

THE BRITISH SOCIETY OF RHEOLOGY

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EDITORIAL.

Publication of this number has been delayed somewhat so that an account of the Conference and Annual General Meeting held in Reading at the end of September, 1950, can be included. As is evident from our new title, we are now a Society; but this does not mean that there will be any radical change from the informal methods which appeared to be so popular in the old British Rheologists' Club.

It is clear, both from discussions held at the Annual General Meeting and from correspondence received, that the problem of publishing original papers read at the Society's meetings is arousing concern. Mr. Mason's letter, reproduced in this number, contains several ideas that deserve consideration. At the moment, however, it must be remembered that the International Union has given first priority to the publication of an international abstracting journal, probably based on our existing Bulletin; and until the position here is clarified (we hope during 1951), it would be unwise to tamper too much with the present system of abstracting. The Bulletin is, in fact, being run along present lines simply as an interim measure until the new Union becomes active. Moreover, we find that many subscribers to the Bulletin like to have all available abstracts together under one cover, even though some of these are of readily accessible papers; and the omission of a substantial part of them would not meet with general approval.

Publication of letters and *short* research communications (of not more than a thousand words) of general rheological interest but too slight to go into existing journals can be made in the Bulletin now. Such communications have never been debarred from our pages, and the probable reason so few have been received in the past is that most members have not realized that the Bulletin is available for them. Authors are reminded that the circulation of the Bulletin is limited and that reprints of their articles will not be obtainable unless ordered beforehand and bought at cost price from the Society; if they do not object to these restrictions, they are quite free to submit manuscripts which will be considered for publication in the usual way. Of course, if, as a result of this notice, the number of papers received is so large as to entail a substantial addition to the size of the Bulletin, the Honorary Treasurer will have views to express on the situation; but the problem of placating him can be faced when it arises.

Publication of full-length papers with tabular matter or diagrams is another problem entirely. The Committee feels strongly that to attempt to launch a publishing organ would be unwise unless there were good prospects that the journal would be of such standing that rheologists of international reputation would be glad to contribute to it without invitation. A journal of this description is very costly to produce and certainly quite beyond the resources of our Society at present.

There is at present hardly a scientific society in the world which is not seriously perturbed at the steadily increasing cost of printing. How much these costs have risen is perhaps not generally realised. I have in my possession books originally published about 1900 at a price of 7/6d. They have gone through numerous reprints, and the price of the 1950 reprint (identical with the 1900 edition except that the present-day paper is thinner and of inferior quality) is 35/-. A little book published in 1900 in stiff cloth covers for 1/- is now reprinted in flimsy paper covers for 3/-. Moreover, these figures do not tell the whole story; for the reprints *are* reprints done from existing blocks and stereotypes; if the books had had to be reset from new material, their cost would have been much higher. The rate of rise of printing costs has been most rapid during and immediately after each of the two world wars; and increase in printing costs during the past decade has been the biggest single factor responsible for the substantial increases in subscriptions which most scientific societies have had to enforce. This does not mean that printers are rogues making enormous profits; wages have been increased, certainly, but so have the costs of paper, ink, binding materials, printing machinery, power and the like.

In addition to the question of printing costs, there is another matter of a more personal character to be considered. From correspondence I receive occasionally, it is evident that some people imagine I have a large office with a brass plate on the door, equipped with an attractive secretary and an office boy for sticking on stamps and running to the post. I am sorry to disillusion such correspondents, but in fact the *Bulletin* is produced at present after normal working hours without any sort of clerical assistance. This is possible only because there is not much correspondence involved. I can usually tell whether an abstract makes sense or not, and I do not have to send it to a referee. I can also do all the proof reading myself. Even so, a fair amount of detailed work has to be done; but it is light in comparison with what is involved in seeing a full-length paper through the press.

Experience has shown that in the publication of scientific papers, the editor must have the advice of competent referees. This means correspondence; and in the not infrequent cases where author and referee fail to agree, a score of letters may pass to and from the editor before honour is finally satisfied and the paper can go to the printer. Next the manuscript has to be edited in such a way that the printer knows the size and style of type to be used, the nature and size of the blocks, and other details. When proofs arrive, it is highly desirable that they should be checked by the author, certainly at the galley stage and sometimes at the later page proof stage. More correspondence. Then the author's corrections have to be transcribed into symbols that the printer can understand, the position of the illustrations must be checked and reprints ordered if required. In short, the work of seeing original papers through the press is far greater than can be undertaken in spare time, and the services of a competent, full-time, paid assistant are essential. To the cost of printing the proposed journal must therefore be added the cost of permanent staff, office materials and stationery. It is this vexed question of finance that makes the production of a proper journal impossible for us at present.

I hope I do not sound too gloomy. Within the next year or two circumstances may alter for the better and the question of publications can be reconsidered; but the production of a publishing journal is a matter not lightly to be undertaken and the difficulties mentioned will have to be overcome before there can be any assurance of success.

V. G. W. HARRISON.

ANNUAL CONFERENCE.

The Annual Conference and Annual General Meeting were held this year at St. Patrick's Hall, University of Reading, and fully lived up to the expectations of those who have attended previous gatherings of this nature.

These Conferences, apart altogether from their scientific and educational side, are social occasions of great value. Living together as we do for a few days in the precincts of a University, we meet many old friends, make new ones and return home with plenty to think and talk about.

Thanks largely to the efforts of Dr. Paul White, everything went smoothly and our creature comforts were attended to, even to the extent of supplying us with coffee or beer at 10 o'clock each night.

The Conference was opened by the President with an interesting address on the rheology of some internal secretions. This work, mainly concerned with secretions from cows but also—to some extent—human subjects, is already making a significant contribution to animal husbandry. Mr. Clift, the gynaecologist associated with Dr. Scott Blair in this work, testified to its usefulness in his clinical researches.

The Conference proper had as its theme the relationship of viscosity and structure, and seven interesting and in general well presented papers were given and discussed. The early papers dealt with low viscosity liquids and proceeded via polymer solutions and rubbers to metallic systems.

It was obvious that rheology is becoming increasingly mathematical and one can apparently make little progress these days without a knowledge of vector methods of analysis. For this reason some of us with limited mathematical knowledge are in danger of being left behind. An outstanding example of an excellent paper with a minimum of advanced mathematics was the paper on the structure and properties of rubber by Dr. Treloar. However, since it is hoped to publish the papers and discussions at a later date, they will not be dealt with further here.

During the Conference a visit was paid to the National Institute for Research in Dairying at Shinfield, where the work of the Chemistry and Physics Departments was the main interest. The development of tests to determine the properties of butter and cheese at present assessed by subjective methods was demonstrated and most of the apparatus used was on show. Part of a film being made by the Shell Film Unit to illustrate craftsmanship versus scientific methods was shown and was followed by an excellent tea in the N.I.R.D. canteen. Afterwards the party split up and we were allowed to roam at will through the various departments of this research establishment.

The Annual General Meeting was one of the most interesting of recent years. The usual reports were presented and once again we realised how well we are served by a hard working and well tried Committee. The pros and cons of publishing our papers in a journal of our own were discussed, and the Committee were asked to look into this and other kindred matters. Finally, there was a lively exchange of opinion on the question of a new name for our Society, and it was eventually agreed to change it to the British Society of Rheology. So good luck to the new Society, and may it function as informally and pleasantly as the old British Rheologists' Club.

D. L. SAMUEL.

TENTH ANNUAL GENERAL MEETING.

The Tenth Annual General Meeting was held at St. Patrick's Hall, University of Reading, Thursday, 28th September, 1950, the President, Dr. G. W. Scott Blair, being in the Chair. After the reading of the Minutes of the previous Annual General Meeting, which were confirmed and signed, Dr. G. W. Scott Blair spoke for a short time on the work of the newly-formed International Union of Rheology. The honorary officers then presented their reports which were duly accepted. Dr. E. W. J. Mardles reported that there had been five general meetings during the year, namely, "Emulsions" at the Institute of Physics, November, 1949; exhibition of research apparatus and colloquium at the Regent Street Polytechnic, January 1950; joint meeting with the Society of Experimental Biologists at Cambridge, April 13th and 14th; joint meeting with the Midlands Branch of the Institute of Physics on the Physics of Lubrication, June 29th to July 1st; and the summer visit to Mars Limited, Slough. The Committee had met nine times.

Dr. J. G. Oldroyd reported a favourable balance of £154 2s. 11d., and gave an analysis of the year's expenses. Dr. V. G. W. Harrison said that publication of the Bristol Conference papers under the title "Recent Developments in Rheology" had been made, and a ten shilling edition was now available. It was hoped to record the proceedings of the Reading Conference in a similar way. There was a discussion on the future of the

Bulletin, and it was agreed that it should contain short accounts of any meetings of discussion groups on new rheological problems.

Elections. Dr. G. W. Scott Blair was re-elected President, with acclamation. Hon. Secretary: Dr. E. W. J. Mardles. Hon. Treasurer: Dr. J. G. Oldroyd. Hon. Editor: Dr. V. G. W. Harrison. Mr. P. Feltham and Prof. A. W. Skempton were elected on the Committee in the place of Messrs. M. Thring and A. G. Ward, the retiring members. Dr. A. H. Nissan and Dr. Susan Neumann were re-elected on the Committee. Mr. W. A. Richardson was re-elected as the Midlands representative and Mr. A. de Waele as Hon. Auditor.

The British Society of Rheology. After some discussion it was unanimously agreed to discontinue the name "British Rheologists' Club" in favour of "The British Society of Rheology" and the new Committee was asked to form a Drafting Committee to recommend some simple rules for use by the Society, to be discussed at the following Annual General Meeting.

FUTURE EVENT.

A General Meeting and Discussion on Rheology in the Confectionery Industry will be held at the Institute of Physics, 47 Belgrave Square, S.W.1, on Friday afternoon, 2.45, 2nd February, 1951. Drs. L. E. Campbell, S. F. Freeman and A. G. Lipscomb have promised to speak.

E. W. J. MARDLES.

CORRESPONDENCE

*Holloway,
London, N.7.
6 October, 1950.*

Dear Dr. Harrison,

I was interested to read Mr. de Waele's letter in the June, 1950, issue of the *Bulletin*. Although I agree with Mr. de Waele that it is desirable that papers given to the Society should not be lost sight of, I think it most undesirable that we should undertake the publication of a journal containing original papers. The purpose of the Society is to provide a common meeting ground for workers in widely differing fields, and it would be extremely difficult to found a journal in which workers would publish their more important papers.

Yours sincerely,
ALAN G. WARD.

*Abbots Langley,
24 September, 1950.*

Dear Harrison,

I am very sorry that I shall not be able to get to the Conference at Reading, particularly in view of the interesting discussions which should take place concerning the nomenclature and policy of our organization. I have several reasons for preferring the informal Club, although I think it is quite certain that we shall soon become just another Society. My views have been formed partly from conversations with organising members of other learned Societies, who have envied our informality and freedom. I hope that when the change comes, we shall contrive as flexible a constitution as possible.

The name is, of course, a comparatively trivial issue, and I was much more interested in de Waele's suggestion in the last *Bulletin*. I think he is on the right track, although to go the whole hog and make it purely a research journal would surely court the fate of the *Journal of Rheology*. Would not a compromise be even more effective? For instance, imagine a *Bulletin* on the following lines: a definite size, fixed economically; pride of place given to papers, notes or letters of original rheological value as assessed by the Editor (and his referees if required: I envisage here fairly short, specialized papers, since large

ones of general interest will probably go to journals like the *British Journal of Applied Physics* at present); the remaining space to be taken by abstracts selected for their rheological interest *and* for their rarity. I feel the last point to be important, since, as de Waele remarks, none of us should really *need* a further abstracting service if we are doing our job properly; as we are all human, we miss the more inaccessible papers, and the Bulletin could well serve by giving preferential treatment to these. Against this it might be argued that the Bulletin already exists to perform these functions, and the fact that few letters or specialized notes appear is evidence of the lack of demand. I don't feel that this is really the case: a current colloquium on new or controversial issues would surely be very popular, and all that is needed, I think, is a good lead in the right direction. I cannot pursue this further without involving myself in it, and unfortunately my own work is too remote from the general interest at the moment to fit the bill! However, I have set out these few thoughts on the subject—rather scrappily I am afraid—in the hope that you might possibly inject them into the discussion at Reading, even if only as an Aunt Sally.

Yours sincerely,

PETER MASON.

RHEOLOGY ABSTRACTS

NOTE.—The initials following the Abstracts are those of the abstracting member except for the following abbreviations for abstracts reproduced from other Journals by permission:—

B.C.R.A.	British Ceramics Research Association.
I.D.I.B.	Industrial Diamond Information Bureau.
NICKEL BULL.	Nickel Bulletin.
P.A.T.R.A.	Printing, Packaging and Allied Trades Research Association.
SCI. ABSTR.	Science Abstracts.
B.S.A.	Building Science Abstracts.

1725. The dissociation and specific viscosity of polymethacrylic acid.

R. ARNOLD and J. TH. G. OVERBEEK. *Rec. Trav. Chim. Pays-Bas*. 1950, **69**, 192.

Solutions of polymethacrylic acid have been partially neutralized to different extents, and the pH values and viscosities of the resulting solutions determined. These measurements were carried out at several different potassium chloride concentrations, and on several polymer samples. The calculated dissociation constants of the polymer acid were substituted in the equation developed by J. Th. G. Overbeek, which expresses the change in dissociation constant of a polybasic acid as a function of the radius of the molecular coil and of the charge on the molecule. The derivation of this equation treats the polymer molecules as a sphere containing a continuous charge. The radii found are of the right order and change in the expected way with changing ionic strength and ionisation. Substitution of these radii in the Debye viscosity equation gives satisfactory agreement between observed and experimental viscosities at low degrees of ionisation. At higher degrees of dissociation it would seem that the treatment of the polymer coil as a sphere is no longer satisfactory, although a better approximation is obtained if the charge is considered to be entirely on the surface of the sphere.

AUTHORS.

1726. On the question of the B-coefficient in the Jones-Dole equation.

E. ASMUS. *Z. Naturforsch.*, 1949, **4a**, 587. *In German.*

The values of B in the Jones-Dole equation ($\eta_r = 1 + A\sqrt{c} + Bc$) connecting the relative viscosity η_r of aqueous solutions of strong electrolytes with concentration c , have been determined for a large number of electrolytes, and the ionic contributions to B have been calculated. The cationic values were obtained as a rule from the η functions of chlorides and nitrates and sometimes sulphates. The values for anions were obtained from determinations for Na and K salts. The $F_{25/100}$ values

$$[F_{25/100} = (\eta_0 l^\infty)_{25^\circ} / (\eta_0 l^\infty)_{100^\circ}, \text{ where } l = \text{dilution}]$$

were calculated and plotted against the B coefficients. There is a discontinuity in the curve at Li^+ probably due to the commencement of a second hydration sphere with this ion. The connection between B and the hydration entropy and the lyotropic number of the ions is examined. The curve of B against hydration entropy consists of two straight lines which intersect at Li^+ ; the B -lyotropic number curve is linear. The effect on B of non-electrolytic impurities in the water used in the preparation of the solution is considered. The S-shaped curve of $\psi (= A + B\sqrt{c})$ against $\sqrt{c}$ which has been found for MgSO_4 is due to the secondary influence of such impurities; if these are eliminated the curve is linear.

SCI. ABSTR.

1727. The influence of liquids on the strength and the strain of a solid rod.

C. BENEDICKS. *Tekn. Tidskr.* 1949, **79**, 97; abstr. *Appl. Mech. Rev.* 1950, **3** (3), 80
(Original in Swedish).

Effect of immersion on tensile and bending strength of solids discussed and related to cohesive forces in surface wetted body and surface tension of wetting liquid. Theoretically deduced that strength of solid will vary inversely with surface tension of liquid. Result of experiments described and seem to confirm theory. According to theory, wetting of porous solid shell reduces ultimate strength more than wetting of homogeneous solid.

I.D.I.B.

1728. On the inhomogeneity of plastic deformation in metals.

W. BOAS. *Helv. Phys. Acta*, 1950, **23** (1-2), 159.

Microscopic inhomogeneity of plastic deformation in metals and alloys due to crystal anisotropy and the presence of crystals of different structures is described. The importance of the inhomogeneity in relation to the theory of the deformation of crystal aggregates is discussed. It is shown that macroscopic inhomogeneity is produced by common methods of deformation.

AUTHOR.

1729. Derivation by statistical mechanics of the law of dependence of the compressibility of solids on temperature.

P. G. BORDONI. *Atti. Accad. Naz. Lincei (R. C. Cl. Sci. Fis. Mat. Nat.)* 1949, **6**, 597. *In Italian.*

An analysis based on the equation of state leads to an explicit expression for the compressibility. Numerical values given by this formula are compared with experimental values for several metals. The agreement is good.

SCI. ABSTR.

1730. The second viscosity coefficient in rheological systems.

R. C. L. BOSWORTH. *Austral. J. Sci. Res.*, A, 1949, **2**, 394.

Viscosity in liquids may be regarded as that property which corresponds to elasticity in solid systems, and the coeff. of viscosity is expected to show as many independent components as the modulus of elasticity. For isotropic systems two components are expected. These two components are denoted by η and ζ . The Stokes relationship between the two coeffs., viz. $\zeta = -\frac{2}{3}\eta$ is compared with the Cauchy-Poisson relation-

ship between the two moduli of elasticity of an isotropic solid, and is claimed as of no more general application. Indeed, experience in sound absorption leads to the conclusion that $\zeta \gg \eta$, and many measurements on the viscosity of plastic materials appear tacitly to assume that $\zeta = \infty$. ζ , however, has a finite value for systems which undergo a progressive change in density at constant pressure. For such systems it is shown that the coeff. of viscosity, as determined by a tensile testing method, while always less than that as determined by torsion testing methods, is greater than two-thirds of the latter value. The bulk viscosity, measured by the bulk stress required to produce a progressive density change, is shown to be related to the difference between the shear (or torsional) and the tensile (or flexural) viscosities. Measurements of all three viscosities carried out on a specimen of solid carbon dioxide give a satisfactory agreement with the theory of small deformations. The values recorded are: Coeff. of viscosity traction, 10.5×10^{10} poises; Torsional viscosity, 4.2×10^{10} poises; Bulk viscosity, 5.4×10^{10} poises (measured) or 7.0×10^{10} poises (computed). Both flexural and torsional flow curves are of the Bingham type. Corrected yield points are 6.9×10^6 baryes for tensile stress and 4.8×10^6 baryes for shear stress.

AUTHOR.

1731. Mechanism of the Weissenberg effect.

I. BRAUN, H. FREY AND M. REINER. *Research, Lond.*, 1950, 3, 243.

Experiments with 7 to 12% rubber-toluene solutions suggest that the Weissenberg effect should be attributed to liquid elasticity, rather than to non-Newtonian viscosity, in this case. The liquid is sheared between a rotating lower disc and a stationary upper disc, constrained by a torsion wire. The liquid rises in a central tube fitted to the upper disc (the Weissenberg effect) to a height which gradually falls off to zero while the torque on the disc remains unchanged. If the liquid is allowed to rest, the effect can be reproduced.

SCI. ABSTR.

1732. Study on the viscosity, rigidity and thixotropy of ceramic casting slips.

P. BREMOND AND A. JOUENNE. *Trans. 1st Int. Ceram. Congr.*, p. 232, 1948.

The concepts of viscosity, rigidity and thixotropy are briefly explained in relation to Newtonian and non-Newtonian liquids. The author then deals with the variation of the rigidity with the period of rest, the deflocculant, the density of the slip and the temperature, the variation of the rigidity and thixotropy with the pH, and the determination of the optimum casting slip, illustrating these points by graphs of typical measurements on ceramic slips.

B.C.R.A.

1733. Linear compressions to 30,000 kg./sq. cm., including relatively incompressible substances.

P. W. BRIDGMAN. *Proc. Amer. Acad. Arts Sci.* 1949, 77 (6), 189.

Measurements extended to less compressible substances than in former paper (*Proc. Amer. Acad. Arts Sci.* 1948, 76 (4), 89); now at pressure of 30,000 kg./sq. cm. Description of apparatus and method. Discussion of irregularities and hysteresis which obscure deviations from linearity characterizing ideally homogeneous material. Completely homogeneous materials not easy to find; majority of substances contain imperfections of some sort, perhaps as imperfections of the pure lattice, or chemical inhomogeneities between grains, giving rise to small-scale irregularities in response to pressure and more or less consistent small-scale hysteresis. Discussion as to whether irregularities may not be due to failure of pressure to be adequately hydrostatic in new range.

I.D.I.B.

1734. The thermodynamics of plastic deformation and generalized entropy.

P. W. BRIDGMAN. *Rev. Mod. Phys.*, 1950, 22, 56.

A method is suggested by which the concept of entropy can be generalized so as to apply to intrinsically irreversible processes, in which the final state is not attainable from

the initial state by an alternative reversible process. A plastic solid with a stress-strain hysteresis cycle is considered in detail. An expression is derived for the total irreversible entropy increase arising from an irreversible change in a solid, in the case when the degree of internal disorder may be supposed specified by a single parameter α (in addition to the pressure and temperature).

SCI. ABSTR.

1735. Heat effects in capillary flow I.

H. C. BRINKMAN. *Appl. Sci. Res.* 1950, **A2**, 120.

The temperature distribution in a capillary due to the energy dissipation of viscous flow is calculated while the heat conductivity of the fluid and the transport of heat by convection are taken into account.

AUTHOR.

1736. Anisotropy, symmetry, heterogeneity in elasticity.

A. BRODEAN. *Publ. Sci. Min. Air, France* (No. 229) 61 pp. (1949). *In French*.

This report is a continuation of *Publ. Sci. Min. Air, France* (No. 201). Instead of establishing a general mathematical theory and then making applications to particular cases, the author has preferred to establish the theory of certain particular cases. Chapter headings are: Résumé of fundamental ideas about deformable solids, notations and conventions; Elastic phenomenon near the surface separating two bodies with different mechanical properties but both homogeneous and isotropic; Isotropic non-homogeneous bodies; Fibro-stratified bodies separated by a surface parallel to a common plane of symmetry, the other planes of symmetry being also common; Non-homogeneous fibro-stratified bodies; A fibro-stratified body in contact with any anisotropic body; Fibro-stratified bodies placed symmetrically with respect to the surface; Fibro-stratified body with symmetry variable in space; Study of crystals. Some photographs of actual crystals are included but the remainder of the paper is purely mathematical.

INDEX AERONAUTICUS (*From* SCI. ABSTR.).

1737. Note on the damping of the rotational oscillation of a spherical mass of an elastic fluid in consequence of slipping along the boundary.

J. M. BURGERS. *Proc. K. Ned. Akad. Wet.*, 1949, **52** (2), 114.

Previous work is continued. More accurate formulae are found for the period of oscillation and the logarithmic decrement, for an elastic fluid in a spherical vessel. Values obtained are compared with experimental values for systems having an oleate concentration of 0.6%.

SCI. ABSTR.
(see Abstr. 1200)

1738. Stress cracking of polyethylene.

R. H. CAREY. *A.S.T.M. Bull.* 1950, No. 167.

Tension specimens containing a small hole break at stresses and elongations less than those normally reported, especially when in contact with alcohols and toluene. The properties of polyethylene resembles those of some non-ferrous metals, this comparison being inferred from its crystalline structure, stress-strain diagram and "stress corrosion cracking" phenomenon.

E.W.J.M.

1739. The theory of axisymmetric turbulence.

S. CHANDRASEKHAR. *Philos. Trans. A* 1950, (855), 557.

The present paper completes the theory of axisymmetric tensors and forms to the extent that is needed for the development of a theory of turbulence in which symmetry about a certain preferred direction is assumed to exist. Particular attention is given to the manner in which tensors, solenoidal in one or more indices, can be derived, uniquely, in a gauge-invariant way, as the curl of a suitably defined skew tensor. The explicit

representation of the fundamental velocity correlation tensor $(\overline{u_i u_j})$ in terms of two defining scalars is found; and the differential equations governing these scalars is also derived. In the theory of axisymmetric turbulence these latter equations replace the equation of von Kármán and Howarth in the theory of isotropic turbulence.

AUTHOR.

1740. The response characteristics of linear systems.

M. CINI. *J. Appl. Phys.*, 1950, **21**, 8.

For a linear system, steady-state response to sinusoidal stress cannot have a unique dynamic modulus and phase shift, but these qualities must be related to rate of creep; particularly they cannot be independent of external frequency. A proof is given that such linear system is always equivalent to a viscoelastic system. Finally the discrepancy between the relations deduced and experimental results of various authors is pointed out and discussed.

AUTHOR.

1741. The influence of strain rate on some tensile properties of steel.

D. S. CLARK AND P. E. DUWEZ. *A.S.T.M. Reprint* 17, June, 1950; 16 pp.

After a brief review of the earlier literature, it is demonstrated that the true influence of rate of strain on tensile properties cannot be adequately assessed by means of impact tests. The fundamental requirements of a test method which shall accurately determine the effect of rate of strain are considered, and a description is given of a machine and method of test which have been devised to fulfil such requirements. Using the apparatus described, tests were made at rates of strain up to about 200 in. per in. per sec., on three types of plate steel (plain carbon, low-alloy carbon-manganese, and nickel-chromium 2.5-3/1.5 per cent types). For all the materials tested, the proportional limit increased to a value corresponding to the ultimate strength at a strain rate of between 40 and 80 in. per in. per sec. The ultimate tensile strength in all cases increased with increasing rate of strain up to a rate of about 100 in. per in. per sec., and after that stage was not appreciably affected.

NICKEL BULL.

1742. Rheology of human cervical secretions. Effect of menstrual cycle and pregnancy.

A. F. CLIFT, F. A. GLOVER AND G. W. SCOTT BLAIR. *Lancet*, 1950, **258** (1), 1154.

A constant rate emptying and filling capillary tube micro-rheometer has been designed for the investigation of the flow properties of uterine cervical secretions. The method requires only 0.006 ml. of the sample and gives a measure of the overall consistency and of the deviation from Newtonian behaviour. From data referring to 120 normal subjects this latter has been correlated with the date in the menstrual cycle and the stage in pregnancy. Characteristic variations throughout the cycle and a clear distinction between pregnant and non-pregnant samples have been revealed. The results suggest a possibility of using the measurement of the rheological constants of secretions as a method of hormone assay.

F.A.G.

1743. Equivalent effects of time and temperature in the shear creep and recovery of elastomers.

F. S. CONANT, G. L. HALL AND W. J. LYONS. *J. Appl. Phys.*, 1950, **21**, 499.

An explicit relationship is set forth for the time-temperature dependence of the viscoelastic phenomena in the superelastic polymers. An empirical equation that was found to represent adequately the above-mentioned relationship over the entire multiple-temperature curve is of the form: $\log t_c = [C_a/(T-b)] + C_\beta$. Experimental verification is given for the equivalent influence of time and temperature on the creep and recovery of compounds based on Hevea, GR-S, Neoprene GN, Butaprene, and butyl rubber. A comparison of the empirical equation with that of a theoretical reaction-rate equation of Tobolsky and Eyring indicates a temperature-dependence of the energy of activation.

AUTHORS.

1744. Objective methods of evaluating the physical properties of cheese.

R. DAVIDOV AND N. BARABANSHCHIKOV. *Mol. Prom.* 1950, **11**, 27.

The authors make unacknowledged use of the Hoppler Consistometer (*Kollzeitschr.* 1941, **97**, 61), to measure the overall consistency, elasticity and "viscosity" (i.e., non-recoverable deformations) of cheese mainly of Dutch type. (In the H. Consistometer, a ball is forced through the body of the material to be tested, or the sample is compressed by a piston in a perforated cylinder, the relationships between force and displacement, or rate of shear being recorded. Various other compressing and shearing bodies can be fitted to the machine.) The authors study specifically the effects of pasteurising the milk on the properties measured and show that these can be counteracted by the addition of CaCl_2 . About 50g CaCl_2 per 100 kg. milk would seem to balance the measured effects of pasteurization. G.W.S.B.

1745. The mechanics of large bubbles rising through extended liquids and through liquids in tubes.

R. M. DAVIES AND G. TAYLOR. *Proc. Roy. Soc. A*, 1950, **200**, 375.

Describes measurements of the shape and rate of rise of air bubbles varying in volume from 1.5 to 200 cm^3 when they rise through nitrobenzene or water. AUTHORS.

1746. The influence of shape of cross section on the flexural fatigue strength of steel.

T. J. DOLAN AND W. J. CRAIG. *Trans. Amer. Soc. Mechanical Engineers*, 1950, **72**, 469.

Although the literature of fatigue testing includes a considerable amount of information on the effects of geometrical shape of specimen on fatigue strength, most of the experimental work recorded has been designed to establish the influence of abrupt changes of cross section, which introduce high localized stresses. Relatively little attention has been paid to the manner in which the shape of cross section may influence the fatigue properties of a uniform beam. Such an investigation is now reported. Four shapes of cross section were used: square, diamond, round and a modified diamond. The techniques of manufacture of each specimen were critically studied, to detect any possible changes in surface condition and residual stresses which might be produced, and thus alter the fatigue properties. The first series of tests was made on Mayari-R (very-low-alloy nickel-chromium-copper steel) in the normalized condition; the second on S.A.E. 4340 nickel-chromium-molybdenum steel, quenched and tempered to a static tensile strength of about 150,000 p.s.i. (67.00 tons per sq. in.). The higher-strength steel was chosen in order to accentuate any shape effects which might be observed with the Mayari-R type. The results of the tests lead to the conclusion that susceptibility to localized inelastic action, as governed by the shape of cross section and by the presence of 'sore spots' such as outward projecting corners, is the primary element leading to a reduction of fatigue strength observed in specimens of square and diamond shape, as compared with round specimens. Other factors (residual stresses, alterations of properties, due to machining, and the amount of material subjected to peak stress) may have some influence, but of a minor nature only. NICKEL BULL.

1747. Some implications of work hardening and ideal plasticity.

D. C. DRUCKER. *Quart. Appl. Math.*, 1950, **7**, 411.

The mathematical theory of work hardening and ideal plasticity is discussed and the severe restriction imposed by this on possible stress-strain relations is pointed out. Prager's extension of the Mises plastic potential function is further extended. The meaning of stability of plastic deformation is discussed. SCI. ABSTR.

1748. Hardness testing.

W. VON ENGLEHARDT. *FIAT Review of German Science 1939-1946 (German ed.)*. Vol. 49, Mineralogy Dietrich's Verlag, Wiesbaden, 1948, pp. 63-71. (In German).

Review of recent German work on sand-blast, indenters including Hanemann indenter using diamond pyramid in front lens of microscope objective, scratching and grinding tests. I.D.I.B.

1749. **A rapid determination of the average molecular weight of rubber in Hevea latex.**

W. J. VAN ESSEN. *Rec. Trav. Chim. Pays-Bas* 1950, **69**, 753.

A method is described for determining viscometrically the molecular weight of rubber in freshly tapped latex. For this purpose the latex is dissolved in a toluene-pyridine mixture. From the intrinsic viscosity of this solution the molecular weight of the rubber can be determined, using the Staudinger equation and a known viscosity constant. Molecular weights have been found, varying between 238000 and 480000, depending on the kind of clone. Rubber in fresh latex does not have a lower molecular weight than in old preserved latex. AUTHOR.

1750. **Mechanical properties of substances of high molecular weight. VIII. Dispersion of dynamic rigidity and viscosity in concentrated polyvinyl acetate solutions.**

J. D. FERRY, W. M. SAWYER, G. V. BROWNING AND A. H. GROTH, JR. *J. Appl. Phys.*, 1950, **21**, 513.

The dynamic rigidities and viscosities of concentrated solutions of polyvinyl acetate in 1, 2, 3-trichloropropane have been obtained from transducer and wave propagation measurements. Two polymer samples with number-average molecular weights of 140000 and 840000 were studied in the lower audio-frequency range at concentrations from 3 to 40% and temperatures from -3 to 41°C . For each sample, when the reduced dynamic rigidity $G'T_0/T_c$ and the reduced dynamic viscosity η'/η were plotted against the reduced frequency, $\omega\eta T_0/T_c$, all the data superposed to give two composite dispersion functions. The distribution of Maxwellian relaxation times can be derived from the dispersion of either G' or η' , and the two calculations are in reasonable agreement.

AUTHORS

1751. **Mechanical properties of substances of high molecular weight. VI. Dispersion in concentrated polymer solutions and its dependence on temperatures and concentration.**

J. D. FERRY. *J. Amer. Chem. Soc.*, 1950, **72**, 3746.

Rigidities were measured by transverse wave propagation. A single function can represent the simultaneous dependence of dynamic rigidity on frequency, temperature and concentration well enough to make the method useful for economical presentation of numerous results.

A set of elasticity mechanisms is postulated, each of which contributes to the rigidity in proportion to the total mass of polymer per unit volume and to the absolute temperature and is relaxed by a viscous mechanism such that all relaxation times depend identically on temperature and concentration.

E.W.J.M.

1752. **Measurement of the dynamic properties of rubber.**

W. P. FLETCHER AND A. N. GENT. *Trans. Instn. Rubb. Ind.*, 1950, **26**, 45.

A description is given of an apparatus designed to provide data on the dynamic modulus and viscosity of bonded rubber test-pieces in shear over the frequency range 20-120 c/s and at amplitudes from approximately 0.01% to 5% shear strain, devices being incorporated to apply static shear and/or compressive strains to the specimens. Three stocks have been examined, a gum stock, a lamp-black loaded stock and a gas-black tyre tread type stock. The modulus is independent of frequency in the range examined, but the viscosity varies according to a law of the form $\eta \propto \nu^c$, c being -0.70 to -0.95 dependent on the type of compound employed. A decrease in modulus on increasing amplitude from 0 to $2\frac{1}{2}\%$ shear strain of 5% from the gum stock, 11% for the lamp black stock, and 43% for the gas black stock was observed; similar decreases occur on the superimposition of static strains. The gas black stocks in particular are sensitive to previous history. There are also viscosity changes produced by these factors.

AUTHORS.

1753. Note on the rheological properties of elasto-plastic materials.

K. GOLDSMITH, *Brit. J. Appl. Phys.* 1950, **1**, 107.

It has been shown that the rheological properties of certain elasto-plastic materials (gels and pastes) can be expressed by the following empirical equation, if the materials are subjected to a varying stress which is dependent on the shear :

$$D = at^{(a-1)} S_b^b / \zeta$$

where D = shear, S = stress, and a , b and ζ are constants of the material.

The work was limited to soap gels and chalk pastes but the author considers the results may apply to other materials which exhibit appreciable non-linear flow characteristics.

A.G.L.

1754. The physicochemical properties of solutions of gum tragacanth.

N. GRALÉN AND M. KÄRRHOLM. *J. Colloid Sci.* 1950, **5** (1), 21.

Among the subjects discussed are purification of the gum and preparation of solutions, determination of the refractive index increment, sedimentation experiments, diffusion experiments, determination of the partial specific volume, molecular weight, shape of molecules, viscosity measurements and flow curves. The flow curves show increase of apparent viscosity with increasing rate of shear and there is no appreciable yield value. The molecules of gum tragacanth are considered to be long chain molecules with small adjacent side chains. Hydrolysis first attacks the side chains. The strength difference between the bonds in the side chains and those in the main chain is small. The solutions are polydisperse.

V.G.W.H.

1755. Theory of elasticity in general co-ordinates.

A. E. GREEN AND W. ZERNA. *Phil. Mag.*, 1950, **41**, 313.

The theory of stresses and finite strains in an elastic body is developed, using the notation of tensor calculus. A curvilinear co-ordinate system is used which moves and deforms continuously with the body. Stress-strain relations for isothermal and for adiabatic changes are derived from virtual work considerations, without assuming isotropy of the material. Equations of compatibility for the components of strain are also derived.

SCI. ABSTR.

1756. Finite elastic deformation of incompressible isotropic bodies.

A. E. GREEN AND R. T. SHIELD. *Proc. Roy. Soc. A* 1950, **202**, 407.

The theory of finite elastic deformation of incompressible isotropic bodies is expressed in a simple form in tensor notations, using a general system of co-ordinates which move with the body as it is deformed. In order to illustrate the advantages of the present methods one problem, previously solved by Rivlin, is re-examined. Two new problems are then solved using a completely general form for the strain energy function, the first problem being that of a rotating cylinder, and the second a uniform spherical shell under symmetrical internal and external pressures.

AUTHORS.

1757. Developments in hardness testing.

P. GRODZINSKI. *Machinist* 1950, **94**, 397.

Distinguishes between 3 different methods: (a) determination of surface hardness without differentiation according to direction—indentation tests with symmetrical penetrators, (balls, pyramids, cones), rebound hardness, sand blast methods, file hardness testing; (b) determination of hardness tensors—drilling and grinding methods, indentation with elongated penetrators; (c) determination of hardness vectors—scratching, shaping, rotating wheel with double conical profile, flat grinding. While method (a) has reached a relatively high state of development, full recognition of methods (b) and (c) lacking hitherto. Method (c) belongs exclusively to dynamic type. Recently 2 substantially new methods belonging to groups (b) and (c) have been developed: a hardness tester with double-conical diamond and a micro-abrasion tester. Both instruments described in detail and results of some investigations given. A correlation graph is given in which 21 different materials were tested by (a) square based diamond pyramid; (b) elongated diamond pyramid (Knoop) and Double Cone diamond. Fair degree of correlation found.

I.D.I.B.

1758. The viscosity of slurries in cement manufacture.

F. GUYE. *Rev. Mat. Constr.*, 1949, C, (403), 117.

In connection with the wet process for making Portland cement, an investigation was made of the viscosities of the slurries in order to determine the minimum amount of water needed, and thus to obtain maximum heat conservation, and fuel economy. The method used was extrusion through a steel tube under constant air pressure. The viscosity increased rapidly as the water content was decreased and as the fineness was increased; increasing the amount of CaCO_3 in the mixture markedly reduced the viscosity.

B.S.A. (abridged).

1759. Viscosimetric properties of solutions of high polymers.

G. M. GUZMÁN. *Rev. Cienc. Apl.*, 1950, 4, 29. In Spanish.

After some considerations and definitions of a general character with regard to viscosity the principal methods are explained for its determination in pure liquids as well as in diluted solutions of polymers. Various types of viscosimeters are described, e.g., those with capillary tube, with short tube, with falling globules and the rotational type. The concepts of specific, reduced and intrinsic viscosity are discussed, the latter being especially important for the study of polymeric substances as it is directly related to the individual characteristics of the molecules of the solution and the interaction between solute and solvent. The viscosity of polymer solution especially as regards the relation with the shape of the dissolved particle, the effect of the solvent, of temperature, of concentration, and of molecular weight are studied.

SCI. ABSTR.

1760. Use of an optical property of glycerine-water solutions to study viscous fluid-flow problems.

W. W. HAGERTY. *J. Appl. Mech.*, 1950, 17, 54.

It is a property of certain concentrations of glycerine-water solutions, when in a state of steady flow, that the planes of equal shear in the liquid become visible in ordinary light, if viewed along a path tangent to the shear plane. This phenomenon has been used successfully to study a fluid-flow problem.

AUTHOR.

1761. Properties of fresh concrete.

P. HALLSTROM. *Betong*, 1948, 33 (3), 125.

The properties of newly mixed concrete which are of greater importance for its workability and the homogeneity of the hardened product are its stability, coherence, fluidity and mobility. Considering each of these properties, the author shows how they are affected by the aggregate grading and the flocculation of the cement. Means for increasing the latter, such as increasing the cement fineness, the use of accelerators, wetting and air-entraining agents, and heating are mentioned.

B.S.A. (abridged).

1762. Behaviour of the alumina-water system.

W. E. HAUTH, JR. *J. Phys. Colloid Chem.*, 1950, 54 (1), 142.

The variation of viscosity with pH of finely wet-ground and dry-ground alumina suspensions in water is examined, using a modified MacMichael viscometer. The effects of particle size of the solid and of electrolytes in solution are considered.

G.E.B.

1763. The electro-viscous effect in solutions of sodium carboxymethylcellulose and the dissociation of C.M.C.

TH. HEKKER. *Chem. Weekblad*, 1950, 46, 625.

Acids as well as sodium chloride, have a lowering effect on the viscosity of solutions of sodium carboxymethylcellulose. This effect, in connection with the dissociation constant of the corresponding acid, is studied and explained on the basis of the theory of Hermans and Overbeek.

P.G.M.

1764. An estimate of the volume effect in coiling long chain molecules.

J. J. HERMANS. *Rec. Trav. Chim. Pays-Bas*, 1950, 69, 220.

An approximate treatment of the volume effect in coiling molecules is suggested. It is based upon the assumption that the probability of finding the end of a chain element at a given point at distance A from the preceding chain element is determined by the average density at this point. From the results obtained an estimate of the volume effect in certain polymers is derived.

AUTHOR.

1765. Vibration and the rheology of freshly-mixed concrete.

R. L'HERMITE. *Rev. Mat. Constr.*, 1949, C, (405), 179.

The deformation occurring in cement and concrete mixes when a shearing force is applied was measured in a ring mould comprising two sections. The upper section could be rotated relatively to the lower, and was provided with an annular piston for applying pressure to the concrete. It is shown that the coefficient of internal friction (k) decreases with increasing water content and that the deformation at rupture (θ) depends on the particle size distribution of the cement. The workability of a concrete is defined as $1/k\theta$. The degree of segregation was measured by placing the fresh concrete in an elongated box, and determining the centre of gravity before and after shaking. Measurements were also made of shearing strength before, during, and after vibration.

B.S.A. (abridged).

1766. A cone and plate viscometer.

R. S. HIGGINBOTHAM. *J. Sci. Instrum.*, 1950, 27 (5), 139.

The fluid is sheared between a revolving plate and a cone which has a semi-vertical angle of about $89\frac{1}{2}^\circ$ and whose apex touches the centre of rotation of the plate. The couple required to prevent rotation of the cone is measured. The plate may be rotated at any of a number of speeds between 0.05 and 500 r.p.m. and the torque on the cone is measured by means of a quadrant balance. Temperature control was considered unnecessary for the systems examined, but the development of heat by high rates of shear is discussed briefly. Calibration of the instrument with liquid paraffin gave an instrumental constant in excellent agreement with the calculated value. The apparatus is easy to fill and clean and has proved particularly useful for measurements at rates of shear of $10,000 \text{ sec}^{-1}$ and upwards.

V.G.W.H.

1767. Rheological changes during gel formation in adhesive systems.

H. G. HIGGINS AND K. F. PLOMLEY. *Aust. J. App. Science* 1950, 1, 1.

A method of obtaining experimental consistency curves for systems of rapidly changing rheological properties has been developed and has been used in the study of the gelation of various casein glues and synthetic resin adhesives. The previously accepted explanation of the gelation of the system casein-sodium hydroxide-water is shown to be inadequate. The systems casein-calcium hydroxide-sodium hydroxide-water and casein-calcium hydroxide-trisodium phosphate-water display complex viscosity-time curves with interesting rheological and chemical implications. Where a high yield value has been found in casein glues, it appears to be connected with the presence of suspended inorganic material. The differences in rheological behaviour between urea-formaldehyde and resorcinol-formaldehyde resins are probably related to diverse molecular configurations. The nature of the sol-gel transformation and the accepted criteria of a gel are briefly examined in the light of the observations. The significance of yield value is discussed in relation to the following topics: concentration of polymer, unsolvated material, molecular shape, secondary bonds, network structure and cross-linking. Some technological applications of rheology in the field of adhesives are indicated.

AUTHORS.

1768. **Mechanics of the contractile elements of muscle.**

A. V. HILL. *Nature* 1950, **166**, 415.

This article, based on the introduction to a discussion on muscle at the International Colloquium on Rheological Problems in Biology held at Lund, July 28th, deals with the parallel elastic component, the contractile component at rest and during activity, the mechanical properties of the active state, the structural pattern of muscle and the strength of the molecular architecture.

E.W.J.M.

1769. **On the inhomogeneous deformation of a plastic lamina in a compression test.**

R. HILL. *Phil. Mag.*, 1950, **41**, 733.

A theory is formulated for the calculation of stresses and displacements in a thin sheet of arbitrary shape which is being plastically compressed between parallel plates. Account is taken of inhomogeneous distortion caused by friction or edge constraints. By a transformation the solution is made to depend on that for a certain elastic problem of plane strain. Experimental data in support of the theory is provided by compression tests on long rectangular strips with both fluid and solid lubricants. A new method is suggested for estimating coefficients of friction relevant for cold-working processes.

AUTHOR.

1770. **Measurement of the dynamic elasticity of rubber.**

K. W. HILLIER. *Trans. Instn. Rubb. Ind.*, 1950, **26**, 64.

A method of measuring the propagation and attenuation of longitudinal oscillations in filaments of rubber-like materials is briefly described, and measurements made at temperatures of 0°C to 40°C and at frequencies of oscillation between 0.5 kc/s and 4 kc/s are given. The materials used were natural rubber, gutta percha and the synthetic rubbers GR-S, perbunaa and neoprene, all lightly vulcanized in the form of filaments. The method was used to measure the changes in the velocity of propagation and hence in the modulus when the filament was strained, and the results include such measurements with filaments extended to 300% of their original length. Ordinary tensile measurements have been carried out simultaneously and directly comparable values of the dynamic and "static" modulus obtained.

AUTHOR.

1771. **Some considerations about the influence of the concentration of starch pastes on the viscosigram.**

J. HOFSTEE. *Chem. Weekbl.* 1950, **46**, 515.

The maximum in the "viscosigram" determined in the V.I. viscosigraph is dependent on concentration. An empirical relation $V_T = Ac^t$ (V_T = maximum viscosity, c = concentration) is found; the "end-viscosity" (viscosity after 30 minutes V_{30}) is linearly dependent on concentration.

P.G.M.

1772. **The significance of base-exchange in clay manipulation.**

D. A. HOLDRIDGE. *Trans. 1st Int. Ceram. Congr.*, 1948, 174.

It is pointed out that clay is not a chemical entity, and that its physical properties depend on the arrangement of the crystalline layers and the particle size. Traces of chemical products may cause an exchange of cations between the liquid and the particles of clay, and this exchange is increased by very fine grinding, since clay usually has a lamellar structure and the breakage of these lamellae increases the number of valencies capable of attracting cations. Other properties, such as transverse strength, modulus of rupture, flocculation, shrinkage, permeability and rate of drying, are also influenced by the addition of an exchangeable base which, liberating H ions, can modify the pH. Thus, in a slip that has been made alkaline, the exchangeable bases have been replaced by Na ions associated with the water of hydration, which surrounds the separate particles of clay in a thin layer.

B.C.R.A.



1773. Elastic deformations of infinite strips.

H. G. HOPKINS. *Proc. Camb. Phil. Soc.*, 1950, **46** (1), 164.

Fourier integrals are used to solve some elastic problems of generalized plane stress and small transverse displacements in infinitely long, rectangular, isotropic plates stressed only at their edges.

AUTHOR.

1774. Stress phenomena from the respective viewpoints of solid-state and high polymer physics.

M. L. HUGGINS. *J. Appl. Phys.*, 1950, **21**, 518.

Flow and elastic properties are considered, in a qualitative manner, for the following types of materials: crystalline solids, simple liquids, glasses and high polymers.

AUTHOR.

1775. Roll mill technique.

C. HUMMEL. *J. Oil Col. Chem. Assoc.* 1950, **33** (360), 270.

Calculations are made of roll clearances and deformations and of velocity gradients in the active zone or "nip" of the rolls. Pigment aggregates are dispersed explosively during the 1/1000 sec. they are in the "nip"; the function of the medium is to prevent re-aggregation. Some deductions are drawn as to the efficient construction and running of roller mills.

D.L.T.

1776. The Meyer Law for hardness tests.

E. JIMENO AND J. TERRAZO. *Nature* 1950, **166**, 359.

The following elastic hardness relation, in connection with the Meyer equation $P = a d^n$, has been derived:

$$H_o = \frac{4E}{3\pi(1-\nu^2)} \frac{d_o}{D}$$

where H_o is the "mean pressure strainless indentation hardness." E = Young's modulus
 $\pi = E \left(\frac{d_o}{d} \right)^\eta$ an instantaneous plastic modulus where d_o and η are constants; D is the ball diameter and ν the reciprocal of Poisson's ratio.

E.W.J.M.

1777. Concerning hardness.

E. KAPPLER. *Zeits. angew. Physik.* 1949, **1**, 564; *Metals Rev.* 1950, **23** (3), 37. (Original in German).

Proposes new definition of hardness dependent only on elastic moduli of material and indenter.

I.D.I.B.

1778. The new dynamical method for measuring Young's modulus and internal friction of fibres and films.

H. KAWAI AND N. TOKITA. *J. Phys. Soc. Japan*, 1950, **5**, 17.

A horizontal Fe bar, fixed at one end and driven electromagnetically, vibrates transversely. At the point where one end of the short (about 1 cm) thin, elastic and vertical specimen, S , is attached, the bar carries a small load m . A large load M is attached to the other end of S . By adjusting m so that the frequency of vibration of the rod is the same with or without m , S and M , Young's modulus, E , for S is determined. From a graph of the amplitude of vibration (measured with an electromagnetic pick-up) against frequency the internal friction is determined. The theory of the method, and the experimental apparatus used, are fully described. Results for Cu wire, raw silk fibre and paper samples are given.

SCI. ABSTR.

1779. Apparatus for the determination of elasticity and consistency* of cheese curd.

P. KAZANTSEV. *Mol. Prom.* 1950, **11**, 39.

The curd, which is of Altaï cheese, is compressed by means of a flat plate, within a wire gauze container. The forces required to produce elastic displacements and also to press the curd through the gauze are measured on a spring dynamometer. The gauze container is made in two parts, hinged together at the bottom. The force required to break the block of curd can thus also be determined.

(*The Russian term "Kleikost" should mean stickiness or adhesivity, but in view of the nature of the experiments described, the English "Consistency" is preferred.)

G.W.S.B.

1780. An apparatus for measurement of extremely high internal friction.

T'ING-SUI KÉ AND M. ROSS. *Rev. Sci. Instrum.*, 1950, **20**, 795.

A simple torsion apparatus has been developed for measurement of extremely high internal friction by determining the angle by which strain lags behind the stress in forced cyclic vibration. The results of measurement were compared with torsion pendulum measurements using free decay method. The highest internal friction measured with this apparatus was 0.55. This apparatus can be used to measure internal friction at a constant given stress amplitude and at a constant frequency of vibration. The stress amplitude and frequency of vibration can easily be varied over a wide range. There is no theoretical limit to the lowest frequency of vibration that can be used with this apparatus. The feature that measurements can be made while the zero point is changing renders this apparatus very useful in the study of internal friction of freshly cold-worked metals.

AUTHORS.

1781. A simple field test for consistency of concrete.

J. W. KELLY AND N. E. HAAVIK. *A.S.T.M. Bull.* 1950, **163**, 70.

A simple field test for consistency of concrete is described, which consists in observing the penetration of a 30-lb. metal ball, 6 in. dia., into the surface. Through a coincidence, roughly the penetration equals half the slump. Similar penetration tests have recently been developed in England, Germany and Spain. The results of laboratory and field tests are given and the use, precision and applicability of the test are discussed. B.C.R.A.

1782. Kentron microhardness tester.

KENT CLIFF LABORATORIES, PEEKSKILL, N.Y. *Ind. Diamond Rev.* 1950, **10** (113), 117, 120.

Description of new optical micro hardness tester using the elongated pyramid, working with direct load from 1 to 1,000 g. Load applied by means of an oil dashpot.

I.D.I.B.

1783. Russian opinions on evaluation of metals by mechanical tests.

E. P. KLIER. *Met. Prog.* 1950, **57** (3), 358.

Second Russian questionnaire on mechanical testing dealt with general character of mechanical properties, evaluation of structural behaviour and fabrication characteristics of materials as result of mechanical tests, and quality control. Digest of replies by Russian specialists, dealing with flow and fracture strength, yield strength, tensile strength, ductility and plasticity, importance of impact strength as property of structural materials, practical significance of creep and high-temp. rupture tests and determination of relative machinability of material from mechanical characteristics and micro-structure. General agreement that destructive testing measurements furnish more sensitive index of property changes than non-destructive measurements. Examples of satisfactory application of statistical methods to evaluation of uniformity and standard quality of metals asked for, but not given.

I.D.I.B.

1784. Stress-birefringence in polystyrene.

H. KOLSKY. *Nature* 1950, **166**, 235.

At room temperature the birefringence is initially positive and proportional to the applied stress. On first applying a shear sections of the molecular chains tend to become aligned and this is associated with the elastic behaviour of the material. When the stress is maintained, an orientation of the benzene groups slowly occurs.

E.W.J.M.

1785. A proposal of a new theory concerning the yielding of materials based on Riemannian geometry. I.

K. KONDO. *J. Soc. Appl. Mech. Japan*, 1949, **2** (11), 123.

The sharp yielding of a metal such as mild steel is regarded as an instability phenomenon, analogous to the buckling of a flat plate, under compression in its own plane, into a third dimension. A test-piece which is stressed beyond the yield point ceases to possess a stress-free equilibrium configuration in the ordinary Euclidean space of 3 dimensions, to which it can return when external forces are removed. But such a body with residual stresses is supposed to possess a stress-free configuration in a curved Riemannian 3-dimensional space, embedded in Euclidean space of 6 dimensions.

SCI. ABSTR.

1786. Hardness of some peritectic alloys as a function of composition, structure, and temperature.

A. M. KOROLKOV. *Izvest. Akad. Nauk. USSR Otdel Tekhn. Nauk* 1949, **62**, 114, abstr. *Chem. Zentralbl.* 1950, **121** (15), 1073. (In German; original in Russian).

Hardness changes in peritectic alloys according to their composition do not follow any simple law. Found, e.g., that additivity of hardness, as found in eutectic alloys, is absent. Extent of deviation discussed. In regard to temp. effect, homogeneous mixed crystals had temp. coefficient only about half that of peritectic mixtures. Same applies also to time factor for impression; homogeneous alloys gain more stable. Various systems examined, including Ag-Cd, Ag-Zn, and Sb-Sn. Cast alloys were annealed for 8 to 10 hr. at 20 to 25 deg. C. below solidus temp. Hardness determined by Brinell method with 5 mm. ball.

I.D.I.B.

1787. Size, viscosity and precipitation of high polymer molecules in solution.

E. D. KUNST. *Rec. Trav. Chim. Pays-Bas* 1950, **69**, 125.

The intrinsic viscosities of fractions of polystyrene and polyisobutene have been determined and also their molecular weight and their dimensions, by light scattering. The relations between viscosity and dimensions on one side and between viscosity and molecular weight on the other have been analysed with the aid of recent theories of the viscosity of solutions of macromolecules. The accordance with the theory is of a qualitative character, not of a quantitative one. On the other hand, the relation between the dimensions of the high polymer molecules, the solvent and the temperature have been studied. For polystyrene the dimensions are a unique function of the slope A_2 of the curve giving the relation (H_c/τ) and $f(c)$, independent of the temperature. This leads to the conclusion that the potential barrier opposing free rotation is rather high. For polyisobutene the dimensions increase with temperature for a constant value of the slope A_2 . In this case two potential barriers are present: one preventing the realisation of configurations which are strongly "coiled," the other one, less rigid, preventing the realisation of configurations considerable extended. Finally the preferential adsorption of the solvent in a mixing of solvent and precipitant is discussed. Because of unknown reasons the adsorption becomes obvious when ethanol is used as a precipitant and not when hexane is used.

AUTHOR.

1788. Dynamic creep and rupture properties of temperature-resistant materials under tensile fatigue stress.

B. J. LAZAN. *A.S.T.M. Proc.* 1949, **49**, 757.

The paper discusses the limitations of static testing, and the importance of a knowledge of dynamic creep and rupture properties in designing for high-temperature service. The author describes some dynamic testing machines and measuring equipment which have been newly developed for determining such creep and rupture properties. Data on the following materials are reported: N-155, S-816, Vitallium, and 19-9 DL. The data are presented within mean-stress/alternating-stress co-ordinates, to show the influence of dynamic stress on creep and time to rupture. Influence of temperature of test is demonstrated. Increased creep and rupture resistance during some of the dynamic tests is discussed in the terms of possible metallurgical changes caused by cyclic stress. An appendix contains discussion of the theoretical relationship between static and dynamic creep.

NICKEL BULL.

1789. The effect of thermal oscillations on plastic deformation.

G. LEIBFRIED. *Z Phys.*, 1950, **127** (4), 344. *In German.*

By assuming an effective cross-sectional area equal to the square of the lattice constant of the material, an equation is obtained for the scatter of mechanical waves in the material and for the pressure thus generated. The frictional effect of the wave is estimated and an equation obtained for the friction of the thermal oscillations within the mass. The pressure due to the oscillation is related to the theoretical shear stress, and then a relationship is obtained connecting the theoretical shear strength, the lattice constant and the melting point. The relation appears to be confirmed by the experimental values obtained for Al, Pd, Cu, Ag, Au and Pb.

SCI. ABSTR.

1790. The temperature of surface friction of solids (theoretical error in Bowden's work).

M. P. LEVTSKIĬ. *Ž. Tech. Phys.*, USSR, 1949, **19**, 1010. *In Russian.*

The paper criticized is by F. P. Bowden and K. E. Ridler (*Proc. Roy. Soc. A*, 1936, **154**, 640). It is shown that the generally accepted result of a linear relation between temp. and friction or relative velocity of sliding is wrong and due to a too elementary and, moreover, unfinished derivation by Bowden. The experimental part of Bowden's investigation was partly carried out. The rectified relation has the form $T = f(\sqrt{\nu})$ and could be verified in all experiments on cutting of metals.

SCI. ABSTR.

1791. Hardness tests.

M. D. S. LEWIS. *Ž. Gemmol.* 1950, **2** (6), 221.

General study of types of hardness with consideration of the many different properties it may embrace. Rough division into terms of deformation and fracture possible. Only feasible test for measuring variations in hardness of diamond with crystallographic direction is abrasion test; loss of volume being measured after grinding. Diamond reduces easily to powder. According to P. Grodzinski (*Ind. Diamond Rev.* 1950, **10** (110), 24), 5 ct. of diamond can be reduced to powder by repeated hammering (hand operated) in mortar within 30 min. If hardness were solely defined as "resistance to separation of atoms," hardness of jadeite might exceed diamond by this assessment. Points out error in Mohs' test, in that suitably shaped softer tool can frequently abrade harder substance.

I.D.I.B.

1792. The flow of plastic clay.

H. H. MACEY. *Trans. 1st Int. Ceram. Congr.*, p. 70, 1948.

The author studies the relation between the speed and the stress of flow of a plastic clay. This mathematical relation is of the type known as a Bingham relation, i.e., it is

represented by a straight line which, when extrapolated, cuts the stress axis for a positive value, and gives a curve for low stress values. The distance between the original and the intersection of the curve with the stress axis is in relation to the forces which, in the interior of the plastic medium, oppose the relative movement of the particles; the slope of the straight part of the curve is a function of the rigidity. This distance and this slope vary according to the distribution, dimensions and shape of the particles. This theory allows the prediction of various facts verified experimentally. Thus, the distance between the origin and the intersection of the curve, and the slope of the curves of speed of flow and stress, remain in a constant relation for different values of the water content. The max. actual stress acting on clay specimens subjected to stressing varies exponentially with the humidity. A series of British clays of the same geological origin are then studied, in order to show the influence of the particle dimensions on the plasticity. Finally, the author indicates the possibility of extending this theory to materials other than clay, such as a suspension of carbon black in mineral oil.

B.C.R.A.

1793. Extension to the tri-axial stress relation of solid materials.

J. MAJER. *Öst. Ingen. Arch.*, 1950, 4 (2), 140. *In German.*

A well-known equation for tri-axial, non-linear stress-strain relation can be extended to so-called "brittle" materials. A plausible physical explanation for choosing the given form of equations is made possible by introducing the hypothesis of two deformation mechanisms and their limiting conditions.

AUTHOR.

1794. A new approach to problems in two-dimensional flow.

M. H. MARTIN. *Quart. Appl. Maths.* 1950, 8, 137.

Two dimensional flow of a compressible frictionless fluid is treated by a method in which the pressure and the stream function are used as independent variables instead of the space co-ordinates.

R.R.

1795. Colloidal electrolytes

R. C. MERRILL. *J. Chem. Educn.* 1950, 27, 312.

This is a general review in which reference to some eighty original publications is made. The following properties of a wide variety of colloidal electrolytes are discussed with the help of sixteen graphs from the original texts; colligative properties, electrical conductivity, transference numbers, mean ion activity, light scattering, X-ray diffraction, interaction with dyes, surface properties, and phase behaviour. A table of critical concentration for micelle formation in solutions of twenty six soaps and detergents is included.

F.H.

1796. Gelation of montmorillonite.

M. B. M'EWEN AND D. L. MOULD. *Nature* 1950, 166, 437.

Optical and elastic studies have led to the conclusion that the gelation is due to the formation of a fibrillar network in which the plates are aggregated end-to-end in the form of flat ribbon like filaments. An investigation of the effect of the addition of uni and di-valent electrolytes upon the rigidity indicated that the electrical theory is preferable to that of the random-mesh for explaining the gelation of a lyophobic hydrosol.

E.W.J.M.

1797. Some chemical and physical properties of rubber.

J. MOORE. *Brit. J. Appl. Phys.* 1950, 1, 6.

Rubber consists of a large number of coiled long chain molecules which are not linked together but are considerably entangled. The large degree of permanent set obtained when raw rubber is stretched is attributed to a considerable amount of chain sliding occurring on extension. When rubber is vulcanized the sulphur may link together

different parts of the same molecule or two separate molecules. This reduces considerably the tendency for the chains to slide over each other, permanent set is almost eliminated. The modulus of vulcanized rubber is low compared with that of crystalline materials and rises with temperature. The extensibility of rubber by bond rotation is associated with an entropy decrease corresponding to reduction in "disorder" by the chain-straightening process. The stress F in an extended rubber sample increases with temperature rise according to the expression.

$$F = - \frac{T \delta S}{\delta \gamma}$$

where F = tension, T = abs. temp., γ = extension, S = entropy.

A.G.L.

1798. Cold compression set of elastomer vulcanisates.

R. E. MORRIS, J. W. HOLLISTER AND A. E. BARRETT. *Ind & Eng. Chem.*, 1950, **42**, 1581.

Experiments are recorded, and equipment described, for the measurement of permanent set of gaskets after compression at low temperatures. A constant deformation was imposed for several days at temperatures between 40° and -35°F., the recovery after relaxation for 30 minutes being measured with a thickness gauge. The significance of the tests as regards internal viscosity, second order transition and tendency of the elastomer to crystallise is discussed. It is shown that the ability of a gasket to maintain a seal when compressed for extended periods can be foretold from results of this cold compression set technique. Compositions based on natural rubber, neoprene, GR-S, and Hycar OR-15 were studied.

F.H.

1799. Thixotropic behaviour of carbon black in rubber.

L. MULLINS. *J. Phys. Colloid Chem.*, 1950, **54** (2), 239.

A modified Mooney plastimeter is used to examine the behaviour of both vulcanised and unvulcanised rubbers, and the thixotropic build-up and breakdown of colloidal carbon black structures which are shown to exist in the rubber is discussed. The existing theories of the reinforcement of rubber by carbon black are reviewed, and modifications, making allowance for thixotropic filler structure, are proposed.

G.E.B.

1800. A revision of the theory of elasticity.

F. D. MURNAGHAN. *An. Acad. Brasil. Ciênc.*, 1949, **21** (4), 329.

A matrix notation is used in discussing the consequences of abandoning the hypotheses (i) that strains are infinitesimal, and (ii) that the initial configuration from which strain is measured is unstressed. The exact relation between stress and strain is given in the form $T = (\rho/\rho_0) J^* \phi \eta J$, where T is the stress matrix, ρ_0 and ρ are the initial and final densities, J is the matrix whose elements are the derivatives of the final co-ordinates with respect to the initial co-ordinates, J^* is the transposed matrix, and $\phi \eta$ is the gradient of the energy of deformation per unit volume (ϕ) with respect to the strain matrix (η). Good agreement between theory and experiment, in the case of Na subjected to hydrostatic pressures up to 10⁵ atm., can be obtained by considering only 2nd and 3rd-order terms in the development of ϕ as a power series in the strains.

SCI. ABSTR.

1801. Mechanical and electrical properties of plasticized vinyl chloride compositions.

L. E. NIELSEN, R. BUCHDAHL AND R. LEVREULT. *J. Appl. Phys.*, 1950, **21**, 607.

The temperature-dependence of the dynamic mechanical and a.c. electrical properties of a given polyvinyl chloride plasticizer composition can be characterized by two quantities: (a) the transition temperature, which is defined as the temperature of maximum dissipation factor; and (b) the half-widths of the loss-factor/temperature curve. A simple

relationship exists between the transition temperature determined mechanically or electrically and the volume fraction of a compatible plasticizer. The modification of this relationship for non-compatible plasticizer has been indicated. The half-width is a function of the volume fraction of the plasticizer, although this relationship is not as simple as the one obtained for the transition temperature. A simple correlation exists between the electrical and mechanical half-width. The compliance measured in tensile creep has been found to be a function of the applied load and the compliance/load relationship varies depending on the region in which the material finds itself. The shape of the creep curve at different temperatures has been correlated with the dissipation-factor/temperature curve. The shape of the stress-strain curve has been related to the modulus/temperature curve and a correlation between the initial Young's modulus and the ultimate elongation and breaking strength has been established. It has been shown that the relaxation theory is not sufficient to explain certain features of the modulus (or dissipation factor) temperature relationship. The limited significance of the μ -value and of the viscosity of plasticizers with respect to plasticizer efficiency has been demonstrated.

AUTHORS.

1802. **Mechanical properties of oriented polystyrene film.**

L. E. NIELSEN AND R. BUCHDAHL. *J. Appl. Phys.*, 1950, **21**, 488.

Cast films of polystyrene were oriented by stretching at temperatures above the softening temperature of the material and then cooled. A factorially designed experiment was carried out in which the amount of stretching, temperature of stretching, time held in the stretched state before cooling, and effect of several cycles of stretching before cooling were investigated as they affect the birefringence, the stress-strain properties, dynamic modulus and damping, and the softening temperature of polystyrene. The values of many of the mechanical properties are more closely related to the birefringence than to the amount of hot stretching. In general, the value of the stress-strain properties in the direction of hot stretch, the dynamic modulus, and the birefringence all increase with an increase in the amount of stretching, a decrease in temperature, an increase in rate of cooling after stretching, and a decrease in the number of times the film was stretched before finally cooling. The softening temperature is decreased in direct proportion to the birefringence. Annealed films give higher softening temperatures than films which have been stretched and then allowed to shrink before cooling.

SCI. ABSTR.

1803. **Some instruments for measuring the dynamic mechanical properties of plastic materials.**

L. E. NIELSEN. *A.S.T.M. Bull.* 1950, No. 165, 48.

Descriptions of (a) a torsion pendulum for measuring dynamic shear modulus and mechanical damping, and (b) a resonating reed vibrator.

E.W.J.M.

1804. **Plastic deformation of silver chloride. II. Photoelastic study of the internal stresses in glide packets.**

J. F. NYE. *Proc. Roy. Soc. A*, 1949, **200**, 47.

The pattern of birefringence caused by glide in AgCl is most clearly resolved when the glide planes are observed edge on. It is then possible to sketch the two orthogonal sets of curves giving the directions of polarization at each point of the pattern and, by means of a compensator, to find how the magnitude of the birefringence varies from point to point. The stress distribution can be deduced from the distribution of birefringence, provided that the important influence of the relative orientation of stress axes and crystal axes is taken into account. The state of stress in each plastically deformed grain can be resolved into two parts. (1) Each glide packet is subject to pure bending about two perp. axes lying in the glide plane (but with a neutral plane that is not always the middle plane

of the packet). This gives stresses that vary discontinuously with a period equal to the spacing of the glide zones. (2) There is also a continuously varying stress distribution which changes only slightly in distances equal to the glide zone spacing. The curvature of the glide packet means either that all the dislocations in one glide zone have the same sign or that positive and negative dislocations are present there in unequal numbers. It is found that, throughout any one grain, the "dislocation charge" on each zone (to use an obvious electrical analogy) has the same sign and is never more than about twice the average for the grain.

AUTHOR.

1805. Finite strains in an anisotropic elastic continuum.

J. G. OLDROYD. *Proc. Roy. Soc.* 1950, **202**, 345.

The discussion in a previous paper (see Abstr. 1603), on the invariance properties required of the equations of state of a homogeneous continuum, is extended by taking into account thermodynamic restrictions on the form of the equations, in the case of an elastic solid deformed from an unstressed equilibrium configuration. The general form of the finite strain-stress-temperature relations, expressed in terms of a free-energy function, is deduced without assuming that the material is isotropic. The results of other authors based on the assumption of isotropy are shown to follow as particular cases. The equations of state are derived by considering quasi-static changes in an elastic solid continuum; the results then apply to non-ideally elastic solids in equilibrium, or subjected to quasi-static changes only, and to ideally elastic solids in general motion. A necessary and sufficient compatibility condition for the finite strains at different points of a continuum is also derived. As a simple illustration of the derivation and use of equations of state involving anisotropic physical constants, the torsion of an anisotropic cylinder is discussed briefly.

AUTHOR.

1806. Oppel hardness tester.

OPPEL, BUCHEN (ODENWALD). *Export-Markt* 1950 (5) (Mar). In German.

Two different types produced: type K 300 with a measuring range of 4 hardnesses from 50 to 300 kg./sq. mm., testing hardness of steel, light metal, and bronze; and type K 50 for testing materials in hardness range from 8 to 50 kg./sq. mm.—precious metals, plastics, lacquer, etc. Both instruments stated to be of highest precision. They serve for checking not easily accessible positions in machines; other types of hardness testers are mentioned for harder materials, using a diamond pyramid (Vickers).

I.D.I.B.

1807. Ultrasonic measurements in metallic beryllium at low temperatures.

W. C. OVERTON, JR. *J. Chem. Phys.* 1950, **18**, 113.

The author sends pulses of frequency 10 mc/sec. through rods of beryllium at temperatures varying from a few degrees absolute to room temperature. The velocity of both longitudinal and transverse waves were calculated from the times of return of echoes to the source and hence the adiabatic moduli and compressibility.

E.G.R.

1808. Hardness: its place as a non destructive test.

D. L. PALMER, BENDIX AVIATION CORP. *Non Destruct Test* 1949-50, **8** (3), 12.

Stresses value of lighter load and smaller indentation, responsible for Brinell hardness tester being largely replaced by Rockwell, and Rockwell normal (60, 100 and 150 kg. loads) yielding in turn to Rockwell superficial (15, 30 and 45 kg. loads). Variations due to stress concentrations, bending stresses, tests having to be made on the round, etc., lessened by smaller indentation. Rockwell tests made on specimens machined from same steel bar showed that the lighter the load the less pronounced was the mound or ring caused by outward and upward metal flow; also true as hardness increases, thus decreasing error for

curvature. Author names 4 sources of error, as most prevalent in Rockwell testing. (a) Decarburised surface of sample—may be ground or machined to remove soft layer providing surface finish not left coarser than 80 grit; (b) improper anvil; (c) specimens too small or thin, so that reading tends to indicate hardness of anvil; and (d) inaccuracy of machine.

I.D.I.B.

1809. **Views on rheology.**

L. PRANDTL. *Phys. Bl.*, 1949, 5 (4), 161. *In German.*

The principal items considered in the present review are creep, relaxation, the effect of rate of loading, hysteresis and the effect of temp. fluctuations, much of the treatment being based on a simple one-dimensional model. The properties of liquids and saturated soils are briefly considered. The main object of the review is to bring together the various different viewpoints.

SCI. ABSTR.

1810. **Laboratory gel strength tester.**

R. PRESTON. *J. Oil Col. Chem. Assoc.* 1950, 33 (360), 278.

An apparatus for the measurement of strength of pigmented weak gels, e.g., water paints, consists of a plunger attached to a scale pan which can be loaded at a constant rate. Penetration of the plunger into the paint at each loading is read on a scale, the load/depression relation being a straight line until the limit of Hookean elasticity is reached. The gel strength can be expressed in arbitrary units as the load for unit depression or the rigidity (K) of the gel (for the Hookean range) can be calculated from the formula:

$$K = \frac{\text{Load}}{4 \times \text{radius of plunger} \times \text{depression.}}$$

D.L.T.

1811. **On the quantum mechanics of fluids.**

P. J. PRICE. *Phil. Mag.*, 1950, 41, 948.

The relation of Born and Green's formalism (see Abstr. 742, 1088) to wave mechanics is discussed. Green's hydrodynamical equations are derived independently. But the basis of Green's explanation of the thermomechanical effect in Liquid He II appears to be at variance with the wave-mechanical approach.

J.G.O.

1812. **Influence of experimental conditions on the adsorption effect in facilitating the deformation of metallic monocrystals.**

P. A. REBINDER AND V. I. LIKHTMAN (LICHTMAN). *Dokl. Akad. Nauk, SSSR*, 1949, 69 (2), 219. *In Russian.*

It has been shown that it is advisable not to use the method of stretching at a constant speed but rather the more universal method of "creeping" i.e., flow under a constant load.

SCI. ABSTR.

1813. **The intrinsic viscosity, translational and rotary diffusion constants of rod-like macromolecules in solution.**

J. RISEMAN AND J. G. KIRKWOOD. *J. Chem. Phys.* 1950, 18, 50.

A theory of the intrinsic viscosities, translational and rotatory diffusion constants of rod-like macromolecules in solution is developed on the basis of a rigid-chain model made up of monomeric elements separated by rigid bonds. The general methods of previous papers are used to take proper account of the hydrodynamic interactions of the monomeric units of the molecule. The theory developed leads to results showing qualitatively marked similarity to that obtained for cylindrical and ellipsoidal particles. The intrinsic viscosities, translatory and rotatory diffusion constants are shown, as in the case

of flexible macromolecules, to be related through a pair of parameters. A method for obtaining the molecular weight of rod-like macromolecules is proposed, based on the combination of intrinsic viscosity and rotatory diffusion constant measurements.

AUTHORS.

1814. Theoretical aspects of dynamical experiments on rubber.

R. S. RIVLIN. *Trans. Instn. Rubb. Ind.*, 1950, **26**, 78.

The usual vibration equation employed for evaluating the dynamic elastic modulus and viscosity coefficient in dynamical experiments on rubber is discussed critically for the case when the elastic modulus and viscosity depend on the frequency and amplitude of vibration. A mathematical framework is constructed from which it can be seen how the frequency and amplitude-dependences arise from a phenomenological point of view.

AUTHOR.

1815. Some flow properties of concentrated high-polymer solutions.

R. S. RIVLIN. *Proc. Roy. Soc. A*, 1950, **200**, 168.

A review of a theoretical investigation of the flow properties of fluids in which the assumptions underlying the classical hydrodynamics of viscous fluids no longer holds. For an incompressible visco-inelastic fluid—or visco-elastic fluid in steady-state laminar flow—the stress-strain-velocity relations involve two physical parameters which may or may not depend on the state of flow. One of these is the viscosity and the other the normal stress coeff. On a simple model of a concentrated high-polymer solution, it is shown that the normal stress coeff. may have an appreciable value. Finally, the manner in which the basic assumptions of the theory may be inapplicable to real concentrated high-polymer solutions is discussed.

AUTHOR.

1816. Mechanical models for the representation of visco-plastic properties.

R. ROSCOE. *Brit. J. Appl. Phys.* 1950, **1**, 171.

Models of varying complexity, built of spring and dashpot elements, are frequently used as a simple means of expressing the relation between a particular component of stress and the corresponding component of strain in a visco-elastic material. It is shown that any such model is equivalent to two alternative spring-dashpot models of canonic form. The exclusive use of models in either of these canonic forms is desirable, since it facilitates the interpretation of behaviours and leads to economy in the number of spring and dashpot elements employed.

A.G.L.

1817. X-ray diffraction line broadening and strain hardening.

D. ROSENTHAL. *J. Appl. Phys.*, 1949, **20**, 1257.

An experiment with mild steel suggests that the broadening of lines is indicative of the heterogeneity of strain hardening rather than strain hardening itself.

SCI. ABSTR.

1818. Rheological research of rubber and rubber mixings.

A. VAN ROSSEM. *T.N.O.-Nieuws* 1950, **5**, 143.

A review is given of the rheological research work on rubber carried out since 1924 in the Netherlands Government Rubber Institute and the later Rubber Research Institute T.N.O. since 1941. Research work carried out with the parallel plate plastimeter of Williams, the balance plastimeter of Hoekstra, the high speed plastimeter of Hoekstra, the rubber rheometer of Mooney and the shearing disc plastimeter of Mooney is discussed. Attention is fixed on the work of G.G.H. Hamm with the rotational plastimeter (rubber rheometer) of Mooney in the Rubber Research Institute T.N.O.

AUTHOR.

1819. The effect of applied load in micro-indentation tests.

W. ROSTOKER. *J. Inst. Met.* 1950, **77** (2), 175.

Inconsistencies noted in literature on effect of applied load on hardness number in microhardness testing. Effect of cold work investigated by microhardness tests on mild steel, H.C. copper and brass wires drawn to various reductions in area, and copper sheet rolled to similar reduction. Effect of heat treatment on plain C steel quenched and tempered at different temp. also studied. Bergsman microhardness tester with standard 136 deg. diamond indenter used on stage of Vickers microscope. Applied loads from 25 to 200 g. In each case, measured hardness found to decrease with decreasing load, decline being more rapid as initial degree of cold work in specimen increased. This is contrary to Kick's "rule of similarity" which is normally considered applicable to pyramidal indenters. Observed low hardness values, or in effect excessively large impressions when using light applied loads, considered most likely due to gross distortion of impression by elastic recovery. In every case a large decrease in apparent hardness was associated with a material of high elastic-strain capacity.

I.D.I.B.

1820. Elliptic integral representation of axially symmetric flows.

M. A. SADOWSKY AND E. STERNBERG. *Quart. Appl. Maths.* 1950, **8**, 113.

Axially symmetric flows of a frictionless incompressible fluid are treated by using elliptic integrals instead of the more usual method using discontinuous integrals of Bessel functions. The cases of a source ring, a source disc, a vortex ring and a vortex disc are considered.

R.R.

1821. Elastic properties of metals drawn into wires. Viscosities of metals.

C. SALCEANU; P. LE ROLLAND. *Ann. Franç. Chronom.*, 1949, **3** (4), 387. *In French.*

The wires (of Fe, Ni, steel, Cu, brass, Ag and Al) 0.5 mm. dia. and 1.2 m. long were fixed to a wall at one end and stretched horizontally over a pulley 1 m. from the wall, and held in tension by weights. Two pendulums 19 cm. apart were fixed to the wires symmetrically about the mid-pt., and the time interval between their min. amplitudes when oscillating in resonance was noted. The relation between periods of pendulums supported in this way was examined mathematically, and it was shown that the modulus of rigidity of the metal of the wire could be derived. By passing an electric current through the supporting wire it is easy to determine elastic properties of the metals when submitted to thermal treatment under any desired tension. The metals were also studied by noting the period of oscillation of a torsional pendulum (of the wire concerned under controllable tension) using an electrical timing mechanism accurate to ± 0.000333 sec. The time of oscillation was found to decrease with increasing load until it reached a level attributed to the elastic homogeneity of the metal. The viscosities of Al, Fe, steel, Pb, Ag, Ni, Cu, Pt and W were determined by a new method based on the damping of the oscillations of a torsional pendulum, and it was found that heating increased the coeff. of viscosity of metals. The values found for η ($t = 21^\circ\text{C}$) were: Al 6.1×10^8 ; Fe 21.2×10^8 , steel 21.9×10^8 ; Pb 25.7×10^8 ; Ag 50.6×10^8 ; Ni 64×10^8 ; Cu 106×10^8 ; Pt 111.3×10^8 ; W 481×10^8 , these values being rather higher than those found by previous workers using other methods.

SCI. ABSTR.

1822. Stress analysis with brittle lacquer.

B. SALMON. *Aircraft Engng.* 1950, **22** (259), 256.

A useful though not precise method for the experimental evaluation of loads developed in components of complex shape. The fine continuous cracks in the film of rosin with 25% dammar gum (applied hot) are perpendicular to the maximum elongation at every point.

E.W.J.M.

1823. **On the calculation of the internal stress in a cylindrical transformation system.**

M. SATO AND Y. TINO. *J. Sci. Res. Inst., Tokyo*, 1949, **44**, 59. *In German.*

The authors apply the transformation methods of Honda to obtain the max. and mean stresses in a circular cylinder: the answers being $\frac{2}{3}k(\delta v/v)$ and $0.234 k(\delta v/v)$ respectively, where k is the volume modulus of elasticity.

SCI. ABSTR.

1824. **The temperature-dependence of the form of the flow curves of non-Newtonian compounds and its relation to the transition point.**

W. SCHEELE AND T. TIMM.

Z. Naturforsch., 1949, **4a**, 639. *In German.*

The observed relation $v = K\tau^n$ relating the linear flow v and shear stress τ has been investigated at different temperatures. Curves for a specimen of polyvinylacetate are reproduced to illustrate that n has a max., and K a min., value at a certain temperature ($\sim 60^\circ\text{C}$), at which the graph of $\log$ ("deformation-power") against $1/(\text{absolute temperature})$ has a discontinuity in slope. Experimental proof is still required that this temperature is related to the transition point in the volume-temperature curve.

SCI. ABSTR.

1825. **Measure viscosity at pumping velocity.**

A. M. SHAW. *Chem. Engng.*, 1950, **57**, 116.

Since the viscosity of many liquids and suspensions depends on the rate at which they are sheared, data for pump design should relate to the shear conditions under actual operation.

B.C.R.A.

1826. **A quantized theory of strain hardening as applied to the cutting of metals.**

M. C. SHAW. *J. Appl. Phys.*, 1950, **21**, 599.

A theory of strain hardening is presented which utilizes the fact that metals deform blockwise rather than continuously. A metal is assumed to possess an orderly array of weak spots through which slip planes pass. The slip displacement which occurs upon a single plane is related to the spacing of weak points and the slip inclination. Use of a linear relation between shear plane displacement and resisting shear stress enables the mean shear stress to be computed. In the two examples considered it is seen that the influence of normal stress on the shear plane is less important in cutting than has been generally believed. Strain hardening and the short range inhomogeneity of metals is seen to account for most of the dynamic increase in shear strength during cutting, including the increase in shear energy per unit volume with decreased depth of cut. This size effect is akin to the increase in tensile strength with decreased specimen diameter, both phenomena involving strain hardening as influenced by inhomogeneity.

AUTHOR.

1827. **Flow of the visco-plastic body in an annular space between two coaxial tubes.**

P. K. SHCHIPANOV. *Zhurnal Tek. Fiziki*, 1949 **19**, (10), 1211.

More exact solution than that given by Volarovich and Gutkin (*Zhurnal Tek. Fiz.* 1946, **16** (3), 321).

P.M.

1828. **Note on the role of rifting in cold-work and a possible measure of plastic deformation.**

D. P. SMITH. *J. Appl. Phys.*, 1949, **20**, 1186.

A hypothesis is put forward that plastic deformation of a metallic lattice under compression is preceded by minor irreversible deformations, which take the form of localized

rifts in the lattice. In metals such as Fe and Ni, rifts are opened by H penetration, although there is evidence that H does not penetrate into the normal lattice. At given H-pressure and (sufficiently high) temperature, each metal has a definite solubility for H, which suggests that a metallic crystal has a well-defined rift system. At lower temperatures, the occlusive capacity of the metal is highly dependent on the degree and manner of previous plastic deformation. Occlusive capacity for H at room temperature may be made to serve as a quantitative measure of the degree of cold-working.

SCI. ABSTR.

1829. The Cauchy relations in a molecular theory of elasticity.

I. STAKGOLD. *Quart. Appl. Maths.* 1950, **8**, 169.

Tensor methods are applied to crystalline assemblies of particles for which the total energy depends only on the distances between the particles in the assembly, and a proof is given that the Cauchy relations should hold when the particles are identical and only when they are identical. This conclusion had been previously reached by Born for the more restricted case of central forces, but inaccuracies are pointed out in his derivation and in those of other authors.

R.R.

1830. Strength properties of polymers in an oriented state.

A. V. STEPANOV. *J. Exp. Theor. Phys., USSR*, 1949, **19**, 973. *In Russian.*

New conceptions concerning the phenomena of disruption of solids. Griffith's ideas are only of limited application, viz., to the case of isotropic elastic bodies. The possible cases of development of localized areas of disruption are considered for elastic anisotropic bodies. These areas may present different aspects, characteristic examples of which are "cracks" and "crumbling." Development is not always gradual; the breakdown of the structure then becoming spontaneous. The latter case is the one described by theory, which then agrees with experimental findings. Examples include flax, asbestos and other oriented polymers.

SCI. ABSTR.

1831. Elastic constants of sodium thiosulphate.

R. V. G. SUNDARA RAO. *Proc. Indian Acad. Sci. A*, 1949, **30**, 302.

The 13 elastic constants have been determined by the ultrasonic method. They are, in units of 10^{11} dynes cm^{-2} , $C_{11} = 4.57$, $C_{22} = 3.31$, $C_{33} = 3.02$, $C_{44} = 0.60$, $C_{55} = 0.57$, $C_{66} = 1.11$, $C_{12} = 1.84$, $C_{13} = 1.68$, $C_{23} = 1.83$, $C_{16} = -0.69$, $C_{26} = +0.25$, $C_{36} = +1.04$, $C_{45} = -0.27$. The corresponding s 's have also been calculated.

AUTHOR.

1832. On plastic flow and vibrations.

C. J. THORNE. *J. Appl. Mech.*, 1950, **17**, 84.

A general solution is given for the behaviour in the linear case of a mechanical model proposed and used by Eyring and others. Four examples are worked in detail. In particular, the steady-state solution for the deflection in periodic vibrations is given in terms of the material constants for any frequency. The transients are given in detail for the 3 possible cases and inequalities are given to determine which case a particular problem is.

AUTHOR.

1833. Study of a fraction of polystyrene in mixed solvents.

G. VALLET. *Rec. Trav. Chim. Pays-Bas*. 1950, **69**, 225.

The viscosity of solutions of a fractionated polystyrene, in various toluene-butanol mixtures, and the diffusion velocity of the polystyrene in these solutions are determined. The results obtained are discussed in the light of current theories.

AUTHOR.

1834. Experimental data on the viscous force exerted by a flowing fluid on a dense swarm of particles.

H. VERSCHOOR. *Appl. Sci. Res.* 1950, **A2**, 155.

Experimental evidence is presented to support Brinkman's modification of Darcy's law for fluid flow through porous media. The results of the measurements performed are in close accordance with the prediction from theory.

AUTHOR.

1835. Ultra speed tensile of rubber and synthetic elastomers.

D. S. VILLARS. *J. Appl. Phys.*, 1950, **21**, 565.

A high speed stress-strain machine has been developed which is capable of recording the stress-strain curve of elastomers at elongation rates up to 270%/msec. Data are reported and discussed.

AUTHOR.

1836. Creep and the shear strength of greases.

G. V. VINOGRADOV AND K. I. KLIMOV. *Dokl. Akad. Nauk, SSSR*, 1950, **71** (4) 697. In Russian.

A study of the rheology of Ca-base greases at low rates of shear τ to demonstrate that, despite their low yield point at shear stress of small magnitude, greases have a limit of deformation and creep; also to review the strength of properties of greases using a torsion elastometer in which torque is applied to a cylinder immersed in the grease. Curves are plotted of the deformation γ against time and of τ against γ . The effects on the test performance of the grease working it and allowing it to recover are discussed.

SCI. ABSTR.

1837. Thixotropy and electrical behaviour.

A. DE WAELE. *Nature* 1950, **166**, 401.

Printing inks, under shear and after resting, have been examined by conductimetric methods. With deflocculating media the specific electrical conductivity may have the low value characteristic of the medium even after prolonged ageing. Similarly, pastes after shearing can, on resting, increase in rigidity several fold without showing any appreciable conductivity, so indicating deflocculated particles. Non-conducting dispersions of zinc oxide, rutile titanite oxide, etc. in liquid paraffin, which may have high rigidities and thixotropy, yet show capacitances differing little from that of the pure medium. It would appear that the large changes in capacitance that have been recorded as evidence of thixotropy should rather be regarded as changes in the impedance of the system.

E.W.J.M.

1838. The rheology of unseasoned linoleum. The significance of fillers in calendering.

F. T. WALKER AND J. ARNOT. *Brit. J. Appl. Phys.* 1950, **1**, 207.

In addition to the formation of the sheet, the production of multi-coloured calendered linoleum of desired pattern is dependent on the plastic flow of the unseasoned material. By extruding the unseasoned linoleum mix in the apparatus described, its behaviour under calendering conditions and the effect exerted by the conventional fillers (cork, wood flour and whiting) can be demonstrated with curves showing extrusion rates at different temperatures. A relationship is derived between the volumes of the different fillers required to give linoleum mixes of the same flow characteristics, and this relationship holds over a wide range of temperature and rate of extrusion. A few curves obtained with the apparatus for allied floor-coverings, e.g., asphalt tile and P.V.C. flooring are also given.

A.G.L.

1839. The rheology of unseasoned linoleum.

A. G. WARD. *J. Appl. Phys.* 1950, **1**, 113.

An extrusion method for the measurement of flow properties is described and this can be used for routine purposes.

A.G.L.

1840. The action of phosphates on kaolin suspensions.

J. R. VAN WAZER AND E. BESMERTNUK. *J. Phys. Colloid Chem.*, 1950, **54** (1), 89.

The effects of phosphates in deflocculation and liquefaction of kaolin suspensions are studied by viscosity and cataphoresis measurements. It is shown that the most effective deflocculants are strongly sorbed on the clay particles and that they considerably increase the negative zeta-potential. In the viscosity measurements an anomalous temporary change of shearing force when the shearing rate is changed is noted and is termed "tachypyknosis." The theory of the plastic behaviour of claywater mixture is considered.

G.E.B.

1841. Surface deformation and friction of metals at light loads.

J. R. WHITEHEAD. *Proc. Roy. Soc. A*, 1950, **201**, 109.

A study has been made of the interaction of sliding metals when the normal load between them is very small. An apparatus is described which enables friction to be measured, under controlled conditions of sliding, down to loads of a few mg. The deformation of the sliding surfaces has been studied by light and electron microscopy. These techniques have been used to investigate the validity of Amontons's law (proportionality of frictional force to load) over a very wide range of loads, from a few mg to several kg. Experimental results on electrolytically polished Cu reveal a departure from Amontons's law when the normal load is less than a few g. The results of further experiments show that the friction of Ag on Ag and of Al on Al is constant and Amontons's law holds over the whole range of loads. It appears that the thin film of oxide on aluminium is penetrated even at the lightest loads. The results are discussed in relation to those for Cu, and the difference in behaviour of the various metals is attributed to the contrasting properties of the iroxides. Isolated experiments on sapphire and diamond show that the coefficient of friction is low and constant for these non-metals, and a few experiments made on boundary lubricated metals are recorded.

AUTHOR.

1842. The change of viscosity of oils containing high polymers when subjected to high rates of shear.

L. G. WOOD. *Brit. J. Appl. Phys.* 1950, **1**, 202.

The construction and use of an apparatus for the imposition of rates of shear of at least 10^7 secs⁻¹ on oils containing high polymers is described. The apparatus is constructed from standard fuel injection equipment with minor modifications. A series of typical results is reported, showing that a substantial decrease in the intrinsic viscosity of the polymer, and consequently in the viscosity of the solution, can occur on application of rates of shear of the above order.

A.G.L.

1843. Atomic displacements associated with elasticity in plastically deformed metals.

W. A. WOOD AND N. DEWSNAP. *J. Inst. Met.*, 1950, **17**, 65.

Determination by the X-ray diffraction method has been made of the magnitude of the internal stresses developed between the grains during the plastic deformation of tensile specimens of Fe and Al. It is found that in fine-grained specimens the magnitude of the stresses tends to increase in a regular manner with deformation up to a maximum value comparable with the ultimate stress of the material. But as the grain-size becomes

coarser and of the same order of size as the section of the test-piece, the intergranular stresses become irregular both in magnitude and direction, and also tend to be smaller. A tentative suggestion is made regarding a mechanism by which the intergranular stresses could arise, otherwise than by the previously recognized mechanism which attributes the stresses to mechanical anisotropy of the metal grain.

AUTHOR.

1844. **A new criterion for the occurrence of slip in thin single crystals.**

T. L. WU AND R. SMOLUCHOWSKI. *Phys. Rev.*, 1950, **78**, 468.

It has been found that in thin crystals of Al slip does not occur in the plane or direction which corresponds to the maximum resolved shear. Instead, slip directions are favoured which corresponds to a short path of slip across the crystal. A formula is derived which permits one to predict the behaviour of thin single crystals in tension.

AUTHOR.

BOOK REVIEW

THE PROPERTIES OF ASPHALTIC BITUMEN.

J. PH. PFEIFFER. Published by Elsevier Publishing Company. Distributed by Cleaver-Hume Press. Pp. 285+xvi. 45/-.

Although inspired by Dr. J. Ph. Pfeiffer this, the latest volume in Elsevier's Polymer Series, has the advantage of having been compiled by a number of collaborators including Prof. H. Eilers, Dr. R. N. J. Saal and Messrs. Labout, Siegmann and Slotboom.

The volume sets out the results of some very extensive scientific and technical research by the Royal Dutch Shell Laboratory having as its main object a detailed description of the composition and structure of asphaltic bitumens and to record those properties on which its technical application depends as revealed by scientific research. The authors set out to discuss the properties of asphaltic bitumens with particular reference to its technical application and they achieve this object at a very high standard.

Following an introductory chapter dealing with definitions, nomenclature and concepts, the constitution of asphaltic bitumens is then discussed in detail, first from a chemical point of view and secondly from the colloidal point of view. The physical properties of asphaltic bitumens are then dealt with and under this heading the rheological properties are discussed in considerable detail followed by surface phenomena, thermal and electrical properties, etc. This section of the book is of a particularly high standard and will undoubtedly prove to be of considerable value.

A short chapter on the chemical reactivity is followed by one dealing with the manufacture of asphaltic bitumen. The next section dealing with methods of routine investigation is usefully divided into (a) properties commonly considered as relating to the quality of the bitumen and (b) tests which are generally assumed to bear no direct relation to the asphaltic bitumens for various applications, but which are of importance for their identification. Although quite comprehensive it is a little unfortunate that in this section more reference is not made to the English work with particular reference to the methods standardised by the Institute of Petroleum and the British Standards Institution. For

example, it is somewhat surprising to read that according to the authors the three solvents which are recommended for extraction of bitumen from mixtures with mineral aggregate are carbon disulphide, benzene and chloroform. It is doubtful if any English workers ever use chloroform for this purpose today, whilst on the other hand, it is curious that there is no reference to trichlorethylene in this connection.

Subsequent chapters deal with special forms in which asphaltic bitumen is processed and a discussion of properties of asphaltic bitumens in the light of their technical applications. Adequate author and subject indexes are also included.

Although the book is of high scientific standard and may by some be considered in parts academic, the technological significance of all the work carried out is clearly indicated and is obviously to the forefront in the minds of the authors throughout their work. For example, in discussing the constitution of the bitumen, it is clear that the authors aim is to discover the causes of the variations in the properties of the material and the means by which such desired properties may be imparted to it during manufacture. Similarly, the rheological studies have supplied fundamental knowledge necessary to the selection of the most suitable grade of bitumen for a specific purpose and have also led to much clarification of the significance of routine tests and more aptly interpreting results obtained with them.

The book is well produced and the authors are clearly to be congratulated on the production of a volume which will be in considerable demand in all laboratories concerned with the use of asphaltic bitumens in any form, either from the point of view of manufacture or technical application.

D. C. BROOME.