

BRITISH RHEOLOGISTS' CLUB



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CLUB NOTES.

THE BULLETIN.

In view of the lifting of restrictions on the publication of new journals, it will in future be possible to publish a *Bulletin* quarterly. The Committee has decided that, now that so much work devolves on the Hon. Secretary, it is advisable to ask another member to edit the *Bulletin*. I am therefore continuing this work although Dr. Mardles has succeeded me as Secretary.

A sub-committee has been set up to deal with publications and it is hoped shortly to reorganise the abstracting service so that all journals which normally publish papers of rheological interest will be covered. It has also been agreed to discontinue the practice of adding abstractors' comments in brackets after the abstracts.

The *Bulletin* will include occasional short articles summarising recent rheological developments or discussing current problems, but we do not intend to publish original scientific papers.

Second Report on Viscosity and Plasticity, Amsterdam.

Through the courtesy of our Dutch colleagues, a number of copies of this valuable report have been made available. These may be ordered through Messrs. H. K. Lewis, 136 Gower Street, London, W.C.1.

Rheological Systematics, by Markus Reiner (Jerusalem).

The Rheology Bulletin, Vol. 16, No. 3, August 1945, publication of the Society of Rheology, U.S.A., has an important and interesting contribution, "Rheological Systematics" by Markus Reiner. Through the courtesy of the Society of Rheology a limited number of copies are available to our members and those wanting copies should make application to the Hon. Secretary, Dr. E. Mardles.

FUTURE MEETINGS OF THE CLUB.

(1) A joint meeting with the London Section of the Royal Institute of Chemistry will be held at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2 on Tuesday April 2nd, at 6 p.m.

The subject of the discussion will be "Rheology in the Food Industries." Papers will be read by Dr. E. C. Bate-Smith on Rheology of Muscle, Mr. G. C. Drew on Jellies and Mr. J. E. Caffyn on Dairy Products.

(2) A Visit to the National Physical Laboratories, Teddington has been arranged for Saturday June 15th. There will be a discussion on "Viscosity." Details will be circulated later.

(3) **Week-end Conference and Exhibition.**

A Week-end Conference will be held at Bedford College, Regents Park, London from Thursday Oct. 3rd to Saturday Oct. 5th. There will be accommodation for some 60 members in College and arrangements have been made for further accommodation at the Royal Hotel, Woburn Place. The Programme has been provisionally arranged as follows :

Thursday Oct. 3rd.

Afternoon. Annual General Business Meeting, followed by tea. *After tea*, a Presidential Address will be given by Prof. E. N. da C. Andrade, F.R.S. Dinner will be followed by a Social Evening.

Friday Oct. 4th. Symposium on "The Principles of Rheological Measurement."

10 a.m.-12 noon. "Materials of Low Consistency" (e.g. greases, oils, etc.).

2 p.m.-4 p.m. "Materials of Intermediate Consistency" (e.g. rubbers, pastes and doughs).

5 p.m.-7 p.m. : "Materials of High Consistency" (e.g. metals, glasses, etc.).

The first hour of each Session will be given to addresses by two introductory speakers on the invitation of the Committee. During the second hour, there will be a few shorter contributions followed by general discussion.

It is hoped that all papers will be available in pre-print form and that the complete Proceedings will be published in due course. Members wishing to submit short papers to this symposium should post their contributions to reach Dr. E. W. J. Mardles *not later than July 1st*. The acceptance of a paper by the Committee does not necessarily mean that time will be available for the author to read his contribution.

Saturday Oct. 5th.

10 a.m. Discussion on the Committee's work on Rheological Definitions and Nomenclature. (Introduced by a member of the Committee.) *Afternoon.* It is hoped to arrange visits of rheological interest. *Evening.* Conference closes.

Space will be available during the Conference for exhibits of research apparatus, photographs, etc. Will members who intend contributing to the exhibition inform the hon. sec. in good time as to table space required?

Further particulars will be circulated later.

(4) Preliminary arrangements are being made for autumn and winter meetings.

PROF. E. C. BINGHAM.

It was with profound regret that we learned of the death of Prof. Eugene C. Bingham, often described as "the father of modern Rheology." Prof. Bingham was one of the founders of the (American) Society of Rheology and we would express our deepest sympathy to Mrs. Bingham and to the Society of Rheology in their loss. The name of our science was chosen by Prof. Bingham and many of us were first introduced to the subject through reading his book *Fluidity and Plasticity*.

PROCEEDINGS OF THE OXFORD CONFERENCE (1944).

It is much regretted that, due to circumstances beyond our control, the Proceedings of the Oxford Conference are still unpublished. At the time of writing (February) the Publishers (Sir Isaac Pitman and Sons) have every hope that *Essays in Rheology* will be published before our October Conference.

G. W. SCOTT BLAIR,

Editor.

RHEOLOGY ABSTRACTS

304. Methods of Specifying the Properties of Visco-elastic Materials.

T. ALFREY and P. DOTY. *J. Appl. Phys.*, **16**, 700, 1945.

Various equivalent combinations of dashpots and springs and mathematical methods for specifying visco-elastic behaviour are discussed and the relations between them established.

R.S.R.

305. Some Remarks on the Molecular Mechanism of Viscous Flow.

T. ALFREY. *Rheology Bull.*, **16**, 3, 1945.

Eyring's theory of viscous flow based upon the concept of liquid structure as being essentially a mixture of molecules and "holes," is examined. A molecule situated near to a "hole" is considered to have two possible equilibrium positions, separated by a potential energy barrier; passage over this barrier corresponds to the process of jumping into the adjacent "hole"; in the absence of stress, jumps in all directions are equally frequent, so that while there is diffusion there is no flow, but a shearing stress will make forward jumps more frequent than backward jumps. This stress-biased jumping of molecules into neighbouring "holes" is advanced as the molecular origin of viscous flow. Certain geometrical objections to this hypothesis are set down; these do not invalidate the general results of Eyring's hypothesis, however.

B.R.R.A.

306. Effect of Alpha-Ray Bombardment on Glide in Metal Single Crystals.

Letter from E. N. DA C. ANDRADE. *Nature*, **156**, 113, July 28th, 1945.

Experiments are described which show that alpha-ray bombardment increases the rate of elongation of stressed crystals. It is suggested that initiation of glide takes place from the surface and then continues at a rate independent of the surface disturbances. The technique can be used therefore to show whether glide is taking place by the activation of new glide planes or is continuing on planes already in action.

R.L.B.

307. Symposium on Review of Enamel Tests. II. Review of Tests for Fineness and Consistency of Enamel slips.

C. M. ANDREWS. *Bull. Amer. Ceram. Soc.*, **23**, 475, 1944.

A discussion is given on methods for testing the fineness and consistency of enamel slips including screen tests, settling test, and tests by means of the Bingham plastometer, the Irwin consistometer and the Gardner mobilometer. The consistency of an enamel slip can be determined by pressure flow, the hydrometer and the viscosity tube.

B.R.R.A.

308. Flow Test for Asphaltic bitumen.

ANONYMOUS. *J. Inst. Petroleum*, **31**, 450, 1945.

A simple test is described to compare the flowing tendencies of bitumens, asphaltic compositions, etc. at temperatures when the determination of viscosity is difficult. The sample (50 g. for three determinations) is placed, when molten, in the shorter limb of a hollow "L"-shaped metal container made of brass or tin plate with internal dimensions 2.5 cm. wide and 1.3 cm. deep having limbs respectively 5 cm. and 6.3 cm. long. After cooling for an hour, the container, with sample in the vertical limb, is placed in a thermostatically controlled oven at the desired temperature and the flow along the empty limb is measured after a suitable interval of time.

E.W.J.M.

309. Thixotropy and Ceramics.

D. G. BEECH and M. FRANCIS. *Trans. Brit. Ceram Soc.*, **44**, 25, 1945.

Thixotropy is defined as the property of a suspension in virtue of which it "thickens" on standing and becomes "thin" again on agitation, a cycle which may be repeated indefinitely. Systems which have this property are divided into three classes: (1) stable colloidal solutions of substances whose molecules are of great length; (2) fine suspensions of solid particles; (3) concentrated emulsions of oil drops; (4) foams of gas bubbles in aqueous media. The relationship between the viscosity of a thixotropic suspension and the rate of shear is noted, and Goodeve and Whitfield's "coefficient of thixotropy" is defined. The molecular scaffolding which causes thixotropy is discussed; shear forces will break down this structure. Thixotropy effects occur in the ceramic industry in the handling of glazes and slips; some methods are noted for the control of such effects. B.R.R.A.

310. Shear Modes in Non-Piezo-Electric Crystal Plates.

Letter from S. BHAGAVANTAM and J. BHIMASENACHAR. *Nature*, **156**, 23, July 7th, 1945.

The use of ultrasonic waves of continuously varying frequency is proposed for determination of the elastic constants of crystals. R.L.B.

311. Detonation of Liquid Explosives.

Letter from F. P. BOWDEN, M. F. R. MULCARY, R. G. VINES and A. YOFFE. *Nature*, **157**, 104, January 26th, 1946.

Attention is drawn to the profound influence of minute bubbles of gas in the detonation of explosives. R.L.B.

312. Plastic Characteristics of Coal: Correlation with Chemical and Physical Properties and Petrographic Composition.

R. E. BREWER. *Ind. Eng. Chem.*, **36**, 1165, 1944.

Correlations of technological properties with rank have proved unsatisfactory for certain bituminous coking coals. Thus, the carbonising properties of a particular coal cannot always be predicted accurately from rank alone. The exceptional coals generally have one or more distinctive differences in either, or both chemical and petrographic composition, as compared with other coals of the same rank. Earlier investigations indicated that the order and extent of fusion of whole coals and selected layer samples have a definite relation to petrographic composition. This paper presents a detailed study of chemical and petrographic composition and physical properties of 19 low-, medium-, and high-volatile "A" bituminous coals in relation to Gieseler maximum fluidity. These coals cover the range commonly used alone or in blends for production of commercial coke.

Factors of chemical and petrographic composition found to contribute toward increasing the fluidity of a coal above that expected from its rank, are high an-thraxylon and translucent attritus contents and the presence of cannel coal. For coals of similar rank, those of higher physical strength show a higher maximum fluidity. Factors that reduce the fluidity of a coal below that expected from its high rank are high contents of oxygen, ash, opaque attritus, and fusain. B.R.R.A.

313. Viscosity and Lubrication.

BRITISH RHEOLOGISTS' CLUB AND INSTITUTE OF PETROLEUM. *Nature*, **155**, 734, June 16th, 1945.

A summary of discussions at a joint meeting of the Club and the Institute of Petroleum. Several papers dealt with the measurement of viscosity and the standardisation of the viscosity index. Methods of studying greases, both under practical conditions and more scientifically, were described.

An extensive report was also given on the rheological properties of oils under various oxidation conditions. A full account of the papers and discussions will appear in a separate volume issued by the Institute of Petroleum. R.L.B.

314. Aspects of the Determination of the Strength of Materials.

BRITISH RHEOLOGISTS' CLUB. *Nature*, **156**, 306, *Sept. 8th*, 1945.

A short summary of a number of papers presented to a meeting of the Club at Farnborough; a fuller account will appear elsewhere. The micro-structure of timber was illustrated by photographs, and the methods used for studying the causes of mechanical failures were discussed.

A second paper dealt with the effect of duration of loading on the strength of brittle materials, and a third with the application of statistical methods to mechanical test results. It was proposed to report the stresses below which a given percentage of specimens would be expected to fail, since this method is most suited for design purposes. R.L.B.

315. Packing of Regular (Spherical) and Irregular Particles.

Letter from R. L. BROWN and P. G. W. HAWKSLEY. *Nature*, **156**, 421, *Oct. 6th*, 1945.

A discussion of the voidage of packed particles with reference to the principle of dilatancy and the importance of non-uniformity throughout a packing. R.L.B.

316. Torque-viscosity Characteristics of Lubricating Greases.

L. C. BRUNSTRUM, E. W. ADAMS and E. E. ZIEGLER. *National Petroleum News*, **37**, Part 2, R 150, 1945.

Constant stress-variable shear and constant shear-variable stress methods are used in the study of the behaviour of greases in bearings. The results of both methods are compared and a correlation attempted with apparent viscosities, the latter being evaluated partly from extrapolated values, partly on the assumption that at high rates of shear the flow properties of greases are governed by the flow properties of the base oil alone. Plasticity point is defined as the point at which a break occurs in the curve representing viscosity *versus* temperature. Viscosity is expressed in Saybolt seconds. L.A.S.

317. The General Theory of Stresses and Displacements in Layered Systems. I. and II.

D. M. BURMISTER. *J. Appl. Phys.*, **16**, 89, 126, 1945.

Problems of foundation engineering have become increasingly important. These problems frequently involve the consideration of stresses and settlements in layered soil deposits. The well-known Boussinesq equations apply strictly only to homogeneous soil deposits. The general theory of stresses and displacements in a two-layer system is developed in order to provide the engineer with a useful tool which is more directly applicable to the analysis of actual conditions encountered in soil deposits. The basic equations of stresses and settlements are derived. The numerical evaluation of the surface settlement equation for the simplest case of Poisson's ratio equal to one half, has been completed as the first of a series, and is presented in the form of influence curves for the analysis of practical problems. B.R.R.A.

318. A Method for Determining the Instantaneous Hardness of Plastic Substances.

A. CAMERON. *Trans. Faraday Soc.*, **41**, 583, 1945.

The method depends on measuring the penetration of a conical point dropped on to the plastic from various heights. It is claimed that the time of impact is less

than the relaxation time, and hence that flow does not occur. The treatment is empirical. Data for greases are given. L.R.G.T.

319. Determination of the Pressure-viscosity coefficient and Molecular Weight of Lubricating Oils by means of the Temperature-viscosity equations of Vogel and Eyring.

A. CAMERON. *J. Inst. Petroleum*, **31**, 401, 1945.

From a study of Erk and Eck's viscosity-temperature data it is shown that θ_t of Vogel's equation, $\eta_t = k \exp. \left(\frac{b}{t + \theta_t} \right)$ where k , b and θ_t are constants for any oil, can be put equal to 95 for almost all oils. The viscosity η_p at any pressure and at a given temperature t , can be expressed by the exponential law $\eta_p = \eta_0 \exp. (\phi_p)$ where η_0 is the viscosity at atmospheric pressure and temperature t , ϕ is a constant for any given oil at temperature t , and p is the pressure. It is shown that the product A , of ϕ and $(t + \theta_p)$ is approximately constant, when $\theta_p = 52$; and it is found possible to obtain A in terms of the temperature characteristics of the oil.

M , the molecular weight of an oil can be calculated from the constants in Vogel's equation by means of the empirical relation

$$M = 0.546 (b^{1.47} k^{0.473}) \theta \text{ where } \theta = 95.$$

E.W.J.M.

320. Coefficient of Restitution of Coals.

Letter from C. G. CANNON and W. H. GEORGE. *Nature*, **155**, 787, June 30th, 1945.

Measurements of the coefficient of restitution of coals under differing impact energies are reported. The coefficient of restitution tends to unity as the impact energy tends to zero, and, for some coals, shows a well-defined minimum. The coefficient for coals is greater than that for copper.

R.L.B.

321. Simple Two- and Three-dimensional Cases in the Theory of Consolidation of Soils.

N. CARRILLO. *J. Math. Phys.*, **21**, 1, 1942.

This paper deals briefly with solutions to the differential equation representing heat-flow or soil consolidation.

B.R.R.A.

322. Differential Equation of a Sliding Surface in an Ideal Saturated Plastic Soil.

N. CARRILLO. *J. Math. Phys.*, **21**, 6, 1942.

The relationship between the stresses acting on a failure surface in a plastic soil and the geometric characteristics of the surface may be expressed by a differential equation, provided the law of failure of the material is known. The mathematical treatment of the problem is simplified if the sliding surface is cylindrical. The analysis is then two-dimensional and the sliding surface may be considered as a line in a plane.

B.R.R.A.

323. Definitive Equations for the Fluid Resistance of spheres.

C. N. DAVIES. *Proc. Phys. Soc.*, **57**, 259, 1945.

For calculation of terminal velocities it is convenient to express the Reynolds' number, Re , of a moving sphere as a function of the dimensionless group ψRe^2 , where ψ is the drag coefficient. The following equations have been fitted by the method of least squares to critically selected data from a number of experimenters:

$$(1) \quad Re = \frac{\psi Re^2}{24} - 0.00023363(\psi Re^2)^2 + 0.0000020154(\psi Re^2)^3 \\ - 0.000000069105(\psi Re^2)^4$$

for $Re < 4$ or $\psi Re^2 < 140$. This tends to Stokes' law for low values of Re . It is

specially suited to calculation of the sedimentation of air-borne particles. The upper limit corresponds to a sphere weighing $1.5\mu\text{g}$ falling in the normal atmosphere, that is, one having a diameter of 142μ for unit density.

$$(2) \log Re = -1.29536 + 0.986(\log \psi Re^2) - 0.046677(\log \psi Re^2)^2 \\ + 0.0011235(\log \psi Re^2)^3 \text{ for } 3 < Re < 10,000 \text{ or } 100 < \psi Re^2 < 4.5 \cdot 10^7.$$

Correction for slip in gases should be applied to Stokes' law by the following expression, based on the best results available:

$$1 + \frac{l}{a} [1.257 + 0.400 \exp.(-1.10a/l)],$$

where the mean free path l is given by $\eta/0.499\sigma\bar{c}$.

This conveniently transforms to the following for the sedimentation of particles in air at pressure p cm. mercury:

$$1 + \frac{1}{pa} [6.32 \cdot 10^{-4} + 2.01 \cdot 10^{-4} \exp.(-2.190ap)].$$

(AUTHOR'S ABSTRACT.)

324. Ring and Ball Softening Points of Resins.

V. E. GROTLISCH and H. N. BURSTEIN. *Ind. Eng. Chem. Anal.*, **17**, 476, 1945.

After discussing softening-point methods applicable to resinous materials, the authors describe an air-bath method of test at constant temperature. Data are presented covering the range 70° to 170°C ., and corrections for different bath temperatures are discussed.

L.R.G.T.

325. Viscosity of Ordinary Liquids at High Rates of Shear.

Letter from L. GRUNBERG and A. H. NISSAN. *Nature*, **156**, 241, August 25th, 1945.

A theoretical examination of the viscosity temperature relation suggests that under high rates of shear the viscosity of "Newtonian" liquids may be expected to become a function of the rate of shear. The value of the rate of shear at which the effect become perceptible depends on the relative magnitude of the thermal agitation of the molecules and the "agitation of flow."

R.L.B.

326. Degree of Association of Water from the Energy of Viscosity and the Work of Cohesion.

Letter from L. GRUNBERG and A. H. NISSAN. *Nature*, **156**, 335, Sept. 15th, 1945.

Further calculations following the communication above (*Nature*, **156**, 335).

R.L.B.

327. Pressure Viscosity and Consistency of Greases.

A. E. HICKEL. *Petroleum Refiner*, **24**, 120, 1945.

An instrument is described consisting of a standard Saybolt Orifice or a Saybolt Furol Orifice and associated gear. The time to deliver a certain amount of grease is measured, variable pressure being applied to cause variable rate of flow.

L.A.S.

328. Wave Equations for Finite Elastic Strains.

H. M. JAMES and E. GUTH. *J. Appl. Phys.*, **16**, 643, 1945.

An answer to Dr. Nádai's criticism of a paper by B. A. Mrowca, S. L. Dart and E. Guth (*J. Appl. Phys.*, **16**, 8, 1945) and a note by H. M. James and E. Guth (*Phys. Rev.*, **66**, 33, 1944).

R.S.R.

329. The Determination of the Elastic and Viscous Properties of Glass at Temperatures below the Annealing Range.

G. O. JONES. *J. Soc. Glass Tech.*, **28**, 432, 1944.

An experimental survey has been made of the elastic and viscous properties of a soda-lime-silica glass at temperatures in, and well below, the annealing range,

using specimens cut from drawn sheet and a bending method for observing the development of the strain under an applied stress. The results indicate that down to quite low temperatures the whole of the strain is made of a purely viscous part, plus a completely reversible elastic part. The reversible elastic strain may again be divided into an instantaneous component, which appears rapidly at first and then approaches asymptotically to a maximum value. It was often impossible to continue the measurements until the whole of the delayed elastic strain had appeared, and a method was developed for the analysis of the strain-time curves, based on the observation that only that part of the delayed strain which had already appeared under load was later recovered on removal of the load, and on the assumption that the form of the decay function was similar for both deflection and recovery. The total delayed elastic strain for a given applied stress is a function of the temperature, increasing from about 3% of the instantaneous elastic strain at 200°C. to about 75% at 444°C. (T_g , the transformation point for this glass, was 534°C.) Above this temperature it became increasingly difficult to separate the instantaneous and delayed parts of the elastic strain, and this is suggested as the main reason for the many differences between the present results and the conclusions of other workers. The true viscosity of this glass at 350°C. was $10^{17.8}$ poises—appreciably lower than would be expected from an extrapolation of the curve obtained at higher temperatures. This value of viscosity is substantially higher than measured values previously reported in experiments on glass. Some theoretical and practical implications of the results are discussed. B.R.R.A.

330. Determining the Hardness of Butter at Tropical Temperatures.

Bepaling van de Stevigheid van Boter bij Tropische Temperaturen.

C. I. KRUISHEER and P. C. DEN HERDER, *Off. Org. algem. ned. Zuivelb.*, **25**, 1940.

A modification of the authors' butter penetrometer is described for use up to temperatures of 28°C. A plunger of 4 sq. cm. cross-section is pressed into the butter, forces up to 1 kg. (i.e. pressures up to 250 g./sq. cm.) being used. There are two models of the machine, one mechanically and the other hand driven. G.W.S.B.

331. Frictional Properties of Wool Fibres.

Letter from M. LIPSON. *Nature*, **156**, 268, *Sept. 1st*, 1945.

A method is discussed for measuring the frictional properties of individual fibres in selected fluids. The measurements were made both in the direction of the scale and in the opposite direction, and a number of results are given. R.L.B.

332. Frictional Properties of Wool treated with Mercuric Acetate.

Letter from M. LIPSON and E. H. MERCER. *Nature*, **157**, 134, *Feb. 2nd*, 1946.

Further results on the friction of wool fibres are given with two methods of measurement, and the influence of mercuric acetate treatment is discussed.

R.L.B.

333. A New Cutting-wire Plastometer.

L. L. LYON and R. D. VOLD. *Ind. Eng. Chem. Anal.*, **17**, 585, 1945.

An instrument for measuring the rate of motion of a wire through a body in a direction perpendicular to the wire axis under various loads is described. The viscosity is calculated by means of an equation given by Lamb.

Asphalts show an approximately constant viscosity for different driving forces, but viscosity depends on wire radius. The instrument reveals strong elastic after-effects in asphalts.

Soaps show a quasi-plastic type of curve. Owing to the complexity of flow-conditions, precise calculation of viscosities for soaps is of doubtful significance.

L.R.G.T.

334. Particle Shape.

Letter from A. H. D. MARKWICK. *Nature*, **156**, 177, August 11th, 1945.

The measurement of particle shape in connection with road aggregates is discussed. R.L.B.

335. The Tensile Behaviour of Raw Cotton and other Textile Fibres.

R. MEREDITH. *J. Textile Inst.*, **36**, T-107, 1945.

Curves have been prepared relating stress (in grams per denier) and strain (extension %) for cotton, rayons, silks and synthetic fibres, wool, hair and casein fibres under test conditions of 65% R.H. at 20°C. rate of loading 10g/den./min. 1 cm. test length, 50 tests per sample.

The mean values of fineness, strength and extension at break together with the initial Young's modulus, yield stress and yield strain (if any), work of rupture and work factor are recorded including standard errors for fineness, breaking load, specific strength and extension at break.

Considering the strength of different fibres examined, ramie, stretched viscose rayon and flax hold first place, followed in order by nylon, hemp, silk, jute, cotton, viscose and acetate rayons, wool and casein fibre. Generally speaking the strongest fibres are least extensible but this does not apply to silk or nylon which consequently show a high work of rupture, well above that of any other fibres. Bast fibres and stretched viscose are the least extensible. Silk and nylon are conspicuous by their combination of high strength and extensibility. E.W.J.M.

336. A Comparison of the Tensile Elasticity of some Textile Fibres.

R. MEREDITH. *J. Textile Inst.*, **36**, 147, 1945.

Measurements of recovery from strain (extension/total extension) are recorded against stress, with an arbitrary time cycle, for a variety of fibres. Nylon is the most elastic fibre and shows an excellent recovery from strain up to near rupture. Stretched rayon and flax show high elastic recovery at high stresses but owing to their high Young's moduli their elasticities decrease relatively rapidly as the strain increases. Silk shows a high degree of elasticity for large stresses and strains although it is not so good as nylon. Wool and hair show excellent recovery from large strains but they are inherently weak fibres and show only the same elastic recovery as cotton for comparable stresses. Wool is much more elastic than cotton for any given strain. Casein fibres shows a large degree of plasticity and its elastic recovery falls rapidly when the yield stress is exceeded. E.W.J.M.

337. Elastic Recovery in Capillary Flow.

Letter from A. C. MERRINGTON. *Nature*, **155**, 669, June 2nd, 1945.

Experiments have shown that certain liquids flowing through capillary tubes show a loss in pressure at the tube entrance, followed by uniform fall in pressure in the remainder of the tube. This effect, observed with rubber solutions and soap thickened mineral oils, is attributed to the elastic nature of the material. At high stresses the recovery is delayed, the delay becoming more pronounced as the velocity increases. R.L.B.

338. On the Shape and Dimensions of Myosin Particles in Solution.

W. F. H. MOMMAERTS. *Arkiv for Kemi, Mineralogi o Geologi*, **19A**, N 17, 1, 1945.

Mommaerts has estimated particle dimensions from viscosity data and streaming birefringence measurements, assuming the shape to be rigid cylindrical rods (after Weber 1939) and using formulae developed by Burgers, 1938 (Second Report

on Viscosity and Plasticity, Amsterdam, 1941-2), namely $\eta_{sp} = \frac{2a^2/b^2}{45(\ln. 2a/b - 1.80)} \phi$

where a and b are the length and diameter respectively of the particles, and ϕ the fractional concentration. Mommaerts finds the ratio a/b to be 162, so if the accepted diameter of a myosin particle is 60 to 66 Å the length of the particle is 10,000 to 11,000 Å. E.W.J.M.

339. The Disaggregation of Actomyosin by Adenosinetriphosphoric Acid (ATP).

W. F. H. MOMMAERTS. *Arkiv for Kemi, Mineralogi o Geologi*, **19A**, N 18, 1945.

The paper deals with the question of the forces operating between the components of the contractile parts of the muscle: it was assumed that the phenomena of contraction and relaxation are intimately related to the changes in the strength of certain aggregative forces between the components of the fibrillum.

The addition of adenosinetriphosphoric acid (ATP.) lowers the viscosity of solutions of actomyosin by disaggregation. Myosin particles are about $1\ \mu$ long while actomyosin particles are about $12\ \mu$. Urea, guanidine but not urethane behave similarly but more slowly than ATP. With these reagents disaggregation occurs and in strong urea solution myosin is also split up to single polypeptide chains of mol. wgt. of 100,000 and a length of about 2,000 Å (5 elementary units).

E.W.J.M.

340. The Rugosimeter, an Instrument for Measuring Surface Roughness of Calendered Sheet Rubber.

M. MOONEY, *Ind. Eng. Chem. Anal.*, **17**, 514, 1945.

This instrument measures coarse or microscopic roughness corresponding to irregularities of the order of tenths of a mm., for which Nicolau's term "rugosity" is applied. It makes use of the resistance to flow of air between the rubber surface and an annular plate placed in contact with it. The theory of the instrument is based on the assumption of a sinusoidal surface contour. For surfaces departing from this form the readings are to a certain extent arbitrary. L.R.G.T.

341. Free and Forced Vibration Methods in the Measurement of the Dynamic Properties of Rubbers.

J. E. MOYAL and W. P. FLETCHER. *J. Scientific Insts.*, **22**, 167, 1945.

An electrical vibrator is described in which a steel bar supported by flat springs and carrying the rubber test pieces bonded to it and the base, is excited by A.C. from a variable frequency oscillator for the forced vibrations and by the output of an electronic pulse generator fed to a neon lamp for the free vibration method. The experiments performed on these types of rubber compounds show that resilience results derived by either of the two methods are equivalent to one another. This equivalence is regarded as a proof of the correctness of the deduction from the simple mechanical model of a spring and viscous dashpot in parallel; these being the respective equivalents of a mass in a rubber spring executing free vibrations and a rubber system in resonance with a forced vibration. H.C.T.

342. The Hardness of Butter Fat.

H. MULDER. *Hoorn State Agric. Exper. Sta. Bull.* **44**, 1938; **45**, 1939; **46**, 1940; **47**, 1941; **48**, 1942.

The relative hardness of butter samples is not the same at all temperatures. If comparisons are to be made, measurements should be recorded at a number of different temperatures. Butter loses consistency on working and becomes harder again on subsequent standing. The usual explanation of this behaviour is that it is due to crystallisation of super-cooled liquid fat but the author claims that the phenomenon occurs when no under-cooled liquid fat is present. On the other hand, crystallisation plays an important part in defining such rheological properties of

butter as hardness, shortness, etc. The temperature of setting markedly influences hardness, a setting temperature of 13°C. generally giving the hardest butter.

Cream which before churning contains the greatest amount of solid fat produces the hardest butter if the tests are done immediately, but changes in hardness during the first few days after making are very complex. The complicated relationships between temperature and other factors in butter making and the hardness of the butter are discussed at length. The minimum force required to cause a rod to penetrate the butter (yield-value) is taken as a criterion of hardness. Penetrometers are not adequate for measuring certain other differences in consistency, but for hardness the consistometer method is claimed to be more satisfactory than other tests such as compression of cylinders. Spreadability is a complex property "depending not only on the butter but also on the bread and the knife."

Sodium chloride and certain non-electrolytes such as glucose and urea, decrease the hardness of butter. Butter is envisaged as consisting of a continuous fat phase interwoven with water-holding veins.

The super-cooling of butter fat is studied dilatometrically. In summer, the softer fat can exist at a greater degree of super-cooling than can the harder winter fat. Experiments on butter-fat should be done on the material as it occurs in cream or butter and not in an artificially separated condition. G.W.S.B.

343. The Mechanism of Brittle Rupture in Glass.

J. B. MURGATROYD. *J. Soc. Glass Tech.*, **28**, 406, 1944.

Griffith's "crack theory" and the weak molecular bond theory of the strength of glass are tested by phenomena recorded by different investigators, and it is concluded that modifications are necessary to these theories to account for the facts. The suggestion is made that Griffith's "flaws" consist of pockets of quasi-viscous material surrounded by larger and three-dimensional aggregates, and that when the pocket material has yielded to an applied stress the fact that it then carries no load makes the pocket the equivalent of a "hole" in the glass. Such a "hole" would act as a stress concentrator. In this way the time elapsing before breakage occurs is explained as being due to the time required for the stress in the quasi-viscous material to relax. By means of a model representing the stress concentration at a pocket, an equation is derived relating the breakage strength, P_B , with time. Values of the breaking strength calculated from this equation, $P_B - a = b/t^k$, are in good agreement with published experimental results. B.R.R.A.

344. On a Direct Calculation of the Viscosity of a Liquid, both under Ordinary Pressures and under High Pressures, from the Viscosity of its Vapour, on the basis of a new equation of state.

D. B. MACLEOD. *Trans. Faraday Soc.*, **41**, 771, 1945.

The viscosity of a liquid is calculated from the viscosity of its vapour, using the vibration frequency and the work done on the molecules during condensation. Data for pentane up to 8,000 atmospheres are in close agreement with the theory. L.R.G.T.

345. Rubber Plastimeter with Uniform Rate of Shear—Shearing-cone Plastimeter.

G. H. PIPER and J. R. SCOTT. *J. Scientific Insts.*, **45**, 206, 1945.

A "shearing cone" plastimeter, consisting of a mushroom-shaped rotor with conical upper and lower surfaces rotated in the plastic material contained in a cylindrical mould, is described. Heating elements are built into the mould and speeds of rotation of 12, 1·2, 0·12 and 0·012 r.p.m. are obtained from a synchronous motor through a gear-box and a worm drive at which the torque is measured.

With the type of shearing surface described, a uniform rate of shear is obtained

except for a very small edge zone and the provision of the several speeds enables some approximation to the processing rates of industrial practise to be obtained.

H.C.T.

346. The Cryptostructure of Clays During their Deformation.

I. V. POPOV. *Compt. Rend. (Doklady) Acad. Sci., U.S.S.R.*, **45**, 162, 1944.

A cryptostructure is spontaneously formed in montmorillonite clays under the participation of absorbed calcium and water, and anisotropy can be detected. In experiments with a slip of sodium-montmorillonite, containing 200% or more of water, anisotropy could be induced by the application of an external force. This can be seen by compressing the slip between a glass slide and a cover glass and viewing through a gypsum plate with crossed nicols, the field becoming covered with blue and yellow spots. It is easily shown, by manipulating a wire or flake of mica in the slip, that the blue coloration accompanies compression while the yellow is attributable to tension. Clay films dried by pressing out the water showed a high interference colour: on moistening such films they swelled rapidly and showed a banded structure. It is concluded that the basal planes of the clay crystals become oriented perpendicularly in the direction of application of pressure, while their lengths follow the direction of stretching. These optical phenomena are taken to mean that there exists a relation between the orientation of the clay particles and the direction of the applied stress; it is further deduced that water dipoles and cations participate in the mechanism of the connection of mineral particles in aggregates, and the transmission through such aggregates of any externally applied stress.

B.R.R.A.

347. Strain Hardening Under Combined Stresses.

W. PRAGER. *J. Appl. Phys.*, **16**, 837, 1945.

Experimental investigations of the strain hardening of metals under combined stresses are usually conducted so that the directions of the principal stresses as well as the ratios of their magnitudes remain constant during any one test. The paper is concerned with incompressible isotropic materials which are stressed in this manner and deform in accordance with certain postulates. The most general stress-strain relation which can arise under these circumstances is established and some special cases of this relation are discussed.

AUTHOR'S ABSTRACT.

348. Strength of Glass and Duration of Stressing.

Letter from F. W. PRESTON. *Nature*, **156**, 55, July 14th, 1945.

An equation is given relating the breaking stress to the time of loading and its implications are discussed.

R.L.B.

349. Flow of Water through Very Narrow Channels and Attempts to Measure Thermomechanical Effects in Water.

Letter from J. REEKIE and J. AIRD. *Nature*, **156**, 367, Sept. 22nd, 1945.

Experiments are reported on the flow of water through the channels of the order of 10^{-5} cm. in width, and it is concluded that these present no very unusual features.

R.L.B.

350. A Classification of Rheological Properties.

M. REINER. *J. Scientific Instr.*, **22**, 127, 1945.

A short history is given of the methods of representing the behaviour of complex materials under strain. Structural formulae derived from these methods are proposed and a tabular classification shows their interrelationships. The uniqueness of dilatency and strength as fundamental properties exclude them from this table.

H.C.T.

351. N.G.F. Performance Grease Tests.

J. R. REYNOLDS. *The Inst. Spokesman*, 9, 1, 1945.

Description is given of a grease torque machine built for the study of flow properties of greases. One of the machines was constructed as a single-purpose apparatus for a particular grease used in motors and gun-mountings exposed to low temperatures on Arctic routes.

Torque data are quoted indicating the usefulness of the principles applied and further applications are suggested. L.A.S.

352. Temperature-control Device for MacMichael Viscometer.

W. A. RICE. *Ind. Eng. Chem. Anal.*, 17, 676, 1945.

A thermostatic bath for use in conjunction with a MacMichael viscometer is described. L.R.G.T.

353. Rheology : The Dynamics of Real Fluids.

E. G. RICHARDSON. *Endeavour*, 4, 64, 1945.

The behaviour of Newtonian and non-Newtonian fluids under shear stress is discussed, and the test method for determining the velocity-gradient of a liquid is described. Reference is made to the special properties, including bulk elasticity, of highly concentrated suspensions, sols, gels and emulsions. B.R.R.A.

354. Thermostatic Bath for Low Temperatures.

E. L. RUH, G. E. CONKLIN and J. E. CURRAN. *Ind. Eng. Chem. Anal.*, 17, 451, 1945.

A thermostatic bath, primarily for low-temperature viscosity determinations, operates effectively at temperatures ranging from $+40^{\circ}$ to -70°F . It consists of a three-stage installation, one bath containing solid carbon dioxide and isopropyl alcohol, a second bath maintained under rough thermostatic control, and a third bath under close control, the last being vacuum-jacketed. The whole installation is mounted in a cabinet. L.R.G.T.

355. Viscosity of Liquids and Colloidal Solutions.

G. W. SCOTT BLAIR. *Nature*, 156, 147, August 4th, 1945.

A summary of the report of a conference held in Moscow. The report comprises sections on the viscosity of liquids, of molten materials at high temperatures and of colloidal solutions. More than 70 papers were reported. R.L.B.

356. The Fluidity and Thixotropy of some Ball Clay Slips.

E. SHARRATT and M. FRANCIS. *Trans. Brit. Ceram. Soc.*, 44, 100, 1945.

An investigation of the fluidity of some ball clay slips has been made with the aid of a torsion viscometer. Five raw clays and three treated clays have been examined. It was found that pint weight, p , and fluidity, F , were related according to the equation $K(p - p') = \log(360 - F)$ where p' and K are constants characteristic of the clay. A knowledge of these constants permits the pint weight to be determined for any desired fluidity over a limited range. Organic matter is found to be associated with greater fluidity, and other factors affecting fluidity are discussed and summarised. Only clays capable of yielding slips at high pint weights were found to exhibit high thixotropy. On aging, the clay slips still conformed to the above equation, but the constants changed in value from day to day. Causes of fluidity changes with age are discussed, special note being made of bacterial effects and pH alterations. B.R.R.A.

357. Structural Viscosity Studies of Coating Clay Compositions.

G. H. SHEETS. *Paper Trade J.*, 116, 38, 1943.

An instrument for measuring and distinguishing thixotropy, dilatancy, plas-

ticity, and Newtonian flow is described, and suitable technique for the use of this instrument has been developed. Several representative coating clays were studied, and large differences in their flow properties were found. It has been established that the differences in the flow properties of these clays are caused by differences in their particle size distribution, in clay species, and in their hydrating ability. Of these factors, particle size had the greatest effect upon the flow properties of the clays studied, when enough dispersing agent had been added to give minimum viscosity to the clay slip. The amount of dispersing agent is the most important single variable and exerts the greatest effect upon the flow properties of the clay suspensions studied. It was definitely established that an intense thixotropic build-up occurs in suspensions made from these clays when certain amounts of dispersing agent are used; both sodium silicate and sodium pyrophosphate showed this effect. The amount of dispersing agent required to give this thixotropic build-up is slightly less than the amount required to give minimum viscosity to the clay slip. In two of the three commercial coating clays studied, acid washing of the clays altered their flow properties, tending to make them more non-hydrous. A mild heat-treatment at a temperature of 250°C. was found to dehydrate irreversibly a kaolin clay sufficiently to change its flow properties to some extent. The flow properties indicate that the heat treatment produced an agglomeration of the particles of the clay. Neither acid washing nor heating singly or in combination, was found to be sufficient to change the flow properties of one clay to those of another. With one exception, there was little difference in the action of sodium silicate compared with that of sodium pyrophosphate in regulating the flow properties of the coating clays studied. The one exception was in the case of an English clay, where it was found that excess of sodium silicate over the amount required to give minimum viscosity resulted in a marked thickening effect. This did not happen when sodium pyrophosphate was used. Clays with relatively large particle size showed a weakly dilatant behaviour over relatively wide clay concentrations, whereas clays with small particle size gave a strongly dilatant behaviour over a relatively narrow range of clay concentration, when enough dispersing agent had been added to these clay slips to give minimum viscosity. For concentrated clay suspensions and with enough dispersing agent to give minimum viscosity, clays of smaller particle size gave a thinner suspension for a given solids content than clays having a large particle size. This conclusion applies only where the clay fractions are of the same species. It is shown that it is possible to have clay systems which possess simultaneously both dilatancy and thixotropy in the same slip. B.R.R.A.

358. **Textile Fibres. An Engineering Approach to their Properties and Utilisation.**

H. DEWITT SMITH. *Rayon Textile Monthly*, **26**, Nos. 6 to 11, 1945.

A comprehensive survey of data for the evaluation of textile fibres, together with definitions and suggestions for the systematic analysis of the mechanical behaviour of fibre materials is given, with numerous tables and figures. Tenacity is expressed as breaking strength per grex (the grex of a fibre, yarn, cord or rope is its linear density or fineness in grams per 10,000 metres). If the breaking stress P in terms of either tensile strength or tenacity, and the breaking strain E in terms of unit elongation (one hundredth of the percentage elongation) are known, then the average stiffness, $S_a = P/E$ and the toughness index $W = PE/2$.

These two indices are based on the arbitrary assumption that the shear-strain curve is a straight line from the origin to the breaking point.

Toughness is defined as the property of enduring large permanent deformation without rupture and measured in terms of the work absorbed. E.W.J.M.

359. Determination of Modulus of Elasticity of Varnish Films.

A. G. STEFFENS. *Ind. Eng. Chem. Anal.*, **17**, 417, 1945.

A simple machine for determining stress-strain properties of thin varnish films is described. The effect of water-immersion on a particular insulating varnish is examined.

L.R.G.T.

360. Relaxation of Stresses in Annealing Glass.

A. Q. TOOL. *J. Res. Nat. Bur. Stds.*, **34**, 199, 1945.

An empirical equation representing relaxation of stresses in annealing glass is derived. Although the derivation is based on Maxwell's equation for viscous flow, consideration is also given for the changing viscosity as a glass anneals at a constant temperature. This new equation has been applied to data that were obtained by Adams and Williamson on the relaxation of stresses in annealing glass at various temperatures. It is shown that this equation applies very satisfactorily to their data. Also, it appears to be much more suitable than the reciprocal relation which these authors proposed as a substitute for the wholly unsatisfactory exponential relation that is derived directly from Maxwell's equation; this exponential relation is unsatisfactory because it does not take into account the changing viscosity of annealing glass. The new equation therefore leads to a clearer understanding of the nature and behaviour of glass.

B.R.R.A.

361. Physical and Chemical Degradation of Rubber.

Letter from D. F. TWISS. *Nature*, **156**, 9, July 7th, 1945.

A summary of a symposium, to be reported in full in the *Transactions of the Institution of the Rubber Industry*. Amongst others, papers were presented on the effect of repeated stress cycles on the cracking and ageing of rubber.

R.L.B.

362. Significance of Grease Viscosity in Aircraft Lubrication.

J. C. ZIMMER and S. B. PATBERG. *Aero Digest*, **51**, 75, 1945.

The authors stress the point that there are a number of factors which affect the practical use of a grease that are not revealed by the tests generally employed in specifying greases. The requirements of greases for low temperatures, intermediate and high temperatures as well as extreme pressure conditions are discussed. Viscosity *versus* rate of shear is the most important property of a grease so far as its lubricating effect under service conditions is concerned.

L.A.S.