extension (35% elongation in a 2-in. initial gauge length) and a sensitivity of 0.0001 in. extension. One of the two dynamometers used had a maximum capacity of 1300 pounds and a sensitivity of one pound; the other dynamometer had a maximum capacity of 2500 pounds and a sensitivity of two pounds. The analytical expression ($\sigma = K\delta^n$) relating true stress (σ) and true strain (δ) in the plastic range in simple tension is discussed. When using the method described the material constant n , for a single grade of steel, was found to be reproducible in 48 tests within ± 1.7 per cent. and the K value within ± 1.9 per cent. The material constants K and n for a number of different materials (steels and aluminium alloys) are reported, along with typical logarithmic stress-strain curves. The only material tested which failed to conform to the general law $\sigma = K\delta^n$, was austenitic stainless steel and in this case it is believed that a phase change occurring during plastic deformation accounts for the observed deviation. In the case of annealed low-carbon steels which exhibit a marked yield-point, the relation does not apply in the immediate region of discontinuous yielding but is applicable to the rest of the stress-strain curve. B.S.A.

887. Viscosity-temperature Function for Paint Vehicles.

P. G. MEERMAN. *Verfkroniek*, **17**, 7, 1944.

The application of Walther's empirical viscosity-temperature relation is experimentally verified for linseed oil and synthetic resin solutions. For nitrocellulose solutions, however, the relation $\eta = a e^{b/T}$ holds.

For bodied linseed oil the slope of the $\log \log \eta - \log T$ straight line decreases with increasing body, which is an argument against ring formation. P.G.M.

888. Wetting of Pigments by Oil Media.

P. G. MEERMAN. *Verfkroniek*, **17**, 93, 1944.

A brief consideration of wetting phenomena is given, including $D - \tau$ diagrams for zinc oxide paints (rotational viscometer measurements), showing the decrease in apparent yield-value by the addition of a small percentage of benzoic or salicylic acid, or by the use of blown linseed oil. P.G.M.

889. Flow of Paints.

P. G. MEERMAN. *Verfkroniek*, **19**, 77, 1946.

The technological properties of paints can be expressed by $\tau - D$ diagrams. For technical measurements the Gardner mobilometer is useful. P.G.M.

890. The Ribbon Viscometer of Wachholtz and Asbeck.

P. G. MEERMAN. *Verfkroniek*, **19**, 155, 1946.

With Wachholtz and Asbeck's viscometer very high shearing stresses, comparable with those produced during brushing of paints, may be obtained. With Newtonian or nearly Newtonian fluids the viscosities, calculated from ribbon viscometer measurements, agree with those obtained from rotational viscometer experiments. With materials having large yield-values, however, no satisfactory results are obtained. P.G.M.

891. Elastic Behaviour and Creep of Refractory Brick Under Tensile and Compressive Loads.

L. E. MONG. *J. Amer. Ceram. Soc.*, **30**, 69, 1947.

Specimens were cut from 9 in. bricks of nine brands of refractories, including two high alumina, four fireclay, two siliceous fireclay, and one silica, which were subjected to tensile and compressive creep tests at eleven temperatures from 25° to 950° C., inclusive. The duration of each test was approximately 240 days. Small length changes, independent of stress direction (that is, compressive or tensile), occurred at the lower temperatures. The lowest temperatures at which creep was significant were (a) high-alumina brick, 700° to 850° C.; (b) fireclay brick, 600° to 700° C.; and (c) siliceous and silica brick, 950° C. Creep results under compressive stress could not be correlated with results under tensile stress. Specimens of different brands, at 950° C., showed greatly different capacities to carry load. Repeated heatings caused growth of the silica brick of approximately 0.28%. Moduli of elasticity at room temperature were determined before and after the various heat-treatments, and resultant changes were recorded. The changes in moduli were 15% or greater for silica and siliceous bricks and 4% or less for the fireclay bricks. The moduli of elasticity at room temperature were approximately $2.7 - 4.3 \times 10^6$ for high-alumina bricks, $0.6-1.9 \times 10^6$ for fireclay bricks, $0.3-1.7 \times 10^6$ for siliceous fireclay bricks, and 0.4×10^6 for the silica brick. B.R.R.A. (see Abstr. 795).

892. Useful Apparatus for Measuring Yield Value of Enamel Slips.

G. MORREN. *Bull. Amer. Ceram. Soc.*, **26**, 180, 1947.

A description is given of the suspensometer, an apparatus to be dipped in the enamel slip in obtaining the yield value. Results obtained from the use of this apparatus are given. B.R.R.A.

893. The Fluid Solids Technique. Applications in the Petroleum Industry.

E. V. MURPHREE, E. J. GOHR, and A. F. KAULAKIS. *J. Inst. Petrol.*, **33**, 608, 1947.

A powder-gas mix can behave as a "fluid" having flow properties similar to ordinary liquids but with density subject to variation at will. A powdered solid when suspended in a gas stream flowing upwards at relatively low velocities will form, contrary to Stokes' law, a continuous dense phase which in many aspects resembles a boiling liquid and which assumes a relatively well defined level. The authors describe the engineering technique of circulating powder-gas systems without the benefit of mechanical devices such as pumps, etc., and of carrying out such functions as heat transfer and providing process reaction time requirements in reasonably sized equipment. E.W.J.M.

894. Viscosity Measurements in the Paint Industry.

W. J. NIJVELD. *Verfkroneik*, **18**, 137, 1945.

For paint factory practice a Ford or Din-cup gives sufficiently accurate results. P.G.M.

895. Photo-elastic Investigation of Internal Stresses in Silver Chloride Caused by Plastic Deformation.

J. F. NYE. *Nature*, **161**, 367, 1948.

A series of observations has been made on polycrystalline silver chloride, a material that is transparent, cubic in structure and also very ductile. Rolled sheets of thickness from 0.3 to 1 mm., heat-treated to 400° C. and cooled slowly to remove patches of birefringence, were plastically deformed. The pattern of birefringence

produced by white light between the crossed nicols of a polarizing microscope, were photographed after unloading the strip. It was observed that the average width of the grains is large compared with the thickness of the sheet and the grains are crossed by one and sometimes two sets of light and dark bands, indicating that deformation by glide or by kinking has occurred. An examination of a plastically deformed strip that was annealed in stages showed that heating near the m.p. causes a gradual reduction of the intensity of the picture but leaves the pattern unaltered. It is concluded that during annealing there occurs no large-scale migration of dislocations but only localized processes of atomic rearrangement. A striking phenomenon observed in the elastic stress range was that the grain boundaries flash out brightly when the bending moment is applied. The light passing through a grain traverses a layer of tension on one side of the strip and a layer of compression on the other.

E.W.J.M. (see Abstr. 743).

896. **Rectilinear Plastic Flow of a Bingham Solid. II : Flow between Confocal Elliptic Cylinders in Relative Motion.**

J. G. OLDROYD. *Proc. Camb. Phil. Soc.*, **43**, 521, 1947.

The methods of an earlier paper are extended to the case of confocal elliptic cylindrical boundaries. Variation of the velocity distribution with the dimensionless parameter S is computed; for $S = 0$ it is that of a Newtonian liquid. The extents of the plastic and elastic regions are obtained for several cases. Some results are shown diagrammatically.

SCI. ABSTR. (see Abstr. 718, 719).

897. **The Propagation of Shock Waves in Steel and Lead.**

D. C. PACK, W. M. EVANS, and H. J. JAMES. *Proc. Phys. Soc.*, **60**, 1, 1948.

An investigation is made of the stress system set up by an explosive detonating in contact with a metal surface. An extrapolation from data on the compressibility of steel and lead leads to the conclusion that the shock wave set up by the detonation has an initial velocity in steel which is less, and an initial velocity in lead which is greater, than the velocity of plane elastic waves. The time taken by the fastest pulse to penetrate various lengths of steel and of lead has been measured experimentally, and the results confirm that the plane elastic waves move more quickly for steel; while for lead the shock wave before damping has a velocity well in excess of that of the elastic waves.

AUTHORS' ABSTR.

898. **Acoustic Opacity of Liquids.**

M. PANCHOLY and S. PARTHASARATHY. *J. Sci. Industr. Res.*, **5**, 109, 1946.

Following a brief discussion of the classical formulae for the attenuation coeff. (α) of sound in a medium, a comprehensive review is given of the methods which have been used for its determination in the case of liquids. Possible experimental errors are considered together with the theories advanced to account for the anomalous absorption obtained in liquids. Brief mention is made of experiments now in progress for studying the change of α/r^2 with frequency (ν).

SCI. ABSTR.

899. **A Hot-wire Anemometer for Low Wind Speeds.**

R. G. PARR. *J. Sci. Instr.*, **24**, 317, 1947.

The details of construction of a hot wire anemometer suitable for wind-speeds from 0.2 to 2.0 m.p.h. are given. The method of calibrating the instrument is also described.

J.E.C.

900. **Physical Basis of a Concept about the Mechanism of Viscosity of Liquids** (Letter).

R. PARSHAD. *J. Chem. Phys.*, **16**, 152, 1948.

A theory of viscosity is proposed in which the energy of activation for viscous flow is related, not to the cohesive energy of the liquid, but to the difference of attractive and repulsive interatomic forces. L.R.G.T.

901. **Orifice Discharge Coefficients in the Viscous-flow Range.**

G. S. PETERSON. *Trans. A.S.M.E.*, p. 765, 1947.

A summary of available data, including original measurements, is given. 5 Refs. A.G.W.

902. **A Note on the Theory of Corrugated Diaphragms for Pressure-measuring Instruments.**

A. PFEIFFER. *Rev. Sci. Instrum.*, **18**, 660, 1947.

A hypothetical model for the distribution of stress in diaphragms is discussed. It is constructed of members in series, with each consisting of one flexural and one tension spring acting in parallel. This hypothetical model lends to a correlation between pressure P acting on the diaphragm, corresponding deflection of the diaphragm h , effective diameter $2r$, sheet thickness d , and "plate modulus" F , as a measure of elasticity, of the following form:

$$Fh/2Pr = \sum_{k=1}^{k=n} [c_{k1}(d/2r) + c_{k2}(d/2r)^3]^{-1}$$

where the quotients Fh/Pr and $d/2r$ each are factors without dimensions. SCI ABSTR.

903. **Sliding Friction of Ball Bearings of the Pivot Type.**

H. PORITSKY, C. W. HEWLETT, R. E. COLEMAN. *J. Appl. Mech.*, **14**, A261, 1947.

While ideal rotational surfaces of the pivot and the race of ball bearings can touch the spherical ball surfaces only at mathematical points, these surfaces actually "flatten" at the contact, due to elastic compression so that contact occurs over a finite area. It is shown that as a result of this flattening, owing to unavoidable small relative slipping over some of the contact areas, that even the most precise and flawless ball bearings possess definite friction. This source of unavoidable friction is analysed, and the frictional torque due to it is computed for an individual ball, for the whole bearing, and for both bearings holding a rotor or gimbal. I.D.I.B.

904. **Calculation of the Shear Elastic Constants of the Alkali Halides.**

W. J. PRICE. *Phys. Rev.*, **72**, 514, 1947.

The calculations of Fuchs on Cu and alkali metals have been extended to the alkali halides NaCl, KBr, KI, KCl and the results do not agree very well with theory. It is pointed out that the results are very sensitive to the type of repulsive force chosen. SCI. ABSTR.

905. **Improved Mechanical Test Methods for Better Plastics Design.**

H. M. QUACKENBOS, *Product Engng*, **18**, 113, 1947.

It is generally agreed that physical tests on moulded plastics should be suited to their design and particular applications in practice so that the products designer may more fully appreciate their characteristics and hence select the proper material for the job. To this end the author proposes modifications of the standard flexural and impact tests for moulded plastics. Impact evaluation as an area under a flexural

curve is demonstrated. The relation of notched and unnotched specimens to the finished product is discussed. It is urged that notch sensitivity should be used in conjunction with the tensile and flexural strength of plastics. B.S.A. (see Abstr. 668).

906. **Viscosities, etc., of Solutions of Dodecyl Ammonium Chloride in Various Dilutions of Aqueous Ethanol.**

A. W. RALSTON and C. W. HOERR. *J. Amer. Chem. Soc.*, **69**, 1867, 1947.

The solubility and equivalent conductance of a concentrated solution of dodecyl ammonium chloride in aqueous ethanol increase rapidly then decrease as the solvent goes from the pure water to pure ethanol, a behaviour ascribed to micelle formation. Maximum viscosity occurs at about 25 mole per cent. of ethanol and the presence of the amine salt shifts this maximum towards a lower ethanol content. E.W.J.M.

907. **Orientation of Strain Gauges in Stress Analysis.**

A. W. RANKIN. *Gen. Elect. Rev.*, **50**, 14, 1947.

Having recapitulated the theory of two-dimensional stress systems, the author applies it to deduce the number of strain gauges required to determine the principal stress in various cases. Examples are given. SCI. ABSTR.

908. **Measurement of Young's Modulus at High Temperatures.**

M. H. ROBERTS and J. NORTCLIFF. *J. Iron Steel Inst.*, **157**, 345, 1947.

In view of difficulties inherent in the use of the static methods for measurement of Young's modulus at high temperatures the authors used a vibration procedure, based on that proposed by Förster and Köster. This method consists essentially in setting up transverse vibrations in a cylindrical rod and measuring the resonant frequency. The characteristic frequency depends upon the dimensions of the rod and upon the density and the Young's modulus of the material. Optimum conditions of test, determined at room temperature, are described, and the test apparatus and the furnace-assembly for the high-temperature tests are illustrated. The steels tested were of the following types: mild and 0.3 per cent. carbon; medium chromium-silicon; 12 per cent. chromium; 30 per cent. chromium containing 2 per cent. of nickel; $2\frac{1}{4}$ per cent. nickel nickel-chromium-molybdenum; complex austenitic nickel-chromium steels and nickel-chromium-iron alloys of the heat-resisting type. Young's modulus values are tabulated for all the materials at 20°, 200°, 400° and 600° C.; for all except the carbon and nickel-chromium-molybdenum steels at 800° C., and for several of the higher-alloy types at 1000° C. The modulus of all the steels decreases by about 25 per cent. between room temperature and 600° C., the decrease being almost linear up to the latter temperature. In austenitic steels the modulus continues to decrease linearly up to 800° C., but with the ferritic steels there is a considerable increase in the rate of fall of Young's modulus above 600° C.

NICKEL BULL.

909. **Researches on the Elasticity of Gelose (agar agar) Gels.**

V. ROMANOVSKY. *C.R. Acad. Sci.*, **224**, 1760, 1947.

Experiments are described with different kinds of plungers allowed to set in the system for 24 hours. The various deformations observed are reported.

E.W.J.M. (see Abstr. 725).

910. **Progress Report on Triaxial Shear Research.**

P. C. RUTLEDGE. *U.S. Waterways Expt. Station*, Vicksburg, 1947.

This report, of 178 pages, contains an account of the results obtained in a co-

operative research on the triaxial test, carried out primarily in the soils laboratories at Harvard (Professor A. Casagrande) and M.I.T. (Professor D. W. Taylor) during the period 1940-44, under the auspices of the U.S. Corps of Engineers. A complete series of tests on several sands is described, from which valuable information on the angle of internal friction and the critical density has been derived. Six clays are also investigated, using tests in which (1) the water content is held constant during the application of the deviator stress, and (2) the specimen is allowed to consolidate fully under this stress. In some cases these latter tests were carried on for more than 100 days. The effect of rate of strain is studied in some of the tests at constant water content and it is found that the strength decreases by only 16 per cent. on reducing the rate from 1 per cent. per minute to 10^{-3} per cent. per minute. The most important conclusion is that the strength of any clay in both types of test is exclusively a function of the water content at the end of test, provided the clay is not over-consolidated. Finally very detailed consideration is given to the apparatus and many recent improvements are described. A.W.S.

911. A Study of Wet-strength Mechanism. I: the Effect of Melamine Resin on the Bonding of Paper Fibres.

D. J. SALLEY and A. F. BLOCKMANN. *Paper Trade J.*, **125**, 35, 1947.

The effect of melamine resin, used in producing wet-strength paper, on the "ultimate strength" of fibres and on the "adhesion" (or bonding) between fibres in paper has been examined by means of tensile strength tests on both zero and 1-in. spans and by a shear adhesion test. The results indicate that the effect of the resin in increasing the wet strength of paper arises primarily from an increase in adhesion between fibres, the ultimate fibre strength being increased but little. Further, the upper limit to the wet tensile strength of a sheet is fixed by the ultimate strength of the wet sheet as ordinarily measured. The resin appears roughly equally effective in increasing the adhesion between fibres whether the paper is wet or dry. This suggests that the resin forms bonds of a certain strength between fibres and this strength is not decreased by wetting. Because of the greater opportunity for bonding between fibres as fibrillation of a pulp increases, the resin becomes more effective in increasing adhesion as beating proceeds, at least up to a point. P.A.T.R.A.

912. Type and Usefulness of the various Methods for Testing Rheological Properties.

A. SCHURINGA and H. C. J. DE DECKER. *Polytechnisch Weekblad*, **38**, 45, 85, 121, 141, 1944. *C.I.M.O. Mededeling* No. 24, 1946.

A survey is given of the theories about the flow of Newtonian and non-Newtonian fluids, including those about temperature variation of viscosity. About 100 methods and instruments are described and—where necessary—criticized. A large number of illustrations and references accompanies the report. P.G.M.

913. Hardenability of Shallow Hardening Steels Determined by P.V. test = Penetration Velocity, or Penetration-vee shape.

B. F. SHEPHERD. *A.S.M. Trans.*, **38**, 354, 1947.

Describes new test specially suited for this type of steel which requires cooling rates faster than 80°F./sec. at 1300°F. for the micro structure to retain 50 per cent. martensite. Illustrations include one showing slabs being cut for P.V. wedges with two diamond wheels. Ground sides of these slabs are traversed for hardness depth data. They are cut from two specimens on magnetic chuck of Brown & Sharpe grinder, using Norton Alundum grade cutting wheels 7 in. Rockwell hardness testing machine was used, and results correlated with other hardness scales. I.D.I.B.

914. **On the Rolling of a Cylinder over a Surface covered with a Viscous Layer.**

N.A. SLEZKIN. *C.R. Acad. Sci. U.R.S.S.*, **52**, 573, 1946.

A circular cylinder of given length, radius and weight rolls on a horizontal plane covered with a material of given viscosity. A formula for the tractive force is found and an expression for the coefficient of rolling friction is obtained. SCI. ABSTR.

915. **Thermal Hardening of Cadmium Crystals.**

C. L. SMITH. *Nature, Lond.*, **160**, 466, 1947.

Appreciable raising of the critical yield stress of Cd crystals after a few hours annealing at room temp., or correspondingly less at higher temps, is reported. The amount of hardening was found to depend materially on the angle between the applied stress and the glide direction, being virtually zero for 40°–45° inclination, and rising rapidly on each side of this minimum. SCI. ABSTR.

916. **Types of Strain Measuring Devices and their Range of Utility.**

K. F. SMITH. *Product Engng*, **18**, 107, 1947.

Based on experience gained at the Battelle Memorial Institute, data here are presented for selecting the proper extensometer, strain gauge, or strainometer for the measurement of strains between 0.01 and 10 per cent. in metallic materials. The characteristics of over 20 strain measuring devices are listed in descending order of sensitivity, their special limitations and particular adaptations being discussed. Gauges illustrated include (1) a roller-type gauge for measuring large deformations on sheet specimens, load and strain readings being observed simultaneously, (2) the accurate and highly sensitive Tuckerman extensometer for averaging out bending stresses, (3) a 4-oz. Porter-Lipp extensometer having mechanical lever action and adapted for measuring elastic strains on any surface by means of suitable attachment and recording. B.S.A.

917. **Diffusion of Turbulent Pairs.**

L. N. SRETENSKIĬ. *Bull Acad. Sci. U.R.S.S. Dep. Sci. Tech. (No. 3)*, 271, 1947.

An examination is made of the propagation of turbulent motion in a viscous liquid under the action of two turbulent zones of opposite intensity and symmetrical with reference to the horizontal plane. A solution is attempted on the basis of approximation and two common postulates. From the energy equation of a viscous liquid a linear equation is developed describing the conditions of flow. The analytic solution is demonstrated by two examples dealing with movement and diffusion around a circular shaft, and the propagation of vortex movement in a damping liquid from two vortex zones possessing at the commencement a motion around an almost uniform vector vortex. The path of the zone centres is investigated, together with the kinetic energy and turbulence as a function of time and initial conditions.

SCI. ABSTR.

918. **Paper as a Visco-elastic Body. II : Importance of Stress Relaxation in Paper.**

B. STEENBERG. *Svensk Papperstidning*, **50**, 346, 1947.

The significance of the stress relaxation of visco-elastic bodies was demonstrated by comparing the strength properties of creped and uncreped paper. It can be assumed that the softness of a paper bears a definite relation to the stress relaxation relations. With the help of a simple mechanical model it is demonstrated that there are two types of stiffness, namely the stiffness of an elastic spring and that of a flow

element. Usually when determining the stiffness of papers, only the elastic stiffness is taken into account ; but it is shown that the stiffness of the viscous element is also of importance. Reversible extension is very pronounced in creped paper, but it is also found in ordinary paper if this has passed through the paper machine without unnecessary stretching. Irreversible stretching is always at a maximum in the cross direction, at the edge of the paper web. Experience has shown that paper with pronounced irreversible extension possesses greater strength than other papers of corresponding tearing strength. P.A.T.R.A. (see Abstr. 816).

919. Stress-strain Compatibility in Greatly Deformed Engineering Metals.

L. H. SWAINGER. *Phil. Mag.*, **38**, 422, 1947.

Elastic, plastic and inelastic stress-strain compatibility are discussed, and the stress-strain expressions of recent papers are generalized. Isotropic inelastic metals with constant moduli, or with moduli a function of position, are treated. It is suggested that the problem of rupture under complex stresses can be approached, now that strains of any magnitude can be analysed. SCI. ABSTR. (see Abstr. 817).

920. The Viscosity of a Mixture of Two Liquids.

H. W. TALEN. *Verfkroniek*, **17**, 72, 1944.

Hofman and Reid's supposition that in mixtures of two liquids the fluidities are additive, is not even approximately justified for mineral oils and important groups of paint media (alkyds, nitrocellulose solutions, etc.). To a good approximation the logarithms of viscosity are additive for these materials. P.G.M.

921. Knoop Hardness Independent of Load.

L. P. TARASOV and N. W. THIBAUT, A.S.M.E. *Trans.*, **38**, 331, 1947; *Ind. Diamond Rev.*, **7**, 313, 1947.

After discussing briefly the (negligible) effect of elastic recovery of the indenting diamond and its elastic flattening under load, the authors point out that there are three different approaches to Knoop hardness testing: (1) The indenting load is considered to be irrelevant. This approach has its merits as long as a single load is used throughout an investigation; (2) The load or loads are standardized, as was done long ago in Brinell testing; (3) The unrecovered hardness number is computed from measurements at different loads, preferably five, as suggested in this paper. I.D.I.B.

922. A Connexion Between the Criterion of Yield and the Strain Ratio Relationship in Plastic Solids.

G. I. TAYLOR. *Proc. Roy. Soc., A*, **191**, 441, 1947.

The assumption that the work done during a small plastic strain is a max. as the yield-stress criterion is varied is shown to give rise to a connection between the yield-stress and the strain-ratio relationship. The strain-ratio relationship is that which exists between the ratios of principal stress differences and the ratios of the corresponding strain differences. It is common to assume that this relationship is one of simple proportionality. Experiments, however, show that this assumption is not true in metals. The observed strain-ratio relationship is used in conjunction with the assumption of max. work during a given strain to calculate the criterion of yield. It is found that this is very close to, but not identical with, the Mises-Hencky criterion.

SCI. ABSTR. (see Abstr.655).

923. **Mechanism of Fracture of Glass and Similar Brittle Solids.**

N. W. TAYLOR. *J. Appl. Phys.*, **18**, 943, 1947.

A theory is proposed to account for the relation between breaking stress and time of application of the load, in which the process leading to rupture is governed by the rate of orientation of an element of the atomic network. The relation derived has been shown to be experimentally valid over a range of 10^7 in time. Applicability of the theory to certain aspects of fatigue of metals under stress-corrosion conditions, and to the fracture of organic glasses is indicated. L.R.G.T. (see Abstr. 138, 182).

924. **Creep, Long-time Tensile and Flexural Fatigue Properties of Melamine and Phenolic-Plastics Materials.**

D. TELFAIR, C. H. ADAMS, and H. W. MOHRMAN. *Trans. A.S.M.E.*, **789**, 1947.

This paper reports work done to compare the tensile creep, long-time tensile strength, and dynamic flexural fatigue-strength properties of some commercial melamine and phenolic-plastic materials. Tensile-creep data for woodflour-filled phenolic and cellulose-filled melamine indicate that these plastics exhibit similar characteristics—that is, the rate of elongation at 500 hr. is essentially the same for the two materials. Likewise, the total elongation at 1000 hr. is of the same order of magnitude for each of the materials. Similarly, asbestos-filled phenolic and asbestos-filled melamine show comparable tensile creep properties. The long-time tensile strength of the cellulose-filled melamine is superior to that of the woodflour-filled phenolic material. The melamine has a long-time tensile strength of about 67% of the short-time value, as compared with a value for the phenolic of approximately 36%. Results of the repeated flexural stress tests indicate that the woodflour-filled phenolic plastic is slightly superior to the cellulose-filled melamine, the endurance limit for the phenolic being approximately 4000 p.s.i., or 34% of the short-time static flexural strength, and for the melamine 3000 p.s.i. or 31% of the short-time static flexural strength.

AUTHORS' ABSTR.

925. **Stresses and Birefringence in Rubber Subjected to General Homogeneous Strain.**

L. R. G. TRELOAR. *Proc. Phys. Soc.*, **60**, 135, 1948.

A method is described for subjecting a rubber sheet to the most general homogeneous strain, with simultaneous measurement of the principal stresses and the birefringence. As predicted by the statistical theory, the birefringence is found to be proportional to (a) the difference of the squares of the principal extension ratios, and (b) the difference of the principal stresses.

The relation between stresses and strains does not agree accurately with the formulae derived from the statistical theory, but is in better agreement with a formula obtained by Mooney.

L.R.G.T. (see Abstr. 734, 735, etc.).

926. **The Measurement of the Viscosity of Glycerol at high Temperatures.**

V. VAND. *Research, Lond.*, **1**, 44, 1947.

Viscosity of two samples of glycerol was measured from 80–167° C. The measurements were corrected for the moisture content and an empirical formula derived which is in good agreement with the measurements.

SCI. ABSTR.

927. **Dielectrics and Rheology of Non-aqueous Dispersions.**

A. VOET. *J. Phys. & Colloid Chem.*, **51**, 1037, 1947.

The variations in the dielectric constant of a dispersion with the concentration

of the dispersed phase have been investigated for a number of dispersions in organic liquids. Very substantial changes may occur in the dielectric constant of a dispersion of conductive particles and of particles with a relatively high dielectric constant upon subjecting the dispersions to shearing stresses, thus revealing changes in the inner structure of the dispersion. The dielectric constant of a dispersion has been related to the shape of the particles of a dispersion by the introduction of a form factor. The changes in the dielectric constant of a dispersion upon application of shearing stresses have been related to particle agglomeration and orientation, both of which could be differentiated from each other. The agglomeration factor, related to the shape of the particle agglomerates, is indicative of the forces acting between the particles of the dispersion. The index of deflocculation of a dispersion, denoting the highest concentration in which a dispersed phase may exist solely as singular particles, is indicative of the deflocculating and dispersing power of a vehicle. Plastic systems were found to exhibit a time effect either in particle agglomeration or orientation, or in both, although the order of the magnitude may be too short to be detected rheologically. Thus, it was found that plastic systems, contrary to conventional opinion, are always thixotropic. The "false-body" type of thixotropy, characterized by a relatively short time factor, is caused by particle agglomeration and/or orientation. The "ferric oxide" type of thixotropy, characterized by a long time factor, results from a structure in which vehicle constituents are immobilized between particles having minima of potential energy at a distance. P.A.T.R.A.

928. **Swelling Stresses in Anisotropic Cylinders.**

F. L. WARBURTON. *Trans. Faraday Soc.*, **42B**, 151, 1946.

In a material of anisotropic structure, the absorption of liquid gives rise to internal stresses. The vapour pressure isotherms to be expected in such materials are considered theoretically and their relation to data for keratin fibres is examined.

L.R.G.T. (see Abstr. 738).

929. **Initial Oscillation on a Rotational Viscometer.**

R. N. WELTMANN. *J. Appl. Phys.*, **18**, 933, 1947.

The oscillatory system of a rotational viscometer has been investigated. The oscillation equations were checked with experimental bob deflection-time curves obtained for Newtonian liquids.

To be able to rapidly obtain correct values when taking flow curves the oscillatory system should be critically damped. Since this condition cannot be easily obtained in practice, the system should be slightly overdamped, meaning that the inertia (I) should be equal or smaller than $\pi \mu^2 / 720 KS^2$. [μ = viscosity and K and S are instrumental constants.] It is shown that due to the higher viscosity of thixotropic materials at lower rates of shear, the flow curves at these rates of shear give an indication of rather too low than too high shearing stresses.

AUTHOR'S ABSTR. (see Abstr. 457, 458, etc.).

930. **An Integral Equation Approach to Problems of Vibrating Beams.**

W. J. WHITE. *J. Franklin Inst.*, **245**, 25, 1948.

In this paper integral equations are applied for the calculation of the normal modes of vibrating beams. Both exact and approximate methods of solving these integral equation are considered. The Green's function, or kernel, of the integral equation is constructed for both uniform and non-uniform beams. Solutions for the normal modes of a uniform cantilever are given. A non-uniform, naturally-twisted turbine blade is studied in detail and the first and second normal modes are calculated by the integral-equation method. M.W.T.

931. **Mechanical Behaviour of High Damping Metals.**

C. ZENER. *J. Appl. Phys.*, **18**, 1022, 1947.

The relation between the various measures of internal friction are independent of the precise mechanism of the dissipation of energy when the internal friction is small, but not when it is large. In this paper the relation between the two measures most commonly used, logarithmic decrement and tangent of the angle with which strain lags behind stress, is deduced for all levels of internal friction in the important case in which the dissipation of energy is due to a relaxation process having a single time of relaxation. The conditions are further derived under which a specimen of such a metal will not vibrate, but returns aperiodically to its equilibrium configuration.

AUTHOR'S ABSTR. (see Abstr. 519, 669, etc.).

932. **Hot Hardness Testing.**

O. ZMESKAL. *Metal Progress*, **51**, 86, 1947.

Rockwell hardness tester of 12 in. vertical capacity was used to permit a large enough furnace for temperature uniformity over specimen and indenter for determining Rockwell hardness of high-speed steel. 1 illus., 1 table showing high temperature hardness of various alloy steels.

I.D.I.B.

BOOK REVIEW.

TEORIYA VYAZKOSTI ZHIDKOSTEĬ

(Theory of the Viscosity of Liquids)

by G. M. PANCHENKOV

Publ. Gostoptekhizdat, Moscow-Leningrad, 1947.

In a short historical survey of only 150 pages the author follows the course of development of the modern theories of liquid viscosity.

The first part of the book outlines the work of Jaeger, Brillouin, Shirokov, Bachinskij and others, concluding with separate chapters devoted to Frenkel', Andrade, Eyring and Khaikin.

The second part deals with viscosity-temperature and viscosity-pressure coefficients and the third with viscosity of liquid mixtures. The fourth part is concerned with the chemical constitution of mixtures and the book ends with a useful bibliography of over 150 references.

The author's reading of the international literature is extensive and he avoids the all too common tendency among writers of all nationalities to ignore or underestimate contributions from foreign countries.

Unfortunately the book is not well printed and there are a number of misprints, especially in the bibliography where Latin characters are used.

The book costs no more than 6/- (ten roubles) and is an excellent investment for those who do not have easy access to bigger books, such as Frenkel's, and who are prepared to tackle simple rheological Russian well sign-posted with formulae, figures, and tables.

G.W.S.B.