

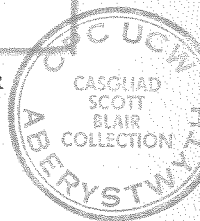
BRITISH RHEOLOGISTS' CLUB

Hon. Sec. :

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CLUB NOTES.

Arrangements for the Week-end Conference in London, October 3rd to 5th, are progressing satisfactorily. A notice will soon be sent to all members of the Club giving detailed information.

We are delighted to hear of the impending visits of two distinguished rheologists from abroad to this country. Dr. Markus Reiner of Jerusalem hopes to be with us by the end of July and Professor H. Mark of New York, who has just paid a very short visit, hopes to return in the autumn. We hope that there will be an opportunity for members of the Club to meet Dr. Reiner and Prof. Mark during their visits.

Plans for a number of future meetings are being made and members will be informed of them in due course.

The Hon. Treasurer wishes it to be known that he has four copies of the Second Report on Viscosity and Plasticity (Amsterdam). Will any members wishing to purchase these please communicate with him?

G. W. SCOTT-BLAIR,
Editor.

Visit to the National Physical Laboratory, Teddington, Saturday afternoon, 15th June, 1946.

An interesting Club meeting was held at the National Physical Laboratory, by the courtesy of the Director, when about a hundred members and guests attended. Dr. Guy Barr spoke on recent developments in viscometry, including the calibration and design of standard viscometers.

After giving a survey of early ideas on viscosity, Dr. Barr stressed the importance of kinematic viscosity in relation to hydraulics and aerodynamics. With regard to standard viscometers Dr. Barr described the Gruneisen, Fenske and Ubbelohde suspended level viscometers which were designed to minimise errors due to any lack of verticality in use of the U-type of viscometers. Small discrepancies in results recently obtained with carefully calibrated viscometers by observers at home and overseas (Joint meeting of Institute of Petroleum and British Rheologists' Club, J.Inst. Petrol, **31**, No. 260, August, 1945) have been traced to surface tension differences in the calibrating liquids used.

Dr. Barr described experiments and exhibited viscometers designed to eliminate the surface tension difficulty. A short interesting discussion followed and the members and guests visited laboratories where investigations of a rheological character were in progress: these included the silting of harbours, the slow creep of metals, the ventilation of buildings, plastics, use of strain gauges, etc.

E.W.J.M.

RHEOLOGY ABSTRACTS

363. Swelling Stresses in Gels.

W. W. Barkas. *Forest Prod. Research, Spec. Rept.* No. 6, 1945.

A report is given on the calculation of the swelling pressures and elastic constants of gel structures from their moisture-absorbing properties. This includes a general consideration of swelling, the swelling of solutions, the swelling of rigid gels, swelling pressures and elastic constants, the influence of applied stresses on the sorption isothermal, elastic constants of gels, sorption compression and bulk modulus, the specific volume of water in tension, and sorption hysteresis. B.R.R.A.

364. Factors which contribute to the Physical Stability of Frozen Cream.

R. W. Bell and C. F. Sanders. *J. Dairy, Sci.*, **29**, 213, 1946.

Viscosity measurements were made in a MacMichael viscometer. The use of fresh milk, containing small unclumped fat globules, quick freezing and low storage temp. produces a stable emulsion of good body when thawed after several months' storage. G.W.S.B.

365. The Consistency of Plastic Suspensions of the Bingham Type.

H. de Bruijn, H. Dols, and C. Kuyper. *Rec. Trav. Chim. Pays-Bas*, **62**, 696, 1943.

The stress-strain diagram of plastic materials is inadequately characterised by the yield value and the mobility in the linear region. The consistency is better characterised by derived fluidity stress diagrams, from which the liquidation tendency can be read off directly; this affords a more exact definition of the non-linear part of a stress-strain diagram. Attention is drawn to the large errors caused by the turbulence set up during measurements at high shearing stress. B.R.R.A.

366. The General Theory of Stresses and Displacements in Layered Soil Systems.

D. M. Burmister. *J. Appl. Phys.* **16**, 296, 1945.

The theory of stresses and displacements for layered soil systems is extended in this paper to cover the more general cases of three layers with full continuity across the interfaces between the layers. The three-layer system gives a closer approximation to the actual soil conditions encountered. B.R.R.A. (Cf. Abstr. 317).

367. Control of High Temperature Short Time Pasteurisation (of Milk).

J. E. Caffyn. *Dairy Ind.* **11**, 327, 1946.

A paper headed "The Problem of Control," read at a joint meeting of the Soc. of Dairy Technol. and the Soc. of Instr. Technol. held in London, 15th May, 1946, giving a brief survey of the hydrodynamic and thermodynamic problems involved. G.W.S.B.

368. The Measurement and Control of some of the Physical Factors which affect the Firmness of Long-keeping Cheshire Cheese.

J. E. Caffyn. *Dairy Ind.*, **11**, 249, 1946.

Extending his earlier work (*ibid*, **10**, 257, 1945) the author has now controlled the manufacture of long-keeping Cheshire Cheese for a single vat for 27 days. Curds were pitched at three standard consistencies as measured on the machine described in earlier papers and corresponding to soft, normal and firm conditions;

milled at three different acidities (0.55, 0.65 and 0.75% lactic acid) and pressed at three different pressures (20, 40 and 60 lb./in.²) only one variation being made on each day, thus giving 27 different sets of cheese. The finished cheese were tested for hardness with a modified Rockwell tester ("Ball Compressor").

With regard to the "green" (young) cheese, it is concluded that firmness and moisture content are influenced by solids-not-fat of incoming milk, by firmness at pitching, and by time from pitching to milling, though the relation of the last factor to firmness is less certain. Correlation with fat content of milk was not established.

For the ripe cheese, hardness testing through the rind, though not ideal, gave useful indications of the properties of the cut cheese and correlated well with the graders' subjective opinions from "thumbing" the cheese. The latter depends on both total and coverable deformations. Judgments of body of cheese samples taken with an "iron" could not be satisfactorily predicted from hardness tests on the surface of the bandaged cheese.

Seccility (force required to cut through cheese with a standard wire) is related to moisture content and to dissipation coefficient determined on cylindrical test-pieces in a constant stress compression rheometer, though this technique is not well suited to so crumbly a material as Cheshire cheese. G.W.S.B. (cf Abstr. 262).

369. On Flow-lines in Liquids.

Sur les veines liquides.

C. Camichel and C. Bory. *Comptes Rend. Acad. Sci.*, **222**, No. 7, 348, 1946.

A study of eddy formation observed directly in two tubes, with flow approaching Poiseuille conditions. Eddies appeared at Reynolds' number of 110; their period, at first of high magnitude, decreased with increase in the Reynolds' number. The authors have prepared curves shewing this relation. E.W.J.M.

370. On the Elastic Properties of Textile Fibres.

Sur les propriétés élastiques des fibres textiles.

P. Chevenard and G. Champelier. *Comptes Rend. Acad. Sci.*, **222**, No. 9, 954, 1946.

Using a micromachine with photographic recording, with test specimens from 2 to 150 mm. length and rate of extension 6 to 300 mm./min. the authors present data for the elastic behaviour of high polymer fibres. A cycle between two values given with a selected stress was repeated ten times and the eleventh recorded.

Differences in elastic behaviour found with different kinds of fibres are explained by molecular models. E.W.J.M.

371. Testing of Yarns and Fabrics.

N. Eyre. *The Textile Manfr.*, **72**, 154, 1946.

A description of physical tests on yarns and operation of the pendulum type, inclined plane and ballistic testers. E.W.J.M.

372. A Note on the Viscosities of Solutions of Nitrocotton in a mixed Nitroglycerine-Nitroglycol Solvent.

D. Fensom. *Can. J. Res.*, **24** (B), 83, 1946.

Viscosities of solutions of a number of types of nitrocotton in a mixed solvent consisting of 80% glyceryl trinitrate and 20% ethylene glycol dinitrate by weight, have been measured in a modified Stormer viscometer. Complete solution was attained only with difficulty but such solutions, when obtained, showed viscosity-concentration relations similar to those obtained with acetone solutions.

Author's abstract.

373. Flow-Pressure Relations in Calcium-soap-oil Systems.

W. Gallay and I. E. Puddington. *Can. J. Res.* **24** (B), 73, 1946.

Flow-pressure relations have been determined for suspensions of Calcium soaps in mineral oils of varying viscosity and viscosity index. The effect of small amounts of reagents on the character of these curves is very marked. The addition of water generally increases the yield-value of the system without affecting the mobility, while solvents for Calcium soaps tend to change the mobility without altering the yield-value. Author's abstract.

374. Laboratory determined Pour Points of Lubricating Oils as related to Flow under Field Storage conditions.

J. J. Gammara. *A.S.T.M. Bulletin No. 138*, 44, 1946.

A review of the work of sub-committee 16. The proposed modified A.S.T.M. method D 97 uses present A.S.T.M. equipment, being performed in 6 to 8 hours and shewing about 10% divergence from the standard method. E.W.J.M.

375. Absolute Muscle Force in the Ankle Flexors of Man.

H. A. Haxton. *J. Physiol.*, **103**, 267, 1944.

The maximum muscle force developed by the ankle flexors was determined by pressing with the ball of the foot upon a hinged board against the resistance of a spring balance, the necessary allowance being made for the characteristics of the lever system of the ankle. The absolute muscle force of this group of muscles, half-way between full extension and full contraction, was 3'9 kg. per sq. cm.

E.C.B.S.

376. Initial Buckling of Flat Rectangular Panels under Shear and Compression.

H. G. Hopkins and B. V. Rao. *Research Reports and Memoranda of the Aer. Res. Ctee.*, No. 1965, 1943, *Aircraft Engineering*, **18**, 60, 1946.

It is concluded that the buckling stress ratios, i.e. the critical shear for combined loading expressed in terms of the corresponding critical stresses when acting alone, are practically independent of the dimensions of the panel. E.W.J.M.

377. Convection Currents in a Porous Medium.

C. W. Horton and F. T. Rogers. *J. Appl. Phys.*, **16**, 367, 1945.

The problem is considered of the convection of a fluid through a permeable medium as the result of a vertical temperature-gradient, the medium being in the shape of a flat layer bounded above and below by perfectly conducting media. It appears that the minimum temperature-gradient for which convection can occur is approximately $4\pi^2 h^2 \mu / kg \rho_0 a D^2$, where h^2 is the thermal diffusivity, g is the acceleration of gravity, μ is the viscosity, k is the permeability, d is the coefficient of cubical expansion, ρ_0 is the density at zero temperature, and D is the thickness of the layer. This exceeds the limiting gradient found by Rayleigh for a simple fluid by a factor of $16D^2/27\pi^2 k \rho_0$. A numerical computation of this gradient, based upon the data now available, indicates that convection currents should not occur in such a geological formation as the Woodbine sand of East Texas (west of the Mexia Gault zone); in view of the fact, however, that the distribution of NaCl in this formation seems to require the existence of convection currents, and in view of the approximations involved in applying the present theory, it seems safe tentatively to conclude that convection currents do exist in this formation and that the expression given above predicts excessive minimum gradients when applied to such a formation. B.R.R.A.

378. Studies on Siloxanes. The Specific Volume and Viscosity in relation to Temperature and Constitution.

C. B. Hurd. *J. Amer. Chem. Soc.*, **68**, 364, 1946.

The viscosity of eleven siloxanes has been determined by the method of Bingham using two viscosity pipettes, calibration being with standard liquids from the Bureau of Standards and the formula used $\eta = \epsilon p t - \epsilon' \rho/t$. Over the range 20° — 80° the temperature-viscosity relation could be expressed by the equation $\log \eta = Q_\eta/2.30 R T + A$ where Q_η is called the energy activation of viscous flow. Some evidence of association of the siloxanes was obtained. E.W.J.M.

379. A new method for measurement of Fluid Flow applicable to studies of Convective Heat Transfer.

A. Kolin. *Indust. Heating*, **12**, 946, 1945.

A method is described and illustrated which permits measurements within a small distance from the wall and responds to the very small velocities expected in that region. B.R.R.A.

380. The Influence of Traces of Water on the Plasticity of Starch and Quartz Suspensions in Organic Media.

H. R. Kruyt and F. G. van Selms. *Rec. Trav. Chim. Pays-Bas*, **62**, 407, 1943.

Suspensions of starch and quartz in carbon tetrachloride and similar organic liquids are thixotropic only in the presence of water. The yield value is a function of the water content. Quartz suspensions were made in a mixture of tetrabromethane and tetra-chlorethane adjusted to a density equal to that of the quartz. It was again found that the yield value, like the differential viscosity, increased with the water content of the suspended quartz. Experiments are described which show that quartz particles cohere only due to the flowing together of water films around the particles; thus boundary surface tensions are alone responsible for the coherence of the particles, not electrical effects as has been previously suggested. B.R.R.A.

381. The Influence of a Third Phase on the Rheology of Suspensions.

H. R. Kruyt and F. G. van Selms. *Rec. Trav. Chim. Pays-Bas*, **62**, 415, 1943.

The plasticity (thixotropy) of suspensions of small glass beads in carbon tetrachloride and other organic liquids was studied from the standpoint of the dependence of the yield value on the water content. The results suggest that the plasticity of the suspensions studied was due to the work necessary to break the water linkages which join the particles as a third phase. The insolubility of water in the organic medium causes the formation of a third phase which leads to plastic effects when water shows a preference to adhere to the particles. The non-polarity of the organic suspending medium is dismissed as a cause of the observed effects. B.R.R.A.

382. Viscosity Studies of System $\text{CaO-MgO-Al}_2\text{O}_3\text{-SiO}_2$.

J. S. Machin and D. L. Hanna. *J. Amer. Ceram. Soc.*, **28**, 310, 1945.

The viscometer built for the present studies was intended to be usable over the range of temperatures in which platinum viscometer parts and platinum/platinum-10% rhodium thermocouples may be expected to have a reasonable life. No measurements were attempted above $1,500^\circ\text{C}$. although occasionally the temperatures were increased to as much as $1,550^\circ\text{C}$. to facilitate melting the charge. The apparatus was similar to that designed by Nicholls and Reid for use in the laboratories of the U.S. Bureau of Mines. It is of the oscillating or torsion pendulum type. Minor modifications in the lengths of the torsion wires and more convenient means

for setting the vibrating system in motion have been incorporated in the apparatus used in the present study. The viscosities of those compositions in the $\text{CaO—MgO—Al}_2\text{O}_3\text{—SiO}_2$ system which contain 40% SiO_2 , and which are liquid at $1,500^\circ\text{C.}$, have been measured. The "isokoms" are roughly parallel to the lines along which the ratio of acidic components to basic components is constant. A theory of the variation of viscosity with composition, based on the assumption of polymeric silicate ions, is proposed. B.R.R.A.

383. Modern Instruments and Methods for Testing Yarns and Fabrics.
H. Marsden. *The Textile Manfr.*, **72**, 75, 1946.

A description in use of a new group of testing instruments, models of serigraph and tensilgraph instruments by Scott Testers, U.S.A., the application of the load to the test specimen being at a constant and uniform rate. E.W.J.M.

384. On the Nature of Forces operating in Blood Clotting. (i) The Participation of Electrostatic Attraction. (ii) The Clotting of Fibrinogen as a Two-step Reaction.

W. F. H. Mommaerts, *J. Gen. Physiol*, **29**, 103, 113, 1945.

(i) Clotting of fibrinogen with thrombin is, at least partly, a coacervation process, due to electrostatic attraction between +ve and -ve groups. Inhibition by ions increases with increasing charge; inhibition by ions of the same charge increases with increasing ionic radius. (ii) On the acid side of the isoelectric point of fibrinogen thrombin reacts with it to form profibrin, but clotting does not ensue. The combination most probably takes place by hydrogen bonding. E.C.B.S.

385. Influence of Temporary Raising of Temperature on the Consistency and Structure of Butter.

De invloed van tijdelijke verhoogingen in temperatuur op die consistentie en de structuur van boter.

H. Mulder. *Hoorn State Agric. Exp. Sta.* Ref. No. 51(3)c, 1945.

When butter is warmed and then cooled, clusters of fat crystals are formed, which increased its hardness and shortness. At high temperatures a re-crystallisation probably takes place which produces a softening. As well as cluster formation, there is a flowing together and disappearance of fat globules. G.W.S.B.

[Cf. Abstr. Nos. 171 and 342].

386. Some Properties of Protoplasmic Gels. I. Tension in the Chloroplast of *Spirogyra*.

W. J. V. Osterhout, *J. Gen. Physiol*, **29**, 181, 1946.

"The term 'gel' is used here in a very liberal sense to include viscous liquid, elastic solid, and intermediate states." The chloroplast of *Spirogyra* is a long, spirally coiled ribbon which may contract to form a short, nearly straight rod, e.g., by the action of various organic and inorganic substances, or by centrifugally freeing from the protoplasmic connection with the cellulose wall. The problem emphasised by the author is by what means the protoplasm maintains the chloroplastic gel in the spiral, stretched condition. E.C.B.S.

387. Electrical Measurement of Strain.

C. S. Redshaw. *Flight*, **49**, Nov. 1945. April 4th, 349, 1946.

A presentation of modern strain-gauge technique for measuring steady and alternating strain in aircraft structures, an electric gauge being defined as a device

which converts a physical magnitude into an electrical magnitude. The method consists of using an inductance variable with strain in one arm of an alternating current bridge unit.

E.W.J.M.

388. The Modulus of Elasticity of some Ceramic Oxides on the One Component Basis.

E. Ryschkewitsch. *Ber. deut. keram. Ges.*, **23**, 243, 1942.

Available methods of determining the modulus of elasticity of ceramic bodies are reviewed, and preference is given to the measurement of the deformation of a rod loaded at one end. The rod was heated in a molybdenum-wound furnace of elliptical cross-section; this permitted a considerable amount of bending to take place. The movement of the rod was measured by a travelling microscope. At each temperature, a reading was taken with the rod unloaded, with the rod loaded, and, finally, again unloaded; in this way the plastic and elastic deformations can be separated. Experiments were carried out on sintered alumina, beryllia, zirconia, spinel, magnesia and thoria; most of the exploratory work was carried out on alumina. It was found that the modulus of elasticity value depends on the diameter of the rod; the values fell on a smooth curve which, extrapolated to zero diameter, gave an ultimate value for sintered alumina of 5.0×10^6 kg./sq.cm. It was found that the addition of 5% silica to the alumina resulted in a marked decrease in strength. The strength also decreased with temperature, slowly up to about 1,000° C. and then rapidly; at 1,500° C. the modulus was less than one-half that at room temperature. The values for sintered spinel were approximately the same as those for alumina. Beryllia had a lower modulus. The strength of sintered thoria in comparison with that of alumina was quite low, in crushing as well as in tensile tests. The curve for sintered zirconia showed a break at a temperature of 600°—1,000° C., suggestive of a crystalline modification. The tensile strength of the sintered zirconia was 1,800 kg./sq.cm.; it is less brittle than sintered alumina. The strength of sintered magnesia (96-97% MgO) was not very high in comparison with the best of the other oxides.

B.R.R.A.

389. Some Observations on the Free Loaded and After Loaded Muscle Twitch.

G. M. Schoepfle and A. S. Gilson, Jr. *J. Cell and Comp. Physiol*, **26**, 119, 1945. [Cf. *ibid*, **24**, 185, 1944].

The rate of lever displacement with time for the simple muscle twitch is greatly increased during the early phase of contraction, when the muscle is after-loaded by means of a lever spring and lever support. This would indicate that only a part of the initial twitch "foot" is dependent on inertia and viscous-elastic damping. A model is described which represents the simplified behaviour of muscle in terms of two springs and two centred masses in series.

E.C.B.S.

390. Apparatus for Measuring the Consistency of Plastic Suspensions.

F. G. van Selms and H. R. Kruyt. *Rec. Trav. Chim. Pays-Bas*, **62**, 398, 1943.

Two forms of apparatus are described for the study of the rheological properties of suspensions which exhibit plasticity, thixotropy or dilatancy. The first is that developed by H. L. Röder ("Rheology of Suspensions," Dissertation, Utrecht, 1939), in which a sphere is dragged through the suspension by a weight passing over a pulley; experiments proved that this apparatus is inaccurate. The authors then designed a new apparatus in which the velocity of a sphere rolling down an inclined tube filled with the suspension was measured. The advantages of this form of apparatus are considered.

B.R.R.A.

391. The Ultimate Velocity of Fall in a Restricted Space.

K. F. Tromp. *Fuel Sci. Pract.* **24**, 126, 1945.

As the existing formulæ for calculating the ultimate velocity of fall of spheres in restricted spaces give an unsatisfactory agreement with the observed values, a new equation of motion has been suggested which reads: the apparent weight of a particle minus its resistance is equal to the product of the projected area and the difference in pressure between the upper and the under side of the particle. From this relation, a new formula for the falling velocity of spheres in restricted spaces has been derived. The exhaustive tests carried out by Spee on spheres in conical tubes have been of great help in diagnosing exactly the factors involved. The ultimate falling velocity proves to be dependent on δ^2 , i.e., on the ratio between the projected area of the particle and the cross-section of the restricted space. For high values of δ the thickness of the boundary layer has a marked influence on the velocity. With the aid of auxiliary curves the calculation of the rather complicated relations has been simplified. For lower values of δ the new formula gradually passes over to the existing formula for the free fall. For calculating the ultimate velocity of fall of non-spherical particles in restricted spaces, a shape coefficient has been suggested, which can be read from an auxiliary graph.

B.R.R.A.

392. Laboratory Testing of Plastics—small-scale Flexure Test.

O. W. Ward and A. Bailey. *A.S.T.M. Bulletin*, No. 138, 1946.

Description and illustration of apparatus are given for measuring the modulus of elasticity and rupture, with an accuracy of about 1%, by reduced scale test, of plastics using about 1 gram. The method of moulding small beams is also given.

E.W.J.M.

393. The Effect of Milk Products on the Heat Stability and Viscosity of Cream-style Foods.

B. H. Webb and C. F. Hufnagel. *J. Dairy Sci.*, **29**, 221, 1946.

Studies with a MacMichael viscometer.

G.W.S-B.

394. The behaviour of Curved Aluminium Alloy Panels in Compression.

G. Welter. *Aircraft Engineering*, **18**, 56, 1946.

A summary of two reports by Prof. G. Welter, containing experimental data on the effect of size and width of panel, edge conditions, grain of materials and initial imperfections, etc., on the behaviour of curved panels under axial compression. Welter's tests appear to give experimental values for the buckling stress which approach and even exceed the theoretical, but this result may be traced to the experimental edge conditions used whereby the load taken by the panel is reduced.

E.W.J.M.

395. Vapour Pressure—Viscosity Relations in Methyl Polysiloxanes.

D. F. Wilcock. *J. Amer. Chem. Soc.*, **68**, 691, 1946.

With linear methyl polysiloxanes of 7 to 11 silicon atoms simple relations have been found which express vapour pressure and viscosity as functions of temperature and composition. It is concluded by comparing the energy of vaporization with the activation energy for viscous flow that the attraction between molecules in liquid linear polysiloxanes is much lower than those in hydrocarbons of comparable molecular weight.

E.W.J.M.

396. Professor E. C. Bingham—Appreciations.

J. H. Wilson and others. *Rheol. Bull.*, **17**, 1946.