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TABLE OF CONTENTS

RHEOLOGY BULLETIN

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RHEOLOGY PROGRESS ABSTRACTS

APPARATUS AND METHODS

VISCOSITY MEASUREMENT: MASTER VISCOMETERS.

M. R. CANNON, *Ind. Eng. Chem., Anal. Ed.*, **16**, 708–10 (1944).

The construction and operation of two types of master viscometers are described which are designed for accurately calibrating the various types of routine viscometers now in extensive use. Since some fluids change in viscosity with age, the master instruments should be employed to check the standard fluids two or three times per year. The opaque-type master is useful in handling very dark or opaque liquids. B.I.P.C.

DETERMINATION OF YOUNG'S MODULUS OF ELASTICITY FOR FIBERS AND FILMS BY SOUND VELOCITY MEASUREMENTS.

J. W. BALLOU and S. SILVERMAN, *Textile Research*, **14**, 282–92 (1944).

A new method for determining the elasticity of fibers and films is described. Sound waves are passed through the material and cause it to go through rapid stretching and recovery as it vibrates. Measurement of the velocity of sound through the test material—the density of which is known—makes possible the exact calculation of the elastic modulus; it is characteristic of a dynamic, essentially adiabatic, high-loading rate, short-period measurement, since a sound frequency of approximately 10,000 cycles per second is used. Typical results are shown in a number of curves to illustrate applications of the method. B.I.P.C.

PARTICLE SIZE ANALYSIS.

EDMUND N. HARVEY, JR., *Interchem. Rev.*, **3**, No. 3, 59–70 (1944).

The principles of size distribution, methods of measuring particle size and related industrial applications are discussed. 8 references. B.I.P.C.

MEASUREMENT OF THE MODULUS OF RIGIDITY OF SOLID AND LIQUID BODIES.

M. O. KORNFELD, *J. Exptl. Theorel. Phys. U.S.S.R.*, **13**, 116 (1943).

A modification of the method of Stefan, *Sitzber. Akad. Wiss. Wien*, **57**, 697 (1868), for determining the elastic constants of amorphous materials is used. A short cylinder of the material under investigation is mounted on top of a long vertical cylinder of glass or quartz, and the system is subjected to torsional vibrations. From the characteristic frequencies of the lower cylinder alone and of the compound system, and the logarithmic decrement of damping the modulus of rigidity of the upper cylinder and the phase angle between stress and strain can be calculated. In one type of apparatus, used from 10^3 to 2×10^4 cycles per sec., a glass rod is vibrated torsionally by an electromagnetic force. A thin piece of soft iron wire, cemented on the rod, lies between the poles of a horseshoe magnet carrying coils which are excited by an oscillator connected through a 10-watt amplifier. The amplitude of vibration is gaged by the width of blurring of an image of an incandescent filament which

is reflected by a mirror attached to the rod. In a second type of apparatus, used from 2×10^4 to 10^6 cycles per sec., a quartz rod is vibrated torsionally by a piezoelectric force. The lateral surface of the rod is provided with four deposited platinum electrodes at angles of 45° with the optic axis, while the electric axis is parallel to the axis of the rod. It is clamped by four bronze springs which also serve as electrical contacts; each opposite pair is connected to a pole of the oscillator. The characteristic frequencies and damping are determined according to Dye, *Proc. Phys. Soc., London*, **38**, 399 (1926), and Vigoureux, *Quartz Oscillators and Resonators*, London, 1931. In each case, the vibration characteristics of the basic (glass or quartz) rod alone are first determined, and then the material under investigation is mounted on the rod and the measurements are repeated. The method is said to be applicable even to very soft materials, which can be supported by a thin cylindrical shell of paper or aluminum mounted on the basic rod. J. D. FERRY

CHRYSLER RUBBER INJECTION MOLDING MACHINE.

J. V. HENDRICK and D. F. FRASER, *Rubber Age (N. Y.)*, **56**, 3 (December, 1944).

The four basic methods by which rubber and plastic materials may be molded are described and the applications of each are briefly discussed. A new injection molding machine is described in which the conventional cylinder and plunger driving mechanism is replaced by a screw type. Since the injector can be operated continuously, the size of the parts to be made is not limited by its capacity, as is the case with the conventional machine. The new machine is designed so that it may be operated on an automatic cycle, with all operations from the initial closing of the empty mold to its opening for removal of the product controlled by the machine. It is said that the great pressure developed in this process results in a denser product having better physical properties than that obtained by conventional molding methods. It is also stated that scrap resulting from molding defects is greatly reduced and that the high injection pressures ensure that even the driest stocks will knit. R. H. KELSEY

SEAM WELDING OF PLASTICS.

W. C. E. BARNES, *Brit. Plastics*, **16**, 565 (1944).

The author describes a seam welding apparatus which may be referred to as a "high-frequency sewing machine." A working frequency of 50 megacycles is used and the operation is carried on in a manner similar to ordinary sewing, except that needle and bobbin are replaced by two rollers, one of which remains at ground potential while the other carries the high-frequency alternating potential. The rollers are arranged in such a way that danger of shock to the operator is eliminated. Welding speeds and operating power can be varied. Sheet thicknesses between 0.006 and 0.020 inch may be accommodated. The chief advantages of the machine lie in the strength and moisture tightness of the seam. Its scope is claimed to be unlimited in the manufacture of waterproof garments. DAVID TELFAIR

THERMO-ELASTIC FORMING OF LAMINATES.

W. I. BEACH, *Modern Plastics*, **22**, 132–5, 206, 208 (1944).

The author discusses the factors influencing the handling and forming characteristics of fully cured thermosetting laminates, the postforming process resembling that of metal forming to a certain extent. The present method of softening and subsequent shaping contradicts the generalization that thermosetting products, when properly cured, are not subject to reshaping influences. The author states that improperly cured (that is, undercured) laminates tend to produce inferior formed parts and that the use of such material should be avoided. Thermosetting laminates are susceptible to heat-deforming forces throughout their entire useful range. Overcured laminates are capable of good performance, apart from an increasing tendency toward brittleness; they are also somewhat restricted to larger bend radii and generous curved shapes. Fast curing resins of the phenol or cresol type are usually limited to four or five consecutive deforming operations without creating surface crazing of the resin or rupture of the fabric. Cresylic acid mixtures, on the other hand, tend to re-form many more times before the results become erratic and unpredictable. The importance of a careful selection of the filler material is stressed, with particular reference to the superiority of material used on the bias over that cut parallel to the weave. Material stretched on the bias elongates more than twice as much as when pulled in the crosswise or lengthwise direction. In the first case, the elongation results from the deformation of the weave; in the second, it is achieved by lengthening the individual threads. In conclusion, the general behavior and adaptability of laminates to forming techniques and tools is discussed.

B.I.P.C.

WATER VAPOR PERMEABILITY OF ORGANIC FILMS.

PAUL M. DOTY, WM. H. AIKEN, and HERMAN MARK, *Ind. Eng. Chem., Anal. Ed.*, **16**, 686–90 (1944).

An apparatus for a rapid, precise, and reproducible determination of water-vapor permeability is described. It seems that two factors, diffusion velocity and solubility, together determine the vapor permeability of a film. Both can be derived from the measurements. Equations based on the validity of Fick's law were tested with commercial films of low permeability. The dependence of permeability on thickness, vapor pressure, and temperature was studied. On the basis of measurements of a number of films, a discussion of the process of permeation is presented. 16 references.

B.I.P.C.

A BALL IMPACT TESTER FOR PLASTICS.

CHARLES R. STOCK, *A.S.T.M. Bull.*, No. 130, 21–6 (October, 1944).

The recognized defects associated with impact strength tests of plastics where the testing machine has available much more energy than a required minimum to produce fracture has resulted in efforts by various investigators to develop methods not subject to the sometimes large errors resulting from this condition. An apparatus is described which makes use of a set of steel balls of graded weights, from which may be selected one which, after gravitational acceleration down inclined rails, strikes a test specimen horizontally and utilizes all, or almost all, of its kinetic energy in fracturing the specimen. The

construction, operation, and calibration of the apparatus are described, as well as the sources, reduction, and calculation of the magnitudes of several errors, both inherent and experimental. Data are given for several types of thermosetting molded plastics, comparing results obtained by the A.S.T.M. tentative methods of test for impact resistance of plastics and electrical insulating materials as well as by the "ski-ball" method, and pointing out discrepancies in magnitude of the values obtained. Other data illustrate the lower dispersion of results as well as the improved sensitivity obtainable with the latter method.

B.I.P.C.

PHYSICS IN THE SERVICE OF SOUTHERN AGRICULTURE.

SOUTHERN REGIONAL RESEARCH LABORATORY, New Orleans, La., *J. Applied Phys.*, **15**, 629–41 (1944).

The research work of the Southern Regional Laboratory is organized under seven divisions, three of which are devoted to problems related to cotton lint and cotton fabrics, one to investigations on cottonseed and peanuts, and one to sweet potato products, whereas the last two divisions are more general in scope, the one dealing with analytical laboratory techniques, and the other with the development of promising processes at the pilot plant stage. In the present article, a survey is given of those methods of observation and measurement to which physics has contributed in a well-defined and prominent role. They include textile testing, cotton fiber research, testing of textile finishes, physical methods of analysis (spectroscopy, spectrophotometry, and x-ray diffraction), the determination of thermal and thermodynamic properties, applications of viscometry, the testing of rubber and protein adhesives, etc. Several illustrations are included.

B.I.P.C.

STEREOSCOPY WITH THE ELECTRON MICROSCOPE.

L. MARTON, *J. Applied Phys.*, **15**, 726–7 (1944); *cf. B.I.P.C.*, **14**, 321.

With reference to the article by Heidenreich and Matheson—in which the need is pointed out for a universal stage which allows tilting of the object at any desired angle from an external source—the author describes such a universal stage developed in connection with the Stanford electron microscope. Details of the microscope will be published in a separate paper.

B.I.P.C.

THE DEVELOPMENT OF ELECTRON MICROSCOPY AND ITS RELATIONSHIP TO COLLOID CHEMISTRY.

E. RUSKA, *Kolloid-Z.*, **107**, 2–16 (April, 1944). (In German.)

The author reviews the development of electron microscopy and of transmission electron microscopes, giving 35 annotated literature references. The article is written from the angle of the relationship of electron microscopy to colloid chemistry; a bibliography of 134 references is included, representing a compilation of electron-microscopical researches in the colloid field which have appeared up to the end of 1943.

B.I.P.C.

VISCOSITY AND MOLECULAR WEIGHT. III. THE HETEROGENEITY COEFFICIENT.

S. COPPICK, *Paper Trade J.*, **119**, 36–42 (Dec. 28, 1944).

Wood pulps are known to be very heterogeneous as regards both the species and chain length of the component polysaccharides. This nonuniformity leads to divergence from both the theoretical and empirical relationships between viscosity, concentration, and infinite dilution functions which appear to be valid for more uniform preparations. This adds further complications to viscometric methods for the determination of the average molecular weight of commercial wood pulp cellulose. The divergence is followed during sulfate pulping. The results indicate that the distribution of chain length changes during pulping in such a manner as to give viscosity relationships similar to those obtained for blends of a number of pulps. These results confirm the "equalizing" effect of pulping which has been reported by others. Since most commercial pulps may be considered as blends of various proportions of raw and well-cooked fibers, these factors are always present and cannot be neglected in the interpretation of viscosity data. The results indicate that the relationship between viscosity, concentration, and molecular weight must contain a "heterogeneity coefficient." This quantity is worked out for various degrees of sulfate pulping, and the data indicate that its value is unity solely for well-blended, thoroughly cooked or purified pulps. However, with raw cooks, the "heterogeneity coefficient" increases to such an extent as to make viscosity interpretations very inaccurate if the heterogeneity effect is neglected.

R. M. LEVY

VISCOSITY AND MOLECULAR WEIGHT. IV. ACID AND BASIC METHODS.

S. COPPICK, *Paper Trade J.*, **120**, 37–40 (Jan. 4, 1945).

A comparative study is made of the various methods for determining the solution viscosity of wood pulps. These include cuprammonium, cupriethylenediamine, and nitrate viscosities. The molecular magnitude of wood polysaccharide is evaluated from the various solution viscosity data determined at various stages during the purification of wood cellulose. The results indicate that nitrate viscosities are much more reliable than either of the basic methods for celluloses containing residual lignin. Noncellulosic encrustants interfere with the solution of the polysaccharide to such an extent as to produce an entirely erroneous picture of the degradation which occurs during the purification of wood cellulose. By suitable calibration the nitrate method for determining the degree of polymerization may be brought into agreement with the TAPPI standard cuprammonium method.

R. M. LEVY

THE OPTICAL ANISOTROPY OF CELLULOSE FILM.

ROBERT C. GRAY, *J. Soc. Chem. Ind.*, **63**, 241–5 (1944).

The birefringence of cellulose film (cellophane, etc.) is found to be influenced by the pressure in the viscose at the moment of extrusion, by the rate of coagulation, and by the machine direction forces and the transverse

frictional forces exerted on the film during the casting process; the relative retardation is unaffected by change of water contents, but since increase of water content causes increase of thickness, it causes a corresponding reduction in birefringence. The birefringence has a minimum value at the middle of the web and rises toward the selvedges. For the same grade of film, the tensile strength in the machine direction or in the transverse direction is greater, when the birefringence is greater. Stress in the machine direction can increase the permanent birefringence by 50%. Stress in the transverse direction can reduce the permanent birefringence to zero, and can reverse its sign; the final birefringence may be numerically as great as the initial birefringence. All commercial dyed cellulose films are dichroic, the effect being most pronounced in the chocolates and mauves. 29 references. B.I.P.C.

THE STUDY OF CELLULOSE FIBERS. VII. THE PHYSICAL STRUCTURE OF FIBERS.

K. LAUER, *Kolloid-Z.*, **107**, 93–103 (May, 1944). (In German.)

The article, which is mostly speculative, deals particularly with the dry and wet strength of native cellulose and cellulose hydrate fibers (including mercerized cotton fibers) measured in water and organic liquids. An explanation for the different behavior of the various types of fibers toward different liquids of immersion is attempted on the basis of two assumptions. (1) The native cellulose fiber is conceived as being built up of spiral ribbons composed of lamellas, representing the crystalline portions of the fiber, with the amorphous portions in between the spiral ribbons, the lamellas being composed of fibrils which run parallel to the fiber axis. In contrast, cellulose hydrate fibers are pictured as lacking the spiral-ribbon arrangement, the crystalline and amorphous portions being arranged at random. (2) Hermans' β-glucopyranose model (*cf. B.I.P.C.*, **13**, 428), in which the hydroxyl groups are located on one side of a plane, and believed to be projected parallel to the fiber axis, through the anhydroglucose ring, whereas the hydrogen atoms are located on the other side of the plane. In their behavior toward water and organic liquids, distinction is thus made between hydrophilic planes (hydroxyl groups) and hydrophobic and lyophilic planes (C-H groups). Since the main forces which are effective as lattice energy ("forces of orientation") are produced by oppositely located hydroxyl groups, it is probable that the ring planes with the C-H groups lie on the outer surfaces of the spiral ribbons ("forces of dispersion"). It is suggested that, on the immersion of the fiber in water, the water molecules combine only with those hydroxyl groups which are located in the amorphous portions of the fiber, whereas organic liquids are adsorbed on the lyophilic planes. The difference in wet-strength retention between native cellulose and cellulose hydrate fibers is explained by the assumption that the surfaces of the crystalline portions of native cellulose fibers are hydrophobic, whereas those of the cellulose hydrate fibers are hydrophilic. Thus, the tensile strength and elongation of the cotton fiber are retained or even increased in the water-wet state, but decrease in benzene, pyridine, and glacial acetic acid. In contrast, the tensile strength of cellulose hydrate fibers increases in glacial acetic acid but the elongation decreases. Mercerized cellulose (prepared with or without tension) shows a behavior toward water and organic liquids which is more similar to that of cotton than to that of the cellulose hydrate fibers. Freezing of wet cellulose fibers at about −150 °C. causes no loss in tensile strength for

cotton; however, staple fiber loses between 10 and 40%. Both fibers show an increase in elongation. The swelling ability of the frozen cotton fiber increases, while that of the staple fiber decreases. These results are interpreted to show that, in the case of the cotton fiber, freezing results only in a loosening up of the physical structure, whereas in the case of the staple fiber, primary valences are also ruptured. Strength, elongation, and swelling of mercerized cotton remain practically unchanged after freezing, whereas formaldehyde-treated staple fiber shows similar losses as ordinary staple fiber, with the exception of the swelling ability, which increases. Freezing of the various types of fibers in air-dry condition produces similar results, but to a considerably smaller extent. 23 references.

B.I.P.C.

CRYSTALS

ELASTICITY OF A CRYSTAL AS DEPENDENT ON TEMPERATURE.

M. O. KORNFELD and P. SHESTIKHIN, *Compt. rend. acad. sci. U.R.S.S.*, **36**, 52 (1942).

The rigidities of ice, tin, and stearin were studied at different temperatures with the apparatus described in a preceding abstract. In each case the modulus of rigidity diminishes with increasing temperature, and, for stearin, there is an enormous drop as the melting point is approached. Representative values are as follows: Ice: 88°K., 1.68×10^{10} dynes per sq. cm.; 273.0°, 1.14×10^{10}. Tin: 103°, 22.5×10^{10}; 503°, 2.55×10^{10}. Stearin: 88°, 0.79×10^{10}; 313°, 0.20×10^{10}; 323°, 0.005×10^{10}.

J. D. FERRY

LIQUIDS

VISCOSITIES AND RHEOCHORS OF ALDEHYDES, NITRILES AND OF SECONDARY AND TERTIARY AMINES.

J. N. FRIEND and W. D. HARGREAVES, *Phil. Mag.*, **35**, 619–31 (1944).

Data are given for viscosities of 15 amines, 9 nitriles and 6 aldehydes up to their respective boiling points. The data are tested against a rheochor previously reported (*Phil. Mag.*, **34**, 643, 1943). $R = M(10^3\eta)^{1/8}(D + 2d)$, where M = mol. wt., D = density of liquid, d = density of vapor and η = viscosity. The following values are given for R as determined in this and in the previous research:

C	12.8	Cl	27.3
H (in C—H)	5.5	NH_2	20.6
H (in O—H)	10.0	NH	13.6
O< etheric	10.0	CN	33.0
O< ketonic	13.2	N(—)	13.6
Covalent bond	0	C_5H_5, attached to alkyls	100.7
Coordinate bond	(−0.4)	attached to others	102.7
		Satd. 6-member ring	5.6

Numerous references.

S. ZERFOSS

RIGIDITY MODULUS OF LIQUIDS AND ITS DEPENDENCE ON TEMPERATURE.

M. O. KORNFELD, *Compt. rend. acad. sci. U.R.S.S.*, **38**, 298 (1943).

The rigidity of rosin was studied with the apparatus previously described. Taking the ratio of stress to strain as G_{eff}, the rigidity G and vis-

cosity η are given by $G = G_{eff}/\cos\theta$, $\eta = G_{eff}/\omega \sin\theta$ where θ is the phase angle between stress and strain and ω is the angular frequency. The value of G decreases with increasing temperature and falls off rapidly as the melting point is approached. Representative values: 1.2×10^{10} dynes per sq. cm. at 0 °C., 0.2×10^{10} at 60 °C. The logarithm of η is approximately a linear function of the temperature; values of η calculated from the vibration measurements agree with those measured in a rotation viscometer. It is concluded that the elastic behavior of rosin is described by the Maxwell relationship with only one relaxation time.

J. D. FERRY

LUBRICATION

ACTION OF *n*-PRIMARY ALCOHOLS AS METAL CUTTING FLUIDS — ALTERNATING PROPERTIES WITH CHAIN LENGTH.

MILTON C. SHAW, *J. Am. Chem. Soc.*, **66**, 2057 (1944).

It has been found that there is an alternation in the cutting force required to remove chips from aluminum blocks at low cutting speed when the cutting fluids are successively normal, primary, monohydric alcohols. A higher cutting force is required for alcohols having an even number of carbon atoms.

METALS

THE DEPENDENCE ON STRESS OF THE DAMPING CAPACITY OF ALLOYS.

ANDREW GEMANT, *Mech. Eng.*, **67**, 33 (1945).

This paper is concerned with the problem of establishing whether alloys exist which have a low damping capacity at low stresses but a considerably higher damping at high stresses and, if so, what type of alloying favors such a characteristic. This is important from the standpoint of reduction of unwanted vibration in airplane propellers, steam turbines, internal combustion engines, and other rotating or reciprocating equipment. An analysis is carried out on the basis of a correlation between damping capacity and creep characteristics, both being related to certain components of the flow resistance of the material. On this basis, experimental data in the literature on both creep and damping of alloys are analyzed, the results being presented in the form of tables and curves. The conclusion is that alloys of the desired damping characteristics do exist and that certain alloying elements, silicon and nickel in particular, appear to impart this characteristic to both ferrous and nonferrous metals. The influence of alloying elements upon the stress dependence of damping is explained physically, applying Eyring's flow theory to this case.

AUTHOR'S ABSTRACT

POLYMERS

EFFECT OF CHEMICAL STRUCTURE ON PHYSICAL PROPERTIES OF SYNTHETIC PLASTICS.

W. O. BAKER, *Bell. Lab. Record*, **22**, 637 (1944).

A series of x-ray studies of various polyester and polyamide fibers is described. Both the physical properties and x-ray diagrams are shown to change markedly when the polyethylene chain is modified chemically by the introduction of attractive centers such as the C=O group, and NH group.

Also, the degree of order of the molecular arrangement as influenced by quick cooling or annealing is shown to be of importance. To quote the author: "There are two structural factors that determine the useful properties of plastics: First, the concentration or frequency of occurrence along the chain molecules of strong attractive centers, which may be regulated by chemical composition. Secondly, the degree of order of the molecules in these layers which may be modified by heat treatment, by added agents such as plasticizers, or by the introduction of side groups in the molecule." DAVID TELFAIR

PROTEINS

SIZE DISTRIBUTION IN GELATIN SOLUTIONS.

G. SCATCHARD, J. L. ONCLEY, J. W. WILLIAMS, and A. BROWN, *J. Am. Chem. Soc.*, **66**, 1980–81 (1944).

The size distributions of gelatins of different degrees of degradation were studied experimentally. The following picture of the degradation process was derived: "Collagen consists of long chains of polypeptide residues. The bonds between these residues are usually hydrolyzed at about the same rate, but there are a very few bonds equally spaced along the chain which hydrolyze very much more rapidly. In the preparation of gelatin, nearly all the more reactive bonds and a small fraction of the less reactive bonds are hydrolyzed. The degradation of gelatin consists largely in the hydrolysis of the less reactive peptide bonds. There is thus an ideal parent undegraded gelatin molecule, which is the length of chain between two reactive bonds. Real gelatin consists of a mixture of such molecules with the products of their degradation, which include every possible peptide from single amino acids to chains containing only one less residue than the parent molecule." T. ALFREY

SUSPENSIONS

VISCOSITY AND RIGIDITY OF STRUCTURAL SUSPENSIONS.

PAUL S. ROLLER and C. KERBY STODDARD, *J. Phys. Chem.*, **48**, 410–25 (1944).

The authors analyze the phenomena of rigidity and viscous flow in structural suspensions using data obtained on bentonite suspensions and data from the literature. They trace the flow behavior from the state of rest to the state of complete breakdown of the rigid structure where the viscosity becomes constant. At zero rate of shear, the shear stress for structural suspensions is shown to be zero theoretically as well as experimentally. Measurement of the breaking strength of a structural suspension cannot be measured by using rate of shear as the variable but can be measured with the angular displacement as the variable. At zero rate of shear the viscosity is infinite. The existence of structural suspensions is wide and may be found in quite dilute suspensions. C. K. BUMP

RHEOLOGICAL INVESTIGATIONS OF CONCENTRATED SUSPENSIONS WITH SPECIAL CONSIDERATION OF THEIR USE IN THE MANUFACTURE OF COATED PAPER.

H. ERBRING, S. BROESE, and H. BAUER, *Kolloid-Beihefte*, **54**, 365–434 (March 31, 1943). (In German.)

The rheological behavior of suspensions of blanc fixe (barium sulfate), satin white (sodium aluminate, calcium sulfate, and calcium oxide), and

kaolin with various starch preparations, casein, sodium polyacrylate, and bentonite was studied by the use of a modified Couette rotational (torsion) viscometer, an Ostwald-Auerbach overflow viscometer, and an Auerbach vibration viscometer. B.I.P.C.

RATE OF SEDIMENTATION; CONCENTRATED FLOCCULATED SUSPENSIONS OF POWDERS.

HAROLD H. STEINOUR, *Ind. Eng. Chem.*, **36**, 901–7 (1944); *cf. B.I.P.C.*, **15**, 68.

Rates of sedimentation are reported for concentrated flocculated suspensions of various finely divided solids, including microscopic glass spheres. Most of these solids were tested at more than one fineness. Each powder embraced a wide range of particle sizes and was tested at a series of concentrations. A rate equation previously found applicable to flocculated suspensions of approximately uniform-size emery particles was, in general, supported by the new data. The equation is shown to be compatible with Powers' equation for portland cement pastes. 14 references. B.I.P.C.

THEORY

STRUCTURE OF COPOLYMERS. II.

FREDERICK T. WALL, *J. Am. Chem. Soc.*, **66**, 2050 (1944).

A theoretical analysis of some of the implications of the currently accepted theory of vinyl copolymerization. The author recognizes four distinct propagation processes:

(1) A monomer of type A adding to an active chain-end of type A.
(2) A monomer of type A adding to an active chain-end of type B.
(3) A monomer of type B adding to an active chain-end of type A.
(4) A monomer of type B adding to an active chain-end of type B.

The chemical structure of the copolymer is determined by the relative rates of these four competing reactions. The significant quantities are the two ratios σ and ρ, where $\sigma = k_1/k_3$ and $\rho = k_4/k_2$. Mathematical expressions are advanced for the composition of the copolymer as a function of monomer composition, etc. Graphs of these functions for various special cases—special values of σ and ρ—are presented. A novel feature of this paper is the striking analogy made between a copolymerization reaction and the distillation of a binary liquid mixture. Although in general the chemical composition of the copolymer will not be identical with that of the monomer, there will be special pairs of monomers which obey "the counterpart of Raoult's law," and others which form "azeotropic" copolymers. The analogy between "azeotropic copolymerization" and azeotropic distillation is discussed particularly thoroughly. T. ALFREY

POLYMERIZATION; A GREAT FIELD OF CHEMISTRY AHEAD.

G. S. WHITBY, *Chem. Eng. News*, **22**, 1570–75, 1612 (Sept. 25, 1944).

The number of high molecular types in nature is small, cellulose, proteins, and rubber being the most important naturally occurring macromolecular organic materials. A much wider variety of types can be made synthetically by polymerization, either addition or condensation polymerization. The

principles of both reactions are explained and illustrated by examples. The solubility of polymers, their electrical properties, the significance of the degree of polymerization, and the development of useful derivatives from synthetic polymers with properties different from the starting materials are discussed. 11 references.

B.I.P.C.

ABSTRACTORS IN THIS ISSUE

T. ALFREY, JR.
C. K. BUMP
J. D. FERRY
A. GEMANT
R. H. KELSEY
R. M. LEVY
D. TELFAIR
S. ZERFOSS

BULLETIN OF THE INSTITUTE OF PAPER CHEMISTRY (B.I.P.C.)

PROPOSED OFFICERS OF THE SOCIETY FOR 1946

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BINGHAM RHEOLOGY
INDEX B

B1 ALLEN, H. V., JR., *Petroleum Refiner*, **23**, 247–252 (1944). Pressure drop for flow through beds of granular adsorbents. *C.A.* **38**, 4474.

B2 ARNOLD, J. HOWARD, *Trans. Am. Inst. Chem. Engrs.*, **40**, 361–378 (1944); *cf. C.A.* **25**, 17. Studies in diffusion. III. Unsteady-state vaporization and absorption. *C.A.* **38**, 4155.

B3 AULUCK, F. C., and KOTHARI, D. S., *Nature*, **153**, 777 (1944). The hole theory of liquids. (A simple but not quant. description of the variation of viscosity with the pressure.) *C.A.* **38**, 5443.

B4 AVILOV, A. A., and PISARENKO, A. P., *Tsentral. Nauch.-Issledovatel. Inst. Kozhevennoĭ Prom., Sbornik Rabot*, **13**, 187–211 (1940). The relation between physical-mechanical constants and the wear properties of rubber soles. (Too great hardness is undesirable.) *C.A.* **38**, 5106.

B5 AVGUSTINNIK, A. I., *Keramicheskiĭ Sbornik*, **1940**, No. 11, 20–24; *Khim. Referat. Zhur.*, **4**, No. 7-8, 25–26 (1941). The role of ions in the thixotropy of clays. *C.A.* **38**, 673.

B6 BAKER, EDWIN M., and HIPKIN, HOWARD, *Trans. Am. Inst. Chem. Engrs.*, **40**, 291–308 (1944). Film coefficients for condensation of organic vapors on a single vertical Cu tube. *C.A.* **38**, 4158.

B7 BALL, J. M., and MAASEN, G. C., *Am. Soc. Testing Materials*, Symposium on Applications of Synthetic Rubbers, **1944**, 27–38. The physical properties of synthetic rubbers. *C.A.* **38**, 5431.

B8 BARGONE, A., *Met. ital.*, **34**, 473–482 (1942). The influence of the viscosity of the slag on the course of the reaction in the production of steel in the basic electric furnace. (Explanation by theory of Losana.) *C.A.* **38**, 4539.

B9 BARRER, R. M., *Trans. Faraday Soc.*, **39**, 237–241 (1943). Zone of activation in rate processes. *C.A.* **38**, 909.

B10 BASTIEN, P., *Compt. rend.*, **214**, 355–357 (1942). The diffusion into steel of the atomic hydrogen resulting during pickling in acid solutions. (Solid soln. of iron and H with increase in hardness and lowering of strength.) *C.A.* **37**, 2319.

B11 BATTISTA, O. A., *Ind. Eng. Chem., Anal. Ed.*, **16**, 351–354 (1944). Molecular weight of cellulose. Measurement of average degree of polymerization. *C.A.* **38**, 3892.

B12 BECHER, CARL, JR., *Gelatin Leim Klebstoffe*, **10**, 27–32, 49–55, 73–78, 99–102 (1942). The manufacture of adhesives. *C.A.* **37**, 5162.

B13 BERGER, A., *Kolloid-Z.*, **103**, 185–202 (1943). Colloidal Ni hydroxide. Lamellar dispersed substances. *C.A.* **38**, 4853.

B14 BJÖRNSTÄHL, Y., *Kolloid-Z.*, **97**, 46–53 (1941). Streaming double refraction in absorbing optically active solutions. *C.A.* **37**, 19.

B15 BLANCHARD, KENNETH C., *Cold Spring Harbor Symposia Quant. Biol.*, **8**, 1–8 (1940). Water, free and bound. *C.A.* **38**, 672.

B16 BOER, J. DE, *Physica*, **10**, 348–356 (1943). Transport phenomena of gaseous He at very low temps. (The heat cond. and η are proportional to each other from 40°K. to 600°K. Corrections are large at low temps.) *C.A.* **38**, 5121.

B17 BOGOYAVLENSKIĬ, A. F., *J. Gen. Chem. U.S.S.R.*, **12**, 392–397 (1942). Effect of temperature on the electrophoretic transfer of collargol. *C.A.* **37**, 2978.

B18 BOND, D. C., *Am. Inst. Mining Met. Engrs., Tech. Pub.* No. 1674, 10 pp. (1944). Positive colloid muds for drilling through heaving shale. (Bentonite plus basic dyes plus flour or starch.) *C.A.* **38**, 5385.

B19 BOOYS, J., Ger. 719,691, March 19, 1942. Viscose of normal viscosity. *C.A.* **37**, 2181.

B20 BRENSCHEDE, M., *Kolloid-Z.*, **101**, 64–72 (1942); *Chem. Zentr.*, **1943**, I, 716. The elasticity and viscosity of rubberlike substances. *C.A.* **38**, 4179.

B21 BUIST, J. M., and SEYMOUR, R. C., *Rubber Chem. Tech.*, **17**, 366–391 (1944). Position of the rubberlike state on the plastic-elastic scale. *C.A.* **38**, 1907, 5689.

B22 BRUIJN, H. DE, *Rec. trav. chim.*, **61**, 863–874 (1942). Viscosity of suspensions of spherical particles. (The fundamental η–c and Φ–c relations.) *C.A.* **38**, 4851.

B23 BULL, H. B., and GUTMANN, M., *J. Am. Chem. Soc.*, **66**, 1253–1259 (1944). Elasticity of keratin fibers. *C.A.* **38**, 5229.

B24 BUNGENBERG DE JONG, H. G., and MEER, C. V. D., *Proc. Acad. Sci. Amsterdam*, **45**, 490–497 (1942). Factors that determine the volumes of the complex coacervates from gelatin and gum arabic under the influence of neutral salts. (No η.) *C.A.* **37**, 6180.

B25 BRAJNIKOV, B., *Compt. rend.*, **215**, 271–273 (1941). Some properties of silt. *C.A* **37**, 3313.

B26 CHASMAN, B., *Modern Plastics*, **21**, 45–48, 62 (Feb., 1944). Creep and time-fracture strength of plastics under tensile stresses. *C.A.* **38**, 5021.

B27 CHAUDBURY, S. G., and BHATTACHARYA, K. L., *Nature*, **153**, 713 (1944). Cataphoretic velocities of $Cu_2Fe(CN)_6$ sol. *C.A.* **38**, 5449.

B28 CHITTICK, M. B., *Inst. Spokesman*, **5**, No. 3, 3, 6–8; No. 4, 3–4, 7–8; No. 5, 4–5, 8; No. 6, 2, 5, 8; No. 7, 8; No. 8, 5–8 (1941). Rationalizing lubricating greases. (Classification of National Lubricating Grease Institute. 453 refs.) *C.A.* **37**, 4556.

B29 CLARK, C. L., *Oil Gas J.*, **40**, No. 39, 35, 48 (1942). Relative hot-ductility of steels shown by stress-rupture data. *C.A.* **37**, 1969.

B30 COE, J. R., and GODFREY, T. B., *J. Applied Phys.*, **15**, 625–626 (1944). Viscosity of water. (Find provisional value for absolute viscosity of water at 20° to be 1.002 cp.) *C.A.* **38**, 5122.

B31 COHAN, LEONARD H., *J. Am. Chem. Soc.*, **66**, 98–105 (1944). Hysteresis and the capillary theory of adsorption of vapors. *C.A.* **38**, 1158.

B32 COOPER, A., *India-Rubber J.*, **106**, 116–119, 145–146, 148–149, 173–177 (1944). The plasticizing of rubber. Progress made in recent years. (Methods of measuring plasticity, the mechanism of plasticity, methods of plasticization by mech., phys. and chem. means.) *C.A.* **38**, 5105.

B33 COOPER, L. V., *Am. Soc. Testing Materials*, Symposium on Applications of Synthetic Rubbers, **1944**, 17–26. *C.A.* **38**, 5430.

B34 CURRIE, A. B., *Mfg. Chemist*, **14**, 194–197 (1943). Elutriation. (Rev. of theory and practice.) *C.A.* **37**, 6163.

B35 DAVIS, D. S., *Ind. Eng. Chem.*, **35**, 1128 (1943). Nomograph for apparent viscosity of sulfite stock. *C.A.* **37**, 6455.

B36 DESTRIAU, G., and MASSIEU, G., *Compt. rend.*, **215**, 64–65 (1942). η of Hg subjected to the action of a magnetic field. (Foucault currents may mask completely the effect of the field.) *C.A.* **38**, 5119.

B37 DEYSHER, E. F., WEBB, B. H., and HOLM, G. E., *J. Dairy Sci.*, **27**, 345–355 (1944). The η of evaporated milks of different solid concentrations. *C.A.* **38**, 4706.

B38 DOCK, E. H., *J. Rubber Research*, **13**, 19–22 (1944). Hardness testing of vulcanized rubber, IV. Investigation of the ball indentation test. Part 2. Period of application of the load. *C.A.* **38**, 5112.

B39 DOUGLAS, H. W., *Trans. Faraday Soc.*, **39**, 305–311 (1943). Electrophoretic behavior of certain hydrocarbons and the influence of temperature thereon. *C.A.* **38**, 1159.

B40 DUNKEN, H., FREDENHAGEN, I., and WOLF, K. L., *Kolloid-Z.*, **101**, 20–30 (1942). (Gliding friction and interfacial tension. Friction at 17 cm./sec. at 20° given for MeOH, EtOH, PrOH, BuOH, hexanol, and various acids.) *C.A.* **38**, 5447.

B41 DUNN, C. G., *Am. Inst. Mining Met. Engrs., Tech. Pub.* No. 1691, 15 pp. (1944). Recrystallization and twin relationships in Si ferrite. *C.A.* **38**, 5481.

B42 EDWARDS, C. A., PHILLIPS, D. L., and LIU, Y. H., *J. Iron Steel Inst. (London)*, 23 pp. (Jan., 1943). The yield point in steel. *C.A.* **37**, 2319.

B43 EIJNSBERGEN, J. F. H. VAN, *Chim. peintures*, **5**, 4–7 (1942). The paste index of various pigment–plasticizer mixes in the formulation of cellulose-base finishes. *C.A.* **37**, 5259.

B44 ELENBAAS, W., *Physica*, **9**, 665–671 (1942); *Chem. Zentr.*, **1942**, II, 2461; *cf. C.A.* **37**, 4277. Heat transfer by free convection. Horizontal and vertical cylinders, spheres. *C.A.* **38**, 3879.

B45 ENDRES, H. A., *Rubber Age (N. Y.)*, **55**, 361–366 (1944). Derivatives of synthetic rubber. *C.A.* **38**, 5109.

B46 ENGELHARDT, WOLF v., *Kolloid-Z.*, **103**, 88 (1943); *cf. C. A.* **37**, 5900. The theory of thixotropy. *C.A.* **38**, 673.

B47 ERNST, H., and MERCHANT, M. E., *Am. Soc. Metals*, Symposium on Surface Treatment of Metals, **1941**, 299–335. Chip formation, friction and high-quality machined surfaces. (If films are absent, friction rises to high values, and causes union of opposing surfaces. Illustrative data for Al, Cu, Ni, Pb, Sb, Cd, Co, Mg, Zn, Fe. Photographs.) *C.A.* **37**, 1965.

B48 EVERSOLE, W. G., and BOARDMAN, W. W., *J. Phys. Chem.*, **46**, 914–926 (1942). A new method for the determination of electrokinetic potential in the flow of a semiconducting liquid through a single capillary. *C.A.* **37**, 2978.

B49 EYRING, H., *Am. Scientist*, **32**, 87–102 (1944). The drift toward equilibrium. *C.A.* **38**, 4498.

B50 FARRINGTON, B. F., KOSTAINSEK, V. M., DENISON, G. H., JR., U. S. 2,346,156, April 11, 1944. Deterioration inhibitors for bearing lubricants. *C.A.* **38**, 5395.

B51 FEITKNECHT, W., SIGNER, R., and BERGER, A., *Kolloid-Z.*, **101,** 12–20 (1942). Sols with lamellar particles. (Particle size from η and streaming-double refraction with the Peterlin and Stuart formula.) *C.A.* **38,** 4492.

B52 FOWLER, F. C., and BROWN, G. G., *Trans. Am. Inst. Chem. Engrs.*, **39,** 491–516 (1943). Contamination by successive flow in pipe lines. *C.A.* **37,** 6163.

B53 FRIEND, J. N., and HARGREAVES, W. D. (1) *Phil. Mag.*, **35,** 57–64 (1944). Viscosities at the boiling point of some primary amines, cyclohexane and some of its derivatives. *C.A.* **38,** 4169.

(2) *Phil. Mag.*, **35,** 136–147 (1944). Viscosities of unsaturated six-membered isocyclic compounds. *C.A.* **38,** 4169.

B54 FRITZ, W., HENNENHOFER, J., and WEBER, W., *Oel u. Kohle*, **39,** 792–801 (1943). The accuracy of viscosity determinations with the Vogel-Ossag, Ubbelohde and Höppler viscometers. *C.A.* **38,** 3879.

B55 GAMSON, B. W., THODOS, G., and HOUGEN, O. A., *Trans. Am. Inst. Chem. Engrs.*, **39,** 1–35 (1943). Heat, mass and momentum transfer in the flow of gases through granular solids. *C.A.* **37,** 2227.

B56 GEORGI, C. W., *Inst. Spokesman*, **7,** No. 5, 1, 4–7; No. 6, 2, 4–7 (1943). Survey of lubricating-grease test methods. *C.A.* **38,** 4782.

B57 GORDON, I. M., *Zavodskaya Lab.*, **10,** No. 1, 100 (1941). The recording of the time in the determination of the viscosity of liquids. *C.A.* **38,** 4157.

B58 GRAF, L., *Z. Physik*, **121,** 73–99 (1943). Structure of real crystals. Formation of mosaic structure in cast, plastically deformed and recrystallized material. *C.A.* **37,** 6173.

B59 GREEN, H. G. (1) *Phil. Mag.*, **34,** 393–395 (1943). A note on the motion of a Hg index in a capillary tube. (The theoretically derived value is 6% too high.) *C.A.* **37,** 6172.

(2) U. S. 2,345,968, April 4, 1944. Apparatus and method for measuring flow characteristics, such as tack, yield value, viscosity of liquids. *C.A.* **38,** 2276.

B60 GUBAREV, A. S., *Tsentral. Nauch.-Issledovatel. Inst. Kozhevenno-Obuvnoĭ Prom., Sbornik Rabot* **13,** 147–186 (1940). Physical-mechanical properties of sole rubber and artificial leather. (The more repeated bendings withstood, the fewer cracks and breaks in actual wear.) *C.A.* **38,** 5106.

B61 GUNDERMANN, J., *Kolloid-Z.*, **99,** 142–147 (1942). Effect of very fine grinding on the heat of solution and heat of wetting of sugar and cellulose. (Structure of crystal lattice partly destroyed. These heats may be used for testing the effic. of grinding.) *C.A.* **37,** 4297.

B62 HAEHL, A., *Rev. gén. caoutchouc*, **20,** 3–6 (1943). An investigation of the plasticization of reclaimed rubber. *C.A.* **38,** 5112.

B63 HAFFNER, FRITZ, Ger. 738,286, July 8, 1943 (Cl. 50c. 17.40). Fine grinding. *C.A.* **38,** 3881.

B64 HALLSTROM, M. AF, *Ann. Acad. Sci. Fennicae Ser. A II, Chem.*, **1942,** No. 2, 7 pp. Diffusion of K, Na and Li chlorides in cane sugar solution. (In 2*M* sugar soln. the velocity of diffusion decreases in the sequence LiCl-NaCl-KCl, which is the inverse to that in pure H_2O, explained by changes in hydration of the cations.) *C.A.* **38,** 4853.

B65 HAMDI, H., *Kolloid-Beihefte*, **54**, 554–634 (1943). The colloidal chemical properties of humus. Dispersoid chemical observations with graphite oxide. (Degree of dispersion and η increase rapidly with NaOH to pH 10.2 and then decrease rapidly.) *C.A.* **38**, 4495.

B66 HARTMANN, H., *Z. physik. Chem.*, **191A**, 197–212 (1942). The mobility of the hydrogen ion in water–dioxane mixtures. *C.A.* **37**, 6182.

B67 HARDT, C., *Univ. Microfilms*, Pub. No. 586, 223 pp. The operation and application of the Tiselius electrophoresis apparatus. *C.A.* **38**, 5448.

B68 HEMPEL, M., and KRUG, H., *Mitt. Kaiser-Wilhelm Inst. Eisenforsch. Düsseldorf*, **24**, 97–103 (1942). Effect of the elastic limit upon the bending fatigue strength of steel. *C.A.* **37**, 1970.

B69 HERRENG, P., *Compt. rend.*, **217**, 75–77 (1943). The mobility of free electrons in A. *C.A.* **38**, 4506.

B70 HOLLER, H., and SCHEDULER, H. *Autogene Metallbearbeit*, **35**, 141–152 (1942). Behavior of welded steels at low temperatures. *C. A.* **38**, 5188.

B71 HORGER, O. J., and NEIFERT, H. R. *Am. Soc. Metals*, Symposium on Surface Treatment of Metals, **1941**, 279–296. *C.A.* **37**, 1965.

B72 HORNER, WM. L. (to Core Laboratories, Inc.). Measuring the porosity of solids such as porous sandstone. *C.A.* **38**, 666.

B73 HOUWINK, R., *Kunststoffe*, **34**, No. 2, 25–26 (1944). Migration of foreign ions in synthetic resins. *C.A.* **38**, 5449.

B74 JOLIVET, H., *Rev. mét.*, **39**, 233–246 (1942). Structure of cast steels. Brittleness and intergranular fracture. *C.A.* **38**, 4544.

B75 JIRGENSONS, B., *J. prakt. Chem.*, **162**, 237–244 (1943). Viscosity measurements on solutions of deaminoproteins. *C.A.* **38**, 4969.

B76 JOHNSON, W. S., U. S. 2,346,107, April 4, 1944. Elasticity inhibitor in methylacrylate resins. *C.A.* **38**, 5027.

B77 JUNG, E., *Bodenkunde u. Pflanzenernähr.*, **32**, 325–336 (1943). Clay–humus complexes. (Adsorption decreases markedly with increase in temp. indicating that the adsorption is by secondary valence.) *C.A.* **38**, 5036.

B78 KÄSTNER, H., and FISCHER, E., *Z. Metallkunde*, **33**, 323–327 (1941). Influence of iron content upon the working qualities of a zinc alloy. (All Fe admixtures show reduction in deformability due to Fe Zn crystal fragments.) *C.A.* **37**, 3386.

B79 KEEN, W. N., *India Rubber World*, **110**, 174–175, 181 (1944). The du Pont modified Williams plastometer. (The recovery value is an important measure of processability.) *C.A.* **38**, 5105.

B80 KENYON, J. W., *Proc. Am. Soc. Testing Materials*, 6 pp. (1943). Fatigue properties of some cold-drawn Ni-alloy wires. (Fatigue strength, tensile strength and fatigue tensile ratios.) *C.A.* **37**, 6233.

B81 KERN, D. Q., and OTHMER, D. F., *Trans. Am. Inst. Chem. Engrs.*, **39**, 517–555. (1943). Effect of free convection on viscous heat transfer in horizontal tubes *C.A.* **37**, 6164.

B82 KERTESZ, Z. I., and LOCONTI, J. D., *N. Y. (Geneva) Agr. Exptl. Sta. Tech. Bull.* No. 272, 36 pp. (1944). Factors determining the consistency of commercial canned tomato juice. *C.A.* **38**, 4053.

B83 KING, R. M., *Glass Ind.*, **23**, 421–423, 440 (1942). Adherence of glass to metals. (Weyl's theory of "oxygen bonds." No η.) *C.A.* **37**, 2527.

B84 KNIGHT, C. A., *J. Exptl. Med.*, **80**, 83–100 (1944). Sedimentable component of allantoic fluid and its relationship to influenza viruses. (Sedimentation constant depends upon conc. and η of the material.) *C.A.* **38**, 5289.

B85 KNOPF, C. L., *Inst. Spokesman*, **6**, No. 3, 1, 6–7; No. 4, 4–5; No. 5, 2–3, 6–7 (1942). Conical cup for A.S.T.M. penetration test. *C.A.* **37**, 4557.

B86 KÖRBER, R., and EICHINGER, A., *Mitt. Kaiser-Wilhelm-Inst. Eisenforsch. Düsseldorf*, **26**, 37–50 (1943). Resistance against deformation of cold-rolled steel. *C.A.* **38**, 5481.

B87 KORNFEL'D, M. O., *Compt. rend. acad. sci. U.R.S.S.*, **38**, 298–300 (1943) (in English). Rigidity modulus of liquids and its dependence on temperature. *C.A.* **38**, 903.

B88 KOTT, H., U. S. 2,309,910, Feb. 2, 1943. Viscometer (automatic testing and regulating) for printing inks. *C.A.* **37**, 3980.

B89 KOTTLER, F., *J. Phys. Chem.*, **48**, 76–80 (1944); *cf. C.A.* **37**, 5295. Mixture law for viscosity. *C.A.* **38**, 4169.

B90 KRAUSE, O., and KLEMPIN, U., *Sprechsaal*, **75**, 229–231, 251–255, 273–276 (1942). The relationship between particle size of quartz and the properties of hard porcelain. *C.A.* **38**, 5373.

B91 KRIENKE, C. F., *Oel u. Kohle*, **39**, 840–847 (1943). The testing of lubricating oils by friction and wear tests in engines. (Oils containing graphite or fatty oil showed a greater reduction in wear than straight mineral oils.) *C.A.* **38**, 5388.

B92 KRIENKE, C. F., *Oel u. Kohle*, **40**, 19–23 (1944). Lubricating-oil tests with a four-ball testing machine. ("Oiliness" of mineral, fatty and S-containing oils compared with notable results.) *C.A.* **38**, 5067.

B93 KRUYT, H. R., and VAN SELMS, F. G. (1) *Rec. trav. chim.*, **62**, 407–414 (1943) (in English); *cf. C.A.* **36**, 6873, and preceding abstract. The influence of traces of water on the plasticity of starch and quartz suspensions in organic media. *C.A.* **38**, 3890.

(2) *Rec. trav. chim.*, **62**, 415–426 (1943) (in English); *cf.* preceding abstracts. The influence of a third phase on the rheology of suspensions. *C.A.* **38**, 3891.

B94 LACOMBE, J. DE, *Rev. mét.*, **39**, 105–111, 152–158, 171–188 (1942). High-temperature creep properties of steels subjected to tensional loads. (A method for decomposing creep into its elastic, viscous and plastic components.) *C.A.* **38**, 4541.

B95 LAMPORT, H., *J. Clin. Investigation*, **22**, 461–470 (1943). Improvements in calculation of renal resistance to blood flow. Charts for osmotic pressure and viscosity of the blood.

B96 LAUFFER, M. (1) *J. Am. Chem. Soc.*, **66**, 1188–1194 (1944). Size and shape of tobacco mosaic virus particles. (Data on sedimentation, η, and diffusion are in excellent agreement on particle size.) *C.A.* **38**, 4655.

(2) *J. Am. Chem. Soc.*, **66**, 1195–1201 (1944). The influence of concentration upon the sedimentation rate of tobacco mosaic virus. *C.A.* **38**, 4655.

B97 LEBEDEV, P. S., *Coke and Chem. (U.S.S.R.)*, **11**, No. 2, 6–17 (1941); *cf. C.A.* **36**, 2018. A new method for the determination of the coking capacity and the plastic-zone formation of coal. *C.A.* **38**, 4119.

B98 L'HERMITE, R., *Inst. tech. bâtiment trav. publ., Circ. Sér. G.*, **1942**, No. 4, 18 pp. The deformation of Pb. (The extension and tensile strength for various rates of extension at temps. from −20° to 100°. Extended theory of deformation given.) *C.A.* **38**, 4486.

B99 LEIPUNSKIĬ, O. I., *Acta Physicochim. U.R.S.S.*, **18**, 172–182 (1943) (in English). The η of compressed gases. (Applies Enskog's formula to N_2, H_2, CO_2, CO, NH_3, CH_4, H_2O, SO_2 and CH_3Cl.) *C.A.* **38**, 4484.

B100 LIEBER, E., and HODGES, C. E., U. S. 2,350,562, June 6, 1944. Material for improving the viscosity–temperature characteristics of petroleum lubricating oils. (A halogenated noncyclic paraffinic hydrocarbon containing 20–50% of Cl with an elemental metal as electropositive as Ca.) *C.A.* **38**, 5394.

B101 LIESEGANG, R. E., *Z. anal. Chem.*, **126**, 334–336 (1944). Capillary analysis. II. *C.A.* **38**, 4529.

B102 LÖHBERG, K., *Metallwirtschaft*, **20**, 825–831 (1941). Creep in technical zinc alloys. *C.A.* **37**, 3038.

B103 LONDON, F., *Pub. Am. Assoc. Advancement Sci.*, No. 21, 141–149 (1943). Intermolecular attraction between macromolecules. *C.A.* **38**, 3892.

B104 LOSANA, L., *Met. ital.*, **34**, 133–140 (1942). The viscosity of molten steel. *C.A.* **38**, 3940.

B105 McLEAN, D., *Biochem. J.*, **37**, 169–177 (1943). Diffusing factors. II. Methods of assay of hyaluronidase and their correlation with skin-diffusing activity. *C.A.* **37**, 6286.

HUMPHREY, J. H., *ibid.*, 177–181. III. A new biological assay of diffusing factor in guinea pigs. *C.A.* **37**, 6286.

B106 MARK, H., *Rubber Age (N. Y.)*, **55**, 367–370 (1944). Molecular structure and rubber elasticity. *C.A.* **38**, 5103.

B107 MEAGLEY, N. G., *Metal Progress*, **44**, 67–71 (1943). Rating the machinability of bullet core steel. (Varies directly as a function of brittleness, inversely as the strength, if finish, characteristics of chip, decarburization, cutting oils and tools are constant.) *C.A.* **37**, 3001.

B108 MEHL, R. F., *Am. Soc. Metals*, Symposium on Hardenability of Alloy Steels, **1939**, 1–55. The physics of hardenability. The mechanism and the rate of the decomposition of austenite. *C.A.* **37**, 1968.

B109 MIKHAILOV-MIKHEEV, P. B., *Arch. Eisenhüttenw.*, **17**, 177–184 (1944). Temper brittleness and hot-embrittlement of alloy steels. *C.A.* **38**, 4546.

B110 MOTAS, C., *Rev. Stiintifica "V. Adamachi,"* **29**, 198–200 (1943). η and mol. wt. of colloids. (Hevea rubber, purified rubber, balata, mercerized cotton, sulfite cellulose, etc. observed.) *C.A.* **38**, 5127.

B111 MOTT, R. A., *Coke Smokeless-Fuel Age*, **6**, 28–30 (1944). Correct use of "coking" and "caking." *C.A.* **38**, 4121.

B112 MOYAL, J. E., *Nature*, **153**, 777–779 (1944). Deformation of rubberlike materials. (Departure of elastic and viscous effects from linearity is best shown by forced vibrations.) *C.A.* **38**, 5429.

B113 MUKHERJEE, J. N., and MAJUMDAR, B. R., *Indian J. Phys.*, **17**, 3–6 (1943). Effect of sand on the η, yield value, and thixotropic gelation of mud suspensions. *C.A.* **38**, 4492.

B114 NEAL, A. M., and OTTENHOFF, P., *Ind. Eng. Chem.*, **36**, 653–655 (1944). Factors affecting plasticity and recovery of GR-S. *C.A.* **38**, 4831.

B115 NORTON, J. T., and ROSENTHAL, D., *Welding J. (N. Y.)*, **22**, 63–78 (1943). An investigation of the behavior of residual stresses under external load and their effect on safety. *C.A.* **37**, 1965.

B116 NORTON, F. H., and SODERBERG, C. R., *Trans. Am. Soc. Mech. Engrs.*, **64**, 769–777 (1942). Report on tubular creep tests. *C.A.* **37**, 1965.

B117 ODING, I. A., and VIRRILEP, P. R., *Zavodskaya Lab.*, **9**, 1025–1029 (1940). Method of determining the machinability of metals. (The device determines cutting indexes at room and elevated temps. at speed of 0.4 m. per min.) *C.A.* **37**, 3379.

B118 OPITZ, H., and VITS, W., *Deut. Kraftfahrtforsch.*, **1942**, No. 65, 1–17. Grinding process and grinding liquid. (Oils cause wheels to remove more metal.) *C.A.* **38**, 5438.

B119 OSTWALD, W., *Kolloid-Z.*, **106**, 1–22 (1944). The forms of the function connecting viscosity and particle size, especially in solutions of eucolloids. *C.A.* **38**, 3892.

B120 OWENS, H. S., LOTZKAR, H., and PETERSON, M., *J. Am. Chem. Soc.*, **66**, 1178–1182 (1944). η of pectin solutions. *C.A.* **38**, 4493.

B121 PARENT, JOSEPH D., *Chem. & Met. Eng.*, **51**, No. 1, 101–103 (1944). Predicting flow–friction data for sludges. *C.A.* **38**, 1160.

B122 PENN, W. S., *India-Rubber J.*, **106**, 9–12 (1944). Tearing and cracking resistance of GR-S from the theoretical aspect. *C.A.* **38**, 5111.

B123 PENZIG, F., *Motortech. Z.*, **5**, 12–19 (1943). The performance of oils at low temperatures. (Advocates constant shearing velocity. Schwaiger viscometer used for greases.) *C.A.* **38**, 4782.

B124 PESTOV, N. E., and MIRONOVA, A. N., *J. Chem. Ind. (U.S.S.R.)*, **18**, No. 10, 19–22 (1941). The angle of flow or rest of fertilizers, either freely poured out or under pressure. *C.A.* **38**, 5039.

B125 PICKETT, G., *J. Applied Phys.*, **15**, 623 (1944). Rise of water in capillary tubes. (Rense's explanation invoking Reynolds' numbers is implausible.) *C.A.* **38**, 5121.

B126 PFANN, HARRY F., SALLEY, D. J., and MARK, H., *J. Am. Chem. Soc.*, **66**, 983–985 (1944). Mechanism of peroxide-initiated styrene polymerization. *C.A.* **38**, 4179.

B127 PIWOWARSKY, E., and EVERS, A., *Stahl u. Eisen*, **64**, No. 9, 142–144 (1944). Impact toughness of cast steel. *C.A.* **38**, 4544.

B128 POMP, A., and KRISCH, A., *Mitt. Kaiser-Wilhelm-Inst. Eisenforsch. Düsseldorf*, **26**, 59–69 (1943). Creep phenomena in steel at room temperature. (It was observed that at especially high loads the creep can lead to fracture.) *C.A.* **38**, 5481.

B129 PROSZT, J., *Roy. Hung. Palatin-Joseph Univ. Tech. Econ. Sci., Pub. Dept. Mining Met.*, **11**, 114–118 (1939). Nature of the discontinuity of the electrokinetic potential. *C.A.* **37**, 1912.

B130 RABINOVICH, A. I., and VOLKOV, V. N., *ibid.*, 25–41. XVI. Electrophoresis cell and measurements on monodisperse gold sols. *C.A.* **38,** 291.

B131 REININGER, H., *Metallwirtschaft*, **22,** 394–400 (1943). Static strength, elongation and Brinell hardness of porous silumin-gamma-sand castings. *C.A.* **38,** 3947.

B132 RITTER, F., *Teer u. Bitumen*, **40,** 131–132 (1942). Lubrication and the effect of adding (colloidal) graphite (to oils). (Saves 20% of oil.) *C.A.* **37,** 6444.

B133 ROY, M., and BOUTARIC, A., *Bull. assoc. diplomés microbiol. faculté pharm. Nancy*, **1942,** No. 24/25, 7–12. The color of serum. (Ultraviolet radiation up to 150 hrs. causes a const. increase in viscosity and increase in vol. of suspended particles.) *C.A.* **38,** 5551.

B134 RUMPF, K. K., *Oel u. Kohle*, **39,** 640–645 (1943). Characterization of the η-temperature function. (Walther assumed that the η-temp. curves of oil of the same base when plotted as log log kinematic viscosity *vs.* log abs. temp. intersect at a common point, *viz.* the "viscosity pole." Rumpf proposes a broader relation.) *C.A.* **38,** 4784.

B135 SADOVSKIĬ, V. D., CHUPROKOVA, N. P., and OZEROV, S. P., *Stal*, **11,** No. 2-3, 86–90 (1941). Brittleness of Cr–Ni steel annealed at low temperatures. *C.A.* **37,** 6230.

B136 SAN CLEMENTE, C. L., and HUDDLESON, F., *Mich. State College Agr. Expt. Sta. Tech. Bull.*, **182,** 3–44 (1943). Electrophoretic studies of the proteins of bovine serums with respect to Brucella. *C.A.* **37,** 5135.

B137 SCHALLBROCH, H., and LANG, M. Z., *Ver. deut. Ing.*, **87,** 15–19 (1943). Measurement of cutting temperatures by means of temperature-indicating paints. *C.A.* **38,** 5182.

B138 SCHEELE, W., *Kolloid-Z.*, **105,** 209–216 (1943). The rheometry of organic glasses. II. *C.A.* **38,** 5024.

B139 SCHILLING, A. A., and CURRAN, T. B., U. S. 2,350,570, June 6, 1944. Solid lubricants suitable for lubricating bullets. *C.A.* **38,** 5396.

B140 SCHMELZLE, A. F., and WESTFALL, J. E., *J. Phys. Chem.*, **48,** 165–168 (1944). Relative viscosities of aqueous solutions of sulfamic acid and some of its salts at 25°. (NH_4, Mg, Ca and Ba salts to soly. limit.) *C.A.* **38,** 5450.

B141 SCHWARZ, M. V., *Automobiltech.*, **46,** 188–189 (1943). Recent investigations of bearing metals. *C.A.* **38,** 5184.

B142 SCHWARTZ, R. T., and DUGGER, E., JR., *Modern Plastics*, **21,** 39–43, 60–61 (March, 1944). Shear strength of plastic materials. *C.A.* **38,** 5021.

B143 SCOTT, I. J. R., *J. Rubber Research*, **12,** 117–129 (1943); *cf. C.A.* **38,** 509. Hardness testing of vulcanized rubber. III. *C.A.* **38,** 1912.

B144 SELMS, F. G. VAN, and KRUYT, H. R., *Rec. trav. chim.*, **62,** 398–406 (1943) (in English). Apparatus for measuring the consistency of plastic suspensions. *C.A.*, **38,** 3890.

B145 SEUFERT, R., *Oel u. Kohle*, **40,** 23–28 (1944). Viscosity determinations on lubricating oils at low temperatures (+10 to −20°). *C.A.* **38,** 5067.

B146 SIMMONS, O. R., U. S. 2,343,030, Feb. 29, 1944. Apparatus for testing the η of liquids such as crude oil flowing through pipe lines. *C.A.* **38,** 4476.

B147 SIMONS, J. H., and DRESDNER, R. D., *J. Am. Chem. Soc.*, **66**, 1070–1072 (1944). The η of HF. (From $-70°$ $+10°$.) *C.A.* **38**, 4484.

B148 SINGH, I., *Proc. Indian Acad. Sci.*, **18B**, 53–57 (1943). Viscoelastic properties and contraction of unstriated muscle. *C.A.* **38**, 1017.

B149 SPELSHOUSE, W. E., U. S. 2,350,649, June 6, 1944. Saturation of materials such as paper or felt with asphalt without excessive foaming. *C.A.* **38**, 5057.

B150 SMITH, S. L., and WOOD, W. A., *Proc. Roy. Soc.* (*London*), **181A**, 72–83 (1942). A stress–strain curve for the atomic lattice of mild steel in compression. *C.A.* **37**, 62.

B151 SOLOMIN, N. V., *Legkaya Prom.*, **2**, No. 1/2, 13–17 (1942). Determination of refractoriness of clays. (η of clay by sagging of beam at the desired temp.) *C.A.* **38**, 5373.

B152 STEINOUR, HAROLD H., *Ind. Eng. Chem.*, **36**, 618–624 (1944). Rate of sedimentation. Nonflocculated suspensions of uniform spheres. *C.A.* **38**, 4177.

B153 STUART, A. H., *Paint Manuf.*, **13**, 33–34 (1943). Viscosity to order. (Cup-and-ball type giving absolute units.) *C.A.* **37**, 2978.

B154 SZYMANOWSKI, W. T., *J. Applied Phys.*, **15**, 627 (1944). Rapid determinations of elastic constants of glass and other transparent substances. *C.A.* **38**, 5123.

B155 TAKEI, M., *Kolloid-Z.*, **101**, 129–135 (1942). The state of solution of high polymers. II. Association and solvation of acetylcellulose. *C.A.* **38**, 5449.

B156 TELESNIN, R. W., *J. Phys.* (*U.S.S.R.*), **5**, 213–229 (1941) (in German). Influence of magnetic viscosity on the rate of change of the magnetization of iron. (In very thin wires the time of demagnetization is less than 0.5×10^{-6} sec.) *C.A.* **37**, 3380.

B157 TELFAIR, D., CARSWELL, T. S., and NASON, H. K., *Modern Plastics*, **21**, 137–144, 174–176 (Feb., 1944). Creep properties of molded phenolic plastics. *C.A.* **38**, 5021.

B158 TEMPLIN, R. L., *Metal Progress*, **44**, 86–88 (1943). Hardness of aluminum sheet. Tests and conversion charts. *C.A.* **37**, 4999.

B159 THIESSEN, E., *Tech. Zentr. prakt. Metallbearbeit.*, **53**, 25–27, 55–57 (1943). Substitute oils in the working of metals and in the lubrication of tool machines. *C.A.* **38**, 5181.

B160 TRELOAR, L. R. G. (1) *Trans. Faraday Soc.*, **40**, 59–70 (1944). Stress–strain data for vulcanized rubber under various types of deformation. *C.A.* **38**, 5111.
(2) *Trans. Faraday Soc.*, **40**, 109–116 (1944). The statistical length of rubber molecules. *C.A.* **38**, 5103.

B161 TRIFĂNESCU, E. *Rev. Stiintifica "V. Adamachi,"* **29**, 200–201 (1943). Thixotropy and coacervation. *C.A.* **38**, 4178.

B162 TROELSTRA, S. A., and KRUYT, H. R. (1) *Kolloid-Z.*, **101**, 182–189 (1942). Electrophoretic measurements on hydrophobic colloids. *C.A.* **38**, 4850.
(2) *Kolloid-Beihefte*, **54**, 225–261 (1943). Investigation of coagulation by measurement of extinction (of light). *C. A.* **37**, 6179.

B163 UMSTÄTTER, H., *Kolloid-Z.*, **103**, 7–18 (1943); *cf. C.A.* **38**, 1161. Structure mechanics of viscous elastic continuous systems. VII. Viscosity and chemical constitution of macromolecular systems. *C.A.* **38**, 4179.

B164 UNCKEL, H., *Z. Metallkunde*, **34**, 225–228 (1942). Creep experiments with Zn and Zn alloy strips of different orientation. *C.A.* **38**, 5483.

B165 VARLAN, G., *Inst. tech. bâtiment trav., Pub. Circ. Sér. II*, **1942**, No. 3, 26 pp. The adjustment of luting material to present day conditions. (Causes of leaks in roofs discussed. Extensive literature references. Petroleum pitch contg. unsatd. hydrocarbons unsuitable for luting while pitch from asphaltic pitch is well suited.) *C.A.* **38**, 4721.

B166 VASSELIN, MARCELLE, *Ann. chim. anal. chim. appl.*, **25**, 21–22 (1943). Consistometer for highly viscous materials. *C.A.* **38**, 3878.

B167 VERSCHAFFELT, J. E., *Bull. classe sci., Acad. roy. Belg.*, **26**, 193–210 (1940). The thermodynamics of fluids with stationary motion and the Joule-Thomson effect. *C.A.* **37**, 3311.

B168 VOGEL, R. C., and LISSE, M. W., *J. Phys. Chem.*, **47**, 678–685 (1943). *p*H measurements on thixotropic gel systems using the glass electrode. *C.A.* **38**, 907.

B169 WALTHER, H., *Kolloid-Z.*, **99**, 302–314 (1942). Dielectric relaxation measurements on bituminous substances. *S.A.*, **46A**, No. 178.

B170 WEHMER, F., *J. Am. Soc. Testing Materials*, Symposium on Applications of Synthetic Rubbers, **1944**, 129–134. Synthetic rubber adhesives. *C.A.* **38**, 5431.

B171 WEIBULL, W., *Jernkontorets Ann.*, **126**, 333–357 (1942). Stress–strain curve for steel specimens between the upper and lower yield points. *C.A.* **38**, 4541.

B172 WILBRANDT, W., *Arch. ges. Physiol. (Pflügers)*, **246**, 274–290 (1942). Kinetics of ion exchange through selectively permeable membranes. *C.A.* **38**, 4850.

B173 WILDSCHUT, A. J. (1) *Physica*, **10**, 65–78 (1943). The stress–strain relation of natural and synthetic rubbers. *C.A.* **38**, 5429.
(2) *Physica*, **10**, 571–584 (1943). Pseudo-plastic phenomena with vulcanized rubber. *C.A.* **38**, 5690.

B174 WILLIAMS, MILTON (to Standard Oil Development Co.). Drilling muds suitable for use in oil and gas wells. *C.A.* **38**, 474.

B175 WILSON, D. M., *J. Soc. Chem. Ind.*, **62**, 140–141 (1943). Rapid ring-and-ball softening-point test. *C.A.* **38**, 243.

B176 WOLF, K. L., *Die Chemie*, **55**, 295–298 (1942). Molecular-physical problems in lubrication. (Surface tension, adhesion, breaking strength also theoretical aspects.) *C.A.* **37**, 6444.

B177 WOLPERT, OTTO, and BRAHM, HEINRICH (to Otto Wolpert Werke G.m.b.H.). Ger. 738,126, July 1, 1943 (Cl. 42k. 23.01). Hardness tester operating on the principle of a penetrometer. *C.A.* **38**, 3881.

B178 WÜSTEFELD, A., *Kolloid-Z.*, **101**, 82–87 (1942). Adsorption properties and plasticity of phosphate surface layers on ingot steel. *C.A.* **38**, 5446.

B179 ZHAVORONKOV, N. M., *Khimicheskaya Prom.* **1944**, No. 2/3, 12–19. Hydraulic resistance offered by filling bodies in irrigated scrubbers and the limits to which a scrubber can be loaded with a gas and liquid. *C.A.* **38**, 4839.