

RHEOLOGY BULLETIN



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Publication
of the
SOCIETY OF RHEOLOGY

Vol. XV No. 1

February, 1944

RHEOLOGY BULLETIN

Published Quarterly by

THE SOCIETY OF RHEOLOGY

Dedicated to the Development of the Science of the
Deformation and Flow of Matter

175 Fifth Avenue

New York, N. Y.

THE SOCIETY OF RHEOLOGY IS ONE OF THE
FIVE FOUNDER SOCIETIES OF THE
AMERICAN INSTITUTE OF PHYSICS

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Non-member Subscriptions: \$2.00 Annually

Single Copies: 75c

Address All Communications to the Editor

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EDITORIAL

The Rheology Index

In the Journal of Rheology 2, 10-108 (1931) there appeared an alphabetical list of about 5000 papers, with titles and reference locations, but arranged by authors. The same papers are arranged in a Subject Index on pages 424-46, much more concisely, by not repeating titles and locations. A Rheology Index II of nearly the same size now exists in manuscript form which must await a suitable time for publication.

At the recent meeting of the Society of Rheology it was decided to start a current Rheological Index (RI). The references in each number will be arranged alphabetically by authors. Titles will be given in English. The abbreviations of titles will follow the usage of Chemical Abstracts (CA). References to abstracts in the Rheology Bulletin (RB) will be given and elsewhere as Science Abstracts (SA). The use of the symbol η for viscosity and of Φ for fluidity seems desirable.

For the user of the RI to get the most out of it, a few words of explanation are necessary. As time goes on, there may be many of these quarterly indexes, so that cumulative indexes will be desirable, both of authors and subjects, but the original full entries will now run about 500 per year. The quarterly indexes for 1944 will all be designated by the letter A and the individual entries for the year will be numbered consecutively. The indexes for 1945 will bear the letter B etc. By this system any reference can be identified by one letter and, at the most, three digits. The compilation of a bibliography on any subject is thus greatly facilitated.

But after all, a bibliography is merely a find list. To be sure, the references to abstracts enable you to get the gist of papers easily, but many of the papers you consider important are not in your library. It is characteristic of rheology that papers in the field are very widely scattered, both geographically and ideologically. Moreover the Society of Rheology does not publish the papers presented except as they are accepted in the J. Applied Phys. and even the largest societies do not publish in extenso. So the present situation calls for improvement, which will not be explained.

Some sixty of the leading scientific and scholarly societies, councils and institutions have formed the American Documentation Institute, located at the Science Service Building, 1719 N Street, N.W., Washington, D. C. with Mr. Watson Davis as President, in order to remedy situations like ours by an Auxiliary Publication plan making use of microfilm and photoprints.

When you present a paper before the Society, it will at once be given an RI number. You will send the paper, ready for publication to the Editor, who will send it to the ADI after assuring himself that it is in proper form, see below, for directions. Any member desiring to secure the monograph in microfilm is asked to write to the Library, U. S. Department of Agriculture, Washington, D. C. for order blanks, calling for the data given in the RI and explaining the system for supplying microfilms. You pay 50 cents for any single article from any single volume of a periodical, regardless of length; or 50 cents for each 50 pages or fraction thereof in the case of books. All charges are on a basis of cash with the order. Ten cent coupons may be purchased, checks drawn to order of Treasurer of the United States. Photoprints are supplied for 10 cents for each page of text, with 50 cents minimum charge. You do not have to supply the article if available in Washington, nor delivery charges.

The images of the pages on 35 mm film are only 2.5 cm high so that they cannot be read without some form of reader, available in most libraries. Small readers may be obtained inexpensively, e.g. Leitz, in New York, sells one for \$3.75.

Directions for Authors

Papers for submission to the ADI must be typed with a fresh black ribbon with double space on 8 x 11" white paper. Drawings should be in India ink, with all of the letters and lines clear and distinct. Two or more drawings may be placed on one page but each one should bear the number of the figure and the page should be numbered so that it will be close to where it is referred to in the text. Great care should be taken with equations and mathematical formulas. If not typed in, they should be written in with a crow-quill pen using India ink, taking plenty of space so that small letters will show clearly.

It has been suggested that rheological reprints might be exchanged by members. To make this plan more effective, action will have to be taken by the Society making possible the purchase of reprints in quantity from the authors and the subsequent distribution to our members at a low fixed charge to cover the cost. So far as it went, this service would be very useful. The writer has had bound up over thirty very large volumes of reprints acquired by exchange and purchase, amounting to over 1500 items.

Finally, completeness of coverage is the most desirable thing for the RI but it is also an unattainable ideal. Suggestions from every source are desired as well as contributions of titles to make it more so.

EUGENE C. BINGHAM

Abstractors in this Issue

The following are the names and addresses of our Good Friends who have cooperated in making this February 1944 Rheology Bulletin a success:

- T. Alfred, Jr., Monsanto Chemical Co., St. Louis, Mo.
- E. C. Bingham, Dept. of Chemistry and Metallurgy, Lafayette College, Easton, Pa.
- A. Bondi, 1800 Baronne St., New Orleans 13, La.
- T. Boyd, Monsanto Chemical Co., Springfield, Mass. Bulletin of the Institute of Paper Chemistry (B.I.P.C.), Appleton, Wisconsin.
- C. K. Bump, Monsanto Chemical Co., Springfield, Mass.
- Neill M. Brandt, Bausch and Lomb Optical Co., Rochester, N. Y.
- K. J. DeJuhasz, Dept. of Mechanical Engineering, Pennsylvania State College, State College, Pa.
- A. Gemant, The Detroit Edison Co., 2000 2nd Ave., Detroit, Mich.
- T. S. Lawton, Monsanto Chemical Co., Springfield, Mass.
- R. M. Levy, Ecusta Paper Corporation, Pisgah Forest, N. C.
- H. Mark, Dept. of Chemistry, Polytechnic Institute, Brooklyn, N. Y.
- W. H. Markwood, Jr., 101 Lighthouse Road, Wilmington 274, Del.
- H. K. Nason, Monsanto Chemical Co., Springfield, Mass.
- Joseph A. Park, Westinghouse Elec. and Mfg. Co., Bloomfield, N. J.
- D. Telfair, Monsanto Chemical Co., Springfield, Mass.
- Samuel Zerfoss, Dept. of Ceramics, The Pennsylvania State College, State College, Pa.

NOTE

In an attempt to hold the expenses of publishing the Bulletin within our budget we have limited the number of pages in this issue to forty. Nine abstracts from the THEORY group have been held over for publication in Vol. XV No. 2. Increase in membership can be reflected in immediate increase in the size of the Bulletin. If each of us obtained a new member we could more than double the number of pages we could afford to print.

Publication of this issue has been delayed by the disturbances of war, by the flu epidemic and to some extent by the absence of a traveling Publishing Editor.

H. F. W.

THE SOCIETY OF RHEOLOGY

and

THE POLYTECHNIC INSTITUTE OF BROOKLYN

take pleasure in inviting you to attend a conference on

"Time Phenomena in Organic High Polymers"

which will be held on Monday, May 22, 1944 at the

Polytechnic Institute of Brooklyn

Brooklyn 2*, New York

The program will be as follows:

- 10:00 a.m. General Introduction: R. Simha, Howard University, Washington D. C. (Dr. Simha will also act as chairman and discussion leader).
- 10:10 a.m. "Molecular Mechanism of Deformation and Flow": T. Alfrey, Monsanto Chemical company, Springfield, Massachusetts.
- 12:00 noon Luncheon, offered by the Institute.
- 1:15 p.m. "Transition Phenomena in High Polymers": R. F. Boyer, Dow Chemical Company, Midland, Michigan.
- 3:00 p.m. "High Frequency Behavior of Polymers": R. M. Fuoss, General Electric Company, Schenectady, New York.

* The Institute can be reached via any subway, taken to Borough Hall, Brooklyn. The Institute is located directly behind Borough Hall, at 99 Livingston Street, near Court Street.

MEMBERSHIP STATISTICS

Repeated requests have been received by the Secretary for information about the Society of Rheology, particularly as regards the composition of its membership. The War Manpower Board, for example, is interested in the professional standing of the membership insofar as it relates to war needs. To partially answer these requests and also to give the Society statistics on its membership, the Secretary is preparing such a survey with the intention of publishing some of the results in the June issue of the Bulletin. In order that he may have up to date information, will all members kindly send information about themselves as regard professional duties, special training, publications, number of years of industrial and educational experience, etc., as well as any facts pertinent to such a survey. All information received will be held confidential and no person will be mentioned by name. The Secretary is unable to send blanks with specific questions to each member of the Society at this time, but he is counting on the membership to volunteer information about itself. Please cooperate by sending your letters directly to the Secretary at the following address:

R. B. Dow
Ballistic Research Laboratory
Aberdeen Proving Ground, Md.

Your information should be in his hands as soon as possible, and not later than May first if it is to be of use. It will take only a few minutes of each person's time and the result will be of incalculable value to the professional standing of the Society for it is believed that few societies have as high a percentage of key men in industry and education but to date no survey has been made officially to substantiate this opinion.

RHEOLOGY INDEX A, 1944

Arranged Alphabetically by Authors

- 1 Anon. Steam Engr. 12, 236-41 (1943)
Heat transmission of surface condensers.
- 2 Arnold, K. A. Paper Trade J. 117, #9, 28-34 (1943)
Flow properties of coating clays at high rates of shear.
C. A. 37, 6127
- 3 Baker, W. O. & Fuller, C. S. J. Amer. Chem. Soc. 65,
1130 (1943)
Intermoleculr forces and chain configuration in linear
polymers. The effect of N-methylation on the X-ray
structures and properties of linear polyamides.
S. A. 46A, #2585

- 4 Barham, H. N., Wagoner, J. A. & Reed, G. N. Ind. Eng. Chem. 34, 1490-5 (1942)
Viscosity of starches. Determination in a rotating-cylinder viscometer.
S. A. 46A, #1348
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Classification of rheological properties.
S. A. 46A, #1517
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Developments in the measuring of pulsating flows with inferential-head meters.
S. A. 46A, #2523
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Fluidity of Electrolytes. II. (Viscosity data of solutions by Ruby and Kawai, and by Brueckner favor the hypothesis that fluidities are additive.)
- 8 Bloch, I. Bull. Math. Biophys 5, 1-14 (1943)
Some theoretical considerations concerning the interchange of metabolites between capillaries and tissue.
S. A. 46A, #1597
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The viscosity and working characteristics of glasses. I. The viscosity of some commercial glasses at temperatures between approximately 500° and 1400°.
S. A. 46A, #1344
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The fluidity of nylon solutions in m-cresol: measurements of chemical damage in nylon textiles. (Smooth relation between tensile strength and fluidity.)
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The ploughing and adhesion of sliding metals
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Lubrication by thin metallic films and the action of bearing metals.
S. A. 46A, #1738

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The properties of fluids.
S. A. 46A, #2528
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S. A. 46A, #2592
- 15 Burgess, G. Foundry Tr. J. 197-203 (1943)
The fluidity of cast iron.
S. A. 46A, #1357
- 16 Buzagh, A. v. Kolloid-Z 103, 119-6 (1943)
The viscosity of suspensions. The effect of strong electrolytes on the viscosity of starch and bentonite.
C. A. 38, 289
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Breaking of multiple bond and the primary detonating explosives. (The nature of rupture in brittle materials).
C. A. 37, 6131
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A method of viscosity measurement in the region 10⁸ poises.
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Grinding, brightening and polishing for metallic surfaces.
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fractionating columns as a function of the viscosity.
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C. A. 38, 286
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appreciably affecting mechanical properties).
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Intermolecular forces and mechanical behavior of high
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size data on 24 starches).
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Viscosity and mol. wt. with chain polymers (Staudinger's
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NEW BOOKS

A SURVEY OF GENERAL AND APPLIED RHEOLOGY

By G. W. Scott Blair

American rheologists will welcome this latest contribution from one of their eminent British colleagues who has long been a member of the Society of Rheology. This book, while dedicated to "Bill, in every land, wherever he may be", will, nevertheless, hold the interest of a wide circle of professional scientists who are not generally known as rheologists. It has not been written as a second edition to the author's introduction to Industrial Rheology (Blakisten (1938) but does cover much of the same field of experiment and theory. Within its covers the physiologist, biochemist, geologist, and physicist, to mention only a few, become kindred souls with "Bill" as each adds his bit to that great store of knowledge about things that have 'yielded' down through the ages.

The dedication and historical introduction must be read to be fully appreciated. For example, it is found that Engler's viscometer of 1885 is quite similar in several respects to the one proposed by the Egyptian Amenemhet in about 1540 B.C. The chapter on rheological measurements is a valuable summary of some twenty-four methods of measuring rheological properties. Noteworthy references at the end of each chapter are up to date as of 1942, the time the book was written. The analytical relations between stress, strain and time are developed with emphasis on the Nutting and the Scott Blair equation. Although there may be some disagreement as to the validity of this manner of approach to elastic phenomena, nevertheless the summary of stress-strain-time differentials will be of considerable help in analyzing this complicated subject until a time when experiment can compose the various schools of thought and perhaps even reconcile them.

The author is particularly interested in psychological applications to measurements and it is perhaps here that the reader will be most critical of his efforts, although any attempts to clarify the thinking on this subject should command the interest and sympathy of the reader. Considering the extent of and the intrinsic difficulty of classifying rheological phenomena, let alone interpretation, Dr. Scott Blair has done a great service to science by preparing under adverse conditions a most stimulating and readable review which the writer ventures to predict will be the book of the year for all rheologists.

R. B. DOW

RHEOLOGY PROGRESS ABSTRACTS

Apparatus and Methods

A BAND VISCOMETER.—F. Wachholtz, Chem. Fab., April, 1941, 155, The Industrial Chemist, August 1943, 462.

An extremely simple instrument suitable for studying the flow of various pigment suspensions and pastes is described. The viscometer operates at high rates of shear without the production of turbulence because it depends on the linear motion of one plane past another parallel to and very near it. Without altering the arrangement of the apparatus a range of viscosities may be determined, of which the highest is ten times the lowest.

The apparatus consists of two metal blocks separated by two slip gauges, forming a slot through which passes a flexible band of cellulose acetate. The tops of the blocks are cut away to form a shallow trough to hold the liquid under test. The band is pulled through the slot by means of a weight and is held vertically by a counter weight attached to a cord running over a pulley above the instrument. Temperature is controlled by passing thermostated water through the blocks.

For this apparatus it is claimed that

$$K = 2 B H \frac{V}{A} \eta$$

wherein K is the driving force, B the band width, H the slot depth, V the band velocity and A the distance between slot and band. The validity of this equation was tested by many experiments in which K , B , A and η were varied.

With this instrument it was found that plots of concentration vs. viscosity at infinite shearing rate (extrapolated) showed curvatures which were dependent upon the suspended particles and independent of the viscosity of the oil. Furthermore, it was found that $\log \eta_s$ vs. $\log \eta_0$ was linear for any one pigment at any one concentration in various oils (both viscosities at infinite shearing rate). The slope of this relationship is also dependent on the particles and not the oils. Characteristics of the pigment may then be obtained by plotting the slope of this line vs. volume concentration.

W. H. MARKWOOD, JR.

INDUSTRIAL VISCOMETERS.--Ruth N. Weltmann, Interchemical Review (published by the Research Laboratories of the Interchemical Corporation), 2, NO. 3, (1943).

A critical survey is made of the various types of industrial viscometers from the point of view of fundamental principles, stating the advantages and deficiencies of each type. Details are given of the viscometers developed at the author's laboratory, one of which can be used for viscosities up to 2560, poises, and another from 0.03 to 48.6 poises. Essential equations are also presented. The importance of complete flow curves, rather than single measurements, for plastic, pseudoplastic and thixotropic materials, is emphasized. Bibliography of 25 references.

Bituminous Materials

SURFACE CONSISTENCY CHARACTERISTICS OF ASPHALTS.--
E. C. Knowles and F. C. McCoy, Ind. Eng. Chem., Ind. Ed. 35, 1118-22 (1943).

A method for studying the surface characteristics of asphalts with a modified ASTM penetrometer and method was developed with the aim of meeting the requirements:

- (a) procedure adaptable to extremely thin layers of sample,
- (b) unit of measurement comparable over wide range of magnitude,
- (c) method applicable over wide range of temperature,
- (d) method applicable over wide range of consistency, and
- (e) minimum of time for each test.

The procedure developed consisted of determining the load needed to cause a standard depth of penetration at a constant time. The advantages of the "constant depth of penetration" were given to be:

- (1) amount of material displaced remains constant,
- (2) asphalt-surface of needle adhesion factor remains constant,

- (3) depression of sample around needle remains constant,
- (4) constant rate of displacement causes constant "working", and
- (5) unit of measurement permits comparison of any two determinations.

The modifications of the ASTM penetrometer are carefully described, as are the details of the procedure followed in the investigation.

Data are presented to show the comparison of the modified method with the standard ASTM method. The results of preliminary study of surface characteristics of asphalts indicated that the "constant depth of penetration method" could be used. It is tentatively shown that the increased hardness with age of the asphalt was largely a surface phenomenon with temperature the most influential factor, and that this surface hardening was not well correlated with the asphalt aging index of the asphalt consistency in bulk. The studies were made with accelerated weathering tests upon roofing test panels.

N. M. BRANDT

MINERAL POWDER--SUSPENSIONS IN BITUMENS AND RELATED SUBSTANCES III VISCOSITY MEASUREMENTS ON THE SYSTEM BITUMEN - MINERAL POWDER.--Von H. Walther (Schkeuditz) Kolloid Z. 104, 38-50 (1943).

By viscosity measurements on suspensions of various mineral powders in one and the same bitumen, the influences of the concentration and the shearing stress on the relative viscosity were established as follows. The "toughness", therefore, the elevation of the viscosity near smaller concentrations is directly proportional to the specific surface of the mineral powder,

$$\eta = \left[\frac{d\eta_r}{dc} \right] \quad c \rightarrow 0$$

With mineral powders with isodimensional particles, the viscosity-concentration relation even at high concentrations was determined essentially through the specific surface.

The influence of the specific surface on the relative viscosity through preliminary classification of the particles by the flow process was overlapped at higher concentrations with increasing deviation of the particle shape from the corpuscular habit.

The viscosity of powder suspensions with lamellar and especially fibrillar particles is more or less dependent on the shearing stress, in order that such mixtures may show pronounced structural viscosity. In a limited concentration range, which coincides with corpuscular mineral powders perhaps with the technically accessible range, the relation $F_r = 1 - ac_g$ applies for the relative fluidity. On the whole concentration range investigated even with lamellar or fibrillar mineral powders, the dependence of the relative viscosity on the concentration is shown by the formula

$$\log \eta_r = \frac{mc_g}{1 - \eta c_g}$$

T. BOYD

CERAMIC PRODUCTS

DETERMINATION OF THE WORKABILITY FACTOR FOR A PLASTIC REFRACTORY.—G. B. Cunningham, Lt. Comdr., U. S. Navy Reserve and J. F. Kelly, American Ceramic Society, 22, (11), 366-369 (1943).

A plastic refractory for installation in Naval boilers must have proper "workability." The Naval Boiler and Turbine Laboratory has developed specifications for determining workability which have been adopted by the American Society for Testing Materials.

Workability as measured by the Navy is the ability of the material to be readily pounded into place, without shattering, and to occupy the space intended without slumping during the period between installation and firing. The machine used for measuring the property was similar to the one adopted by the American Foundrymen's Association as a sand rammer but conditions of test were modified to suit the material.

The test was consistent and reproducible and readily showed up slight variations in workability. In cases where small variations were exhibited by products of a single company close control over the manufacturing processes were undoubtedly exercised.

The specifications on all properties of a plastic refractory for Naval use are presented. The question "What is workability?" was not discussed.

Cellulose

VISCOSITY AND MOLECULAR WEIGHT. II. Depolymerization during Delignification.—S. Coppick, Paper Trade Journal, 117, (26), 29 (1943).

A method is given which enables one to follow the depolymerization of the carbohydrate constituents of wood at various stages of delignification. The lignified tissues are nitrated, and the cellulose nitrate is isolated from the reaction product. The chain length of this isolated nitrated is then evaluated viscometrically. Intrinsic viscosities were determined in an alcohol - benzene - acetone solvent after precipitation and removal of insoluble residues. The intrinsic viscosities were calculated from the equation:

$$[\eta] = \frac{\ln \eta_r}{c} (1 + 0.5c)$$

which the author developed in the first paper of this series.

The depolymerization of cellulose is followed during a series of sulphate and soda cooks as well as during chlorine dioxide, and Cross and Bevan delignifications.

R. M. LEVY

PHYSICAL CHEMISTRY OF THE CELLULOSE MOLECULE.—Cellulosechemie 21, 57 (1943). Angewandte Chemie 56, 237 (1943).

Exhaustive researches of Svedberg in Upsala on nitro-celluloses and cuprammonium solutions, which are summarized in an especially noteworthy contribution, lead to the following results: By combination of sedimentation (ultracentrifuge) and diffusion, on one hand, and of measurement of streaming-birefringence on the other, molecular weight values were obtained, which are identical within the limits of experimental error, but which differ considerably from the viscometric values, being in general 5 to 6 times higher: unbleached cotton 2,550,000, wood flour 1,200,000, bleached cotton 720,000, wood cellulose I 850,000, II 770,000. The polydispersity can be judged by measurement of the broadening of the sedimentation peak and by studying the anomalies in diffusion and streaming-birefringence. In general the measurements reveal that in strongly degraded celluloses the molecules are relatively straight; with increasing molecular weight, however, they do not increase rectilinearly, but bend more and more, whereby their length increases, unless they form a coil, as one could perhaps expect. Cellulose from cotton is less polydisperse (0.5) than technical wood cellulose (1.0 to 1.3); by bleaching, however, the polydispersity is increased far above these values (2.2).

OSMOTIC PRESSURE AND VISCOSITY MEASUREMENTS WITH CELLULOSE ACETATE FRACTIONS.--A. Bartovics and H. Mark, J. Am. Chem. Soc. 65, 1901-5 (1043).

The specific viscosity of fifteen cellulose acetate fractions was determined at 30°C. over a concentration range, up to 0.5 volume percent of the solute, by means of Ostwald pipettes. The slopes of the η_{sp}/C_v versus C_v curves can be represented by a single constant $k' = 0.70$.

The osmotic pressures of the same fifteen fractions were measured over a concentration range, up to 0.8 weight percent of the solute. The slopes of the π/C_2 versus C_2 curves can be represented by a single constant $\mu = 0.43$.

It was found that the equation $[\eta] = KM^a$ holds for cellulose acetate. The determined values of the constants are $K = 1.04 \times 10^{-2}$ and $a = 0.67$. The values of K and a are constant for a given solute-solvent system.

T. S. LAWTON

MOLECULAR WEIGHT AND POLYDISPERSITY DETERMINATIONS ON NITROCELLULOSE FRACTIONS BY MEANS OF THE SEDIMENTATION-EQUILIBRIUM ULTRACENTRIFUGE.--Hans Mosimann, *Helv. Chim. Acta* 26, 369-98 (1943); *C. A.* 37, 6522 (Nov. 20, 1943). (In German; abstract in English. Abstract only available).

A new sedimentation cell of artificial resin (Tufnol) mounted in a metal cylinder is described; the cell is closed with a screw instead of using a blanketing liquid layer to minimize evaporation of the solvent. Although equilibrium was attained within 4 days, all runs were continued for a total of 6 days. The same nitrocellulose fractions used in the following abstract were studied. Correct values of molecular weight were obtained only with dilute solutions, where it is independent of concentration, centrifugal field, and solvent. Nitrocellulose fractions having a molecular weight over 80,000 deviated in behavior at the lowest concentrations that could be tested. One fraction, which revealed more than one maximum in the velocity centrifuge, gave decidedly anomalous results, because part of the material actually sedimented to the bottom of the cell in the equilibrium run. Except perhaps at low values, viscometric molecular weights were not linearly related to molecular weights determined by the ultracentrifuge but gave a curve convex to the axis of the latter.

B. I. P. C. 14:163

SEDIMENTATION BEHAVIOR OF NITROCELLULOSE FRACTIONS AND THE MOLECULAR SHAPE DEDUCED FROM IT.--Hans Mosimann, *Helv. Chim. Acta* 26, 61-75 (1943); *C. A.* 37, 6522 (Nov. 20, 1943). (In German; abstract in English. Abstract only available).

The sedimentation constants of five fractions of cellulose nitrate (molecular weights of 60,000 to 600,000) dissolved in acetone, methyl alcohol, amyl acetate, and cyclohexanol decreased with increase in concentration and with decrease in molecular weight of cellulose nitrate. There was little difference between the values of the sedimentation constant in the four solvents. The data are discussed in conjunction with available x-ray interference, viscosity, and streaming double refraction data. With increasing molecular weight, the molecules change from an almost completely stretched chain to an irregular somewhat kinked form (not coiled). Since no difference in degree of dispersion was found in dilute solutions in different solvents, a molecularly dispersed system is assumed.

B. I. P. C. 14:163

SUPERMOLECULAR STRUCTURE OF CELLULOSE.--O. Kratky, *Kolloid-Z.* 96, 301-10 (1941); *C. A.* 36, 6793 (1942); *Kolloid-Z.* 98, 170-1 (1942); Kodak Research Labs. Abstract Bull. 29, 230 (1943). (In German; abstracts in English. Abstracts only available).

X-ray photographis investigations show that, in the technical process, the alkali cellulose micelles, still present after xanthation, either disintegrate completely or change into greatly distorted fringe micelles upon solution in caustic. On repeated reprecipitation, a structure is built up in both cases in which the crystalline portions are held together by filament molecules. Amorphous material is found in the intermediate regions. The order of steps in the deformation of hydrate cellulose filaments in various states of swelling can be determined approximately quantitatively if one assumes the presence of lamellar-forming micelles whose deformation is correlated with a distortion of the enclosed space and a reorientation of the micelles in this space. Orientation, deformation, extensibility, and expression of water can be explained on the basis of this theory. The extensibility is limited by the amorphous intermediate regions. The lamellar form can be shown qualitatively by means of small-angle scattering. The small-angle scattering disappears when a solution, whose electron density is the same as that of cellulose, is brought into the intermicellar spaces. It is possible in this manner to draw deductions regarding the metal content of the alkali cellulose.

B. I. P. C. 14:158

EFFECT OF CONCENTRATION AND pH ON THE VISCOUS AND ELECTROCHEMICAL PROPERTIES OF HYDROGEN BENTONITES.—J. N. Mukherjee, N. C. Sen Gupta and M. K. Indra, J. Phys. Chem. 47, 553-577 (1943).

The rate of shear-shearing stress curves of hydrogen bentonite were found to be straight lines at high rates of shear and at concentrations up to 0.7%. Between 0.7% and 1.0% a yield value appears. This is about the same concentration at which the specific conductivity passes through a minimum and the cataphoretic velocity passes through a maximum.

The apparent coefficient of viscosity increases with concentration more rapidly than one would expect from a linear relationship and the observed values deviate from those calculated by the Einstein Smoluchowski relation. Possible reasons are suggested and it is believed that at higher concentrations aggregates are formed which cause a change in effective volume of the particles with concentration.

The yield value, consistency and thixotropy were found to be closely related to the buffer capacity.

Other data on conductivity, cataphoretic velocity, hydrogen ion activity, extinction coefficient and titration curves are given.

C. K. BUMP

ELECTROLYTES

THE FLUIDITY OF ELECTROLYTES II.—Eugene C. Bingham and Robert T. Foley, J. Phys. Chem. 47, 511-527 (1943).

The authors have analyzed the data of Bruckner and of Ruby and Kawai on viscosities of mixtures of electrolytes up to 5 N, and have shown that these data support the thesis of additive fluidities. A "second order" positive or negative deviation from strict additivity is explained in terms of dissociation or of combination. New data on fluidities of mixtures of N NaCl-KCl at 25°C., of N NaNO₃-KNO₃ at 10°, 20°, and 30°C., and of 0.05 N LiF-KI at 25°C. are presented. Bibliography of fifteen references.

Gels

THEORY OF DISSOLUTION OF GELS.--A. Tobolsky, J. Chem. Phys. 11, 290 (1943).

A gel is assumed to represent a continuously cross-linked, three dimensional structure, which is only swellable but not soluble under normal conditions. If placed in a solvent, the swelling takes place until the osmotic forces driving the solvent molecules into the spongy structure of the gel are balanced by the elastic reaction of the three-dimensional network. As long as no bonds are severed, this balance represents the swelling equilibrium. At higher temperatures, however, cross-bonds will eventually break. This process will be favored by the entropy gains of the curling up end of the broken chains.

This picture is put into mathematical formulation. The melting point of a swollen gel is computed as the ratio between the heat and the entropy of fusion.

H. MARK

pH MEASUREMENTS ON THIXOTROPIC GEL SYSTEMS USING THE GLASS ELECTRODE.--R. C. Vogel and M. W. Lisse, J. Phys. Chem. 47, 678-85 (1943).

Thixotropy is the reversal isothermal gel-sol transformation which may be brought about by stirring, shaking, or similar procedure. Within recent years the glass electrode and apparatus to be used in connection with it have been extensively developed, the glass electrode being the only instrument which is suitable for use in measuring the pH of materials in the gel state. Accordingly, it is now possible to study the pH changes which may accompany the first gelation (primary gelation) of a gel-forming material, the thixotropic liquefaction, and the subsequent re-gelation (secondary gelation) of the sol thus produced. The systems under investigation in the present study are thorium molybdate, ferric hydroxide, and bentonite. During the primary gelation, the first two showed pH changes, whereas the bentonite system did not. During the thixotropic liquefaction, no pH change within the limit of experimental error was found in either of the three gels. During the secondary gelation, there was no change in pH within the limits of experimental error in the cases of the three systems under investigation. 11 references.

B. I. P. C. 14:192

Glasses and Slags

RHEOMETRIC INVESTIGATIONS ON ORGANIC GLASSES.--W. Scheele, *Angewandte Chemie* 56, 164 (1943).

From analyses of the reaction products of sulfamides with formaldehyde it was concluded that these resins are not chain polymers of methylenesulfamides, as they are often described in the literature. Most often these resins prove to be glasses frozen from melts of mixtures of the sulfamides with their trimeric methylene compounds. After lengthy tempering at 174° mixtures of this sort change easily to the glassy state. The greater the sulfamide content of these resins, the lower their viscosity. If in the systems p-toluenesulfamide--methylene p-toluenesulfamide and o-toluenesulfamide--methylene p-toluenesulfamide the molecular ratio exceeds 7:3, resins are no longer obtained; moreover, upon freezing of such melts, crystal conglomerates are formed which are intermingled with a resin. This "critical mol: ratio" is 6:4 for the system benzenesulfamide--methylene p-toluenesulfamide. It was further shown that the resins investigated have practically identical viscosities at the same temperature and the same molar fraction. From these experimental results a conception of the inner structure of the sulfonamide resins was developed. Since no resins are obtained by the reaction of benzamides and formaldehyde, the formation of sulfonamide resins may be attributed especially to the sulfo-groups in the trimeric methylene compounds. In the glass-like solidification of the melts, irregular molecular-aggregates of trimeric methylene compounds of the sulfonamides are formed. By replacement of sulfamide, these molecular complexes are partly or completely eliminated, which explains the reduction in viscosity with increasing amounts of sulfamide in the mixture.

The second part treated the rheological properties of chain polymers, and the complications which one encounters in evaluating flow curves of quasiviscous or quasiplastic fluids were discussed. In order to evaluate the relationships between deformation-processes and temperature for practical purposes, a conventional method for the evaluation of flow diagrams was chosen. If one draws the surface-integral, which the flow-curve forms with the τ -axis and the ordinate up to a flow velocity $v = 5 \times 10^4$, and then plots the log of this against the reciprocal of the absolute temperature, then one obtains straight lines for the individual polymers. The slope of this integral, characterizing work of deformation, relative to the T-axis, can be considered a measure of the temperature resistance of a material. The smaller the angle, the greater is the temperature resistance of the particular polymer. In a homologous polymer-series, the angle decreases with increasing average degree of polymerization. In agreement with their higher

temperature resistance, the Oppanols show a much smaller rise in the temperature coefficient of the work of deformation than, for example, polyvinyl acetate. The influence of plasticizers on the temperature function of the work of deformation was demonstrated by several examples.

H. K. NASON

Liquids and Solutions

VISCOSITY MEASUREMENTS ON ESTERS.--H. Staudinger and H. Joerder, J. Prakt. Chem. 160, 166 (1942).

Viscosity measurements on esters with branched and unbranched chains are carried out in order to evaluate the influence of the thickness of long chain molecules on the specific viscosities of their dilute solutions. The number of carbon atoms in the chains was varied from 38 (octadecane (1,12)-diol-dilaurate) to 58 (octadecane (1,12) diol-dibehenate). Solvents used were: benzene, carbon tetrachloride, acetone and m-cresol. Branched and unbranched molecules of the same chain length were measured at the same temperature in the same solvent. Example: Oleyl-oleate (37, unbranched) and octadecane (1,12)-diol-dilaurate (38, branched) were measured in benzene and carbon tetrachloride at 20, 30, 40, and 60°C. Their specific viscosities are the same within the limits of experimental errors. The equivalent K_m constant (computed for the $-CH_2$ group) is 1.0×10^{-4} in benzene and carbon tetrachloride, and 0.54×10^{-4} in m-cresol.

H. MARK

VISCOSITY OF N-PARAFFIN SOLUTIONS.--A. R. Kemp and H. Peters, Ind. Eng. Chem., Ind. Ed. 35, 1108-12 (1943).

Viscosity studies were made of the influence of various solvents with normal paraffins upon the viscosity-molecular weight relation suggested by Staudinger and Staiger and by Meyer and van der Wijk. The apparatus used, an Ostwald type viscometer, the procedure followed, and considerable quantity of data are presented.

It is shown that the viscosity of a series of n-paraffins in carbon tetrachloride benzene, chloroform and cyclohexane in the case of solutions of equal molecular concentration do not conform to the Staudinger rule:

$$\eta_{sp} = KM$$

where M equals molecular weight. The data obtained on n-hexane solutions were found to follow the Staudinger rule

for all n-paraffins above $C_{14}H_{30}$ with the relation:

$$\eta_{sp} = NK$$

where $K = 0.00190$ and $N =$ number of carbon atoms in the chain. In the case of the paraffins and other fractionated polymers the available data indicated that:

$$\eta_{sp} = K_1 N \phi \text{ and}$$

$$\log \eta_r = K_2 N \phi$$

where η_r is the viscosity after Ostwald kinematic correction for differences of density of the solution and the solvent, K_1 and K_2 are constants, and ϕ is the volume concentration.

A chain atom viscosity equivalent, K_{ca} , was calculated by the equation:

$$K_{ca} = \frac{\log \eta_r \times W}{N \times \phi}$$

with W equalling the proportional weight of chain atoms in the repeating unit to base molecular weight.

With $K_{ca} = 0.032$, the average number of atoms in any linear polymer chain could be estimated by measuring the viscosity of a dilute solution of the polymer in a good solvent and using the equation:

$$N = \frac{\log \eta_r \times W}{\phi \times 0.032}$$

If the polymer was linear, the molecular weight could be determined by multiplying N by the chain atom equivalent weight of the polymer.

The author's final conclusion was that their studies indicated that under proper conditions of materials and procedure, the determination of molecular weights by the viscosity method is basically sound.

N. M. BRANDT

VISCOUS FLUID FLOW THROUGH A SMALL ORIFICE IN THE REYNOLDS RANGE FROM 0 TO 2000.—Wm. Jones and O. Lutherer, Instruments 16, 728-9 (1943).

Data was obtained on the flow of oil through fixed valves and orifices to determine the characteristics of viscous liquid flow. For such flow, the Reynolds Number may be expressed by:

$$N_R = \frac{4W}{\pi\mu D}$$

W = flow in lbs./sec.
 μ = viscosity in lbs./ft. sec.
D = orifice diameter in ft.

Thus, for a given diameter orifice, the Reynolds Number may be kept constant by varying the flow and viscosity.

Curves showing the Discharge Coefficient versus Reynolds Number for different oils are presented. The conclusion drawn from this work is that the Discharge Coefficient of an orifice is a function of $\log N_R$ lies between 0 and 2000.

T. S. LAWTON

COMPARATIVE OSMOTIC AND VISCOSITY MEASTUREMENTS WITH POLYSTYRENE FRACTIONS.—T. Alfrey, A. Bartovics and H. Mark, J. Am. Chem. Soc. 65, 2319 (1943).

Styrene was polymerized at 60°, 120° and 180°C. The three resulting polystyrenes were fractionated by selective precipitation. Osmotic and viscosity measurements were carried out on the fractions so obtained.

Huggins has predicted theoretically that the specific viscosity of a polymer solution should change with concentration according to the formula:

$$\eta_{sp}/c = [\eta] + k'[\eta]^2c \quad (1)$$

Here k' is a constant characteristic of a given solvent-polymer system, but independent of molecular weight. This relationship has been found experimentally to hold for a number of polymers. In the case of polystyrene, the relation held within each group of fractions coming from the same original sample, but not between different groups. Three different k' values were required to represent the data:

Sample polymerized at 60°; $k' = 0.42$
Sample polymerized at 120°; $k' = 0.33$
Sample polymerized at 180°; $k' = 0.21$

These data show that polystyrenes prepared at different temperatures are in some way structurally different, so that solutions of such polymers in a given solvent represent different systems.

This result, which involves viscosity data only, is confirmed by the comparison of viscosimetric and osmotic data for the various fractions. The intrinsic viscosity of a given species of polymer is connected with osmotic molecular weight by the equation:

$$[\eta] = K \cdot M^a,$$

where K and a are constants characteristic of a given polymer-solvent system. In the case of the polystyrene fractions above, a single K and a were sufficient to describe the behavior of all fractions prepared at any one temperature. For each polymerization temperature, however, a different pair of constants were necessary.

Sample	polymerized at	60°; K	1.6 x 10 ⁻²	a = 0.70
"	"	" 120°; K	6.6 x 10 ⁻³	a = 0.80
"	"	" 180°; K	4.0 x 10 ⁻⁴	a = 1.10

This fact substantiated the previous conclusion that polystyrenes prepared at different temperatures are in some manner structurally different.

It was pointed out that one possible structural difference among polystyrenes prepared at different temperatures might consist in a variation in the amount of chain branching:

TURNER ALFREY, JR.

Petroleum Products

SYNTHESIS AND PROPERTIES OF HYDROCARBONS OF HIGH MOLECULAR WEIGHT.—R. W. Schiessler, D. G. Clarke, C. S. Rowland, W. S. Sloatman and C. H. Herr, *Petroleum Refiner*, 22, 390 (1943).

In the course of the API Project No. 42 at Pennsylvania State College 24 new hydrocarbons ranging in molecular weight from 326 to 479 have been prepared and their physical properties reported. Kinematic viscosity at 32, 68, 100, 140 and 210°F. and kinematic viscosity index of these substances were determined. Since altogether 66 hydrocarbons in this molecular weight range have been prepared by this project some general trends in the relation of chemical structure to flow properties can be recognized. Cyclisation to phenyl, cyclopentyl and cyclohexyl rings results in large increases in viscosity, the last named causing the greatest

increase in this property. Viscosity index is decreased by cyclisation, cyclopentyl rings, however, affecting this property only slightly. The position of the ring in the molecule affects rheological properties profoundly. Viscosity increases, while viscosity index decreases as the ring is moved towards the center of the molecule. Olefinic unsaturation does not affect viscosity data in any definite direction. Mixtures of various hydrocarbons were prepared and their viscosity determined. The authors postulated weight fraction additivity of "kinematic fluidity" (reciprocal centistokes). But only the mixtures of components with but small viscosity differences obeyed this additivity rule. The mixture of 9-n-octyl-eicosane/ 1-cyclohexyl-2-cyclohexyl-methyl-pentadecane, the components of which differ in viscosity by one power of ten almost, could not at all be fitted into this rule. (The reviewer replotted these data on the Arrhenius as well as the Irany graph and found them to deviate quite remarkably from "Ideality", indicating the paraffin hydrocarbon to be solvated by (to diminish the active concentration of) the cyclic hydrocarbon. Reviewer observed the same phenomenon with all similar mixtures in the course of an unpublished investigation of the viscosity of hydrocarbon mixtures). Multi-component mixtures of these pure hydrocarbons exhibited rather peculiar flow properties at low temperatures. One mixture was flowing down to - 80°F., but solidified while being slowly warmed to 0°F. and remained solid at 0°F.

A. BONDI

FLUID VISCOSITY KEY TO REVERSE CIRCULATION.--H. F. Simons, Oil & Gas J., 42, (1944).

Author deduces from Stokes' law that it would be advantageous to use a truly viscous fluid (such as crude oil) for the removal of cuttings and steel pieces out of completed oil well by reverse circulation.

A. BONDI

VISCOSITY OF DRILLING FLUID; MARSH FUNNEL VISCOSITY; STORMER VISCOSITY OF MUD; GEL PROPERTIES OF DRILLING MUD.--G. L. Stearns, Oil & Gas J., 42, (1944).

In several "installments" salient features of the control of rheological properties of drilling muds are described. While pointing out the necessity of close control of viscosity, thixotropic behaviour, gel strength (yield value) and gel rate (rate of sol-gel transformation of fluid at rest after thixotropic breakdown while being pumped), the author describes also the control instruments used in the field to measure the apparent viscosity of muds. Considering the delicate balance which has to be struck in mud

blending to obtain the proper flow characteristics the control apparatus can only be called pitifully inadequate despite the fact that they have been standardized by the American Petroleum Institute.

A. BONDI

PLASTICS

PHOTOELASTIC DETECTION OF STRAINS.--John Delmonte and Wm. Dewar, *Modern Plastics*, 21, 121-3 (1943).

The variables were examined which affect the quality and photoelastic appearance of injection-molded transparent plastics, chiefly cellulose plastics. It was found that, for minimum stress lines in the photoelastic patterns, the following combinations appear best: (a) low injection pressure, slow ram, and high injection temperature; or (b) high injection pressure, fast ram, and low injection temperature. Photographs are included and their significance is discussed. When viewed with the naked eye in daylight, all specimens appeared clear and uniformly transparent.

B. I. P. C. 14:150

THE FAST AND SLOW EXTENSION OF SOME PLASTIC MATERIALS.--R. N. Haward, *Trans. Faraday Soc.* 39, 267-80 (1943); cf. B.I.P.C. 13:225.

It is suggested in a theoretical discussion that the work taken up by any material under impact may be governed either by the rate at which deformation can take place or by the amount of possible deformation. The results of slow and fast extension experiments are examined and it is found that in this way any apparent contradictions can be resolved. Experiments are carried out on the extension and breaking of cellulose acetate film at different temperatures and it is concluded that temperature changes during adiabatic extension will not be so large as to alter fundamentally the character of the deformation. The work absorption of different materials under changing conditions of testing varies both relatively and absolutely, and the validity of a generalized impact strength is questioned. A more precise formulation of shock conditions seems desirable.

B. I. P. C. 14:184

High Polymers

THE SOFTENING OF THERMOPLASTIC POLYMERS.--R. F. Tuckett, *Trans. Farad. Soc.*, 39, 158 (1943).

A general theory of softening and an analysis of

empirical softening point tests if given. It is assumed that the total deformation can be expressed by two elastic ($E_1 \sim 10^{10}$, $E_2 \sim 10^6$) and one viscous element. The corresponding flow curve is worked out giving the deformation as a function of time and stress. The activation energy for polymethylmethacrylate flow is 20,000 cal. per mol of moving elements.

The significance of empirical flow tests is discussed from the point of view of this simplified theory.

H. MARK

LINEAR SUPER POLYESTERS FROM DILINOLEIC ACID.--John C. Cowan and Donald H. Wheeler, J. Am. Chem. Soc., 66, 84-88 (1944).

In the preparation of superpolyesters of the unsaturated dibasic acid, dilinoleic acid, viscosity measurements were used to confirm the linear nature and high molecular weight of the materials prepared. By comparing the square root of the molecular weight determined by end group titration with the logarithm of the viscosity of the molten polyesters, it was found that the relationship was linear up to molecular weights of about 10,000. Flory had previously shown this relationship to be linear for polyesters of saturated dibasic acids. Deviations at molecular weights in the range 20000-30000 were believed to be due to excess of one of the reactants which renders the determination of molecular weight by end group titration unsatisfactory. Polymerization through unsaturation was shown to have no effect on the viscosity by directly comparing the behavior of the polyesters of dilinoleic acid with those of hydrogenated dilinoleic acid.

C. K. BUMP

Resins

BORATED RESINS.--Ernest P. Irany, Ind. Eng. Chem., 35, 1290-2 (1943).

Boric acid reacts readily with macromolecular substances such as cellulose esters and ethers and partially hydrolyzed polyvinyl esters and acetals, which contain a plurality of hydroxyl groups per molecule. The products formed are spatially linked, insoluble, infusible boric acid esters or esterlike association compounds. These compounds are hydrolyzed by mere contact with water or alcohols and regenerate the original thermoplastic resin without change. Various uses can be made of this effect - for example, in the production of thermoplastic and rubberlike materials in the form of fine powders or in temporary protective

coatings; marginal additions of boric acid provide a means of sensitive control of molding materials and in film casting.

B. I. P. C. 14:151

WATER DISPERSIBLE AND BULKING GUMS. 2. GUM KARAYA.-- Charles F. Mason, Chem. Industries, 53, 858-60 (1943).

The physico-chemical properties of gum karaya are discussed, particularly the viscosities of gum dispersions in water.

B. I. P. C. 14:169

KETONES AS SOLVENTS FOR VINYL RESINS.--Richard W. Quarles, Ind. Eng. Chem., Ind. Ed., 35, 1033-43 (1943).

The use and production of ketones as solvents has grown enormously in the last decade concurrently with the development of vinyl resins. The ketones find their widest application as solvents for the resins: vinyl chloride polymers and vinyl-chloride-vinyl acetate copolymers. Ketones may be used to reduce the viscosity of solutions of the resins in other solvents or as the sole solvent, particularly where high concentration and low viscosity conditions are desired.

The inability of the simple dilution criteria to provide adequate data concerning solution characteristics led to development, from previous work of others with nitro-cellulose solvents, of the viscosity phase method of evaluating the solvents. The experimental procedure is briefly described and data covering considerable number of solvent mixtures are presented. To the rheologist this paper serves as a specific example of an application of rheology in modern industrial research.

N. M. BRANDT

Rubber

K_m VALUES FOR CERTAIN RUBBER DERIVATIVES.--H. Staudinger and H. J. Staudinger, J. prakt. Chem., 162, 148 (1943).

The K_m values for rubber hydrochloride (pliolite), balata hydrochloride, squalene hexahydrochloride, ethyl-hydro-rubber, and ethyl-hydrobalata were determined. The viscosities were measured in Ostwald viscometers at 20° and 60°C. in toluene and chloroform. The osmotic pressures were measured at various concentrations, and the molecular weight of the solute was determined by extrapolating P/C to zero concentration.

Squalene hexahydrochloride has the same K_m constant as squalene itself (5.0×10^{-4}). The hydrochlorides of rubber and balata have smaller K_m constants (1.0×10^{-4} and 0.42×10^{-4}) than rubber and balata themselves (1.7×10^{-4} and 1.3×10^{-4}), which is explained by the fact that the long molecules are shortened by an unknown cyclization reaction. The K_m constants fall with rising degree of polymerization. Hence the Staudinger equation is not fulfilled. The K_m values of ethyl-rubber and of ethyl-balata are very similar to those of the hydrochlorides.

Similar measurements were made with bromo-balata ($K_m = 0.61 \times 10^{-4}$), polychloroprene ($K_m = 1.65 \times 10^{-4}$), chloro-rubber ($K_m = 0.34 \times 10^{-4}$), chlorobalata ($K_m = 0.49 \times 10^{-4}$), chloro-buna 85 ($K_m = 0.30 \times 10^{-4}$) and chloro-buna S ($K_m = 0.35 \times 10^{-4}$). The osmotic molecular weights of the investigated samples ranged between 80,000 and 400,000. The increase of

η_{sp}/c with concentration was investigated and it was found that it is not proportional to the molecular weight but depends upon the intrinsic viscosity, as required by the recent theories developed by P. J. Flory and M. L. Huggins.

H. MARK

THE FIELD OF SYNTHETIC RUBBER VS. NATURAL RUBBER AND PLASTICS.—Ray P. Dinsmore, Chem. Eng. News 21, no. 21: 1798-801 (1943).

The author differentiates between the two extremes, the true plastic and the true rubber, on the basis of their probable structural formulas and with reference to the effect of vulcanization on the resulting properties. Although these formulas must be viewed with caution, they afford some understanding of the way in which polymers intermediate to plastics and rubbers may exist and exhibit certain properties of each class. The time may not be far distant when known resins will form a continuous chain of properties from the truly plastic to the truly elastic type, vulcanization serving to link more closely many plastics with the rubbers. There is a field of application for the properties of all of them, once their constitution is properly understood and evaluated.

B. I. P. C. 14:185

Theory

GLOSSARY OF RHEOLOGY.—Earl K. Fischer, Henry Green and Ruth N. Weltmann, Interchemical Review 2, 1, (1943).

Members of the research staff of Interchemical Corporation, 432 W. 45th St., New York 19, N. Y., have published a compact and useful summary of definitions of

terms relating to the flow properties of surface coatings. Terms defined are "body, centipoise, consistency, deflocculation, dilatancy, dispersion, false body, flocculation, flow curve, fluidity, gel, gelation, laminar flow, livering, millipoise, mobility, Newtonian flow, oil absorption, plastic flow, plasticity, plastometer, plug flow, poise, pseudoplastic flow rate of shear, shearing stress, sol, tack, telescopic flow, thixotropy, turbulence, velocity gradient, viscometer, viscosity, apparent-, intrinsic-, kinematic-, plastic-, relative-, specific-, and structural viscosity, and yield value. Seventeen references are cited. This handy little booklet* deserves a wide distribution. *R. B. H. Dispersions, Technical Section, Sept. 1943.

THE PROPERTIES OF FLUIDS.--S. C. Bradford, Phil. Mag. 34, (234), 433-471 (1943).

A general theory of fluids, based on molecular attraction in which all of the properties can be calculated by means of Newton's dynamics and Edser's inverse eighth power law of molecular attraction is presented in detail. The theory is derived without recourse to any arbitrary assumptions. Agreement of calculated and observed data is offered in support of the theory. The various general properties of fluids are discussed and data compared.

S. ZERFOSS

THREE TYPES OF ENERGY OF VISCOSITY.--A. E. Dunstan and A. H. Nissan, Phil. Mag. 34, (234), 479-486 (1943).

For narrow ranges of temperature the viscosity temperature relationship of unassociated liquids is best represented by the equation $\text{Ln}\eta = A' + B/T$ in which η is the viscosity in absolute units, T is the absolute temperature and A , B are constants. The constant A' is essentially invariant with temperature but the constant B varies with temperature in an interesting manner. B is related to the viscosity energy of activation --- $B = Q/R$ in which equation Q is the energy of activation of the process and R is the gas constant. B is also related to the energy of vaporization. When the value of Q , as it varies with temperature, is properly analyzed it is found to be the resultant of several energy terms. With Q is associated two types of energy of viscosity probably resulting from variations among the molecular force fields. Analysis of equations and of the three energy types are given.

S. ZERFOSS

LETTERS TO THE EDITOR

Sir: I read with a great deal of interest and approval your recent editorial entitled, "Streamlining Production and Distribution of Current Periodical Articles". I think that it would be of very much help to have available any of the miscellaneous articles so very adequately abstracted in the Bulletin. The source periodicals in so many cases are out of reach of one who does not live in the vicinity of one of our largest libraries. Please do all you can to push this idea to completion.

In particular I would be willing to pay any fair price for a biblio-film or other reproduction of the program given on the Rubber Symposium at the recent Evanston meeting.

Very truly yours,

MILTON L. BRAUN
Head of Department of
Mathematics and Physics
Catawba College
Salisbury, No. Carolina

Sir: I have today received a parcel of "Rheology Bulletins" which are not only full of interest to me but will also be most valuable to our Club.

I know that our Committee will be especially interested in the correspondence on Nomenclature but I thought that I should explain that these bulletins have only just reached us in case you might feel that our Committee's long delay in replying to the suggestions was due to some lack of interest. I can assure you that we are all profoundly interested in your activities and we look forward to the end of the war when our co-operation need not be so long delayed.

Again many thanks for sending the Bulletins.

Yours very truly,

GEORGE W. SCOTT BLAIR
Hon. Secretary
The British Rheologist's Club

APPLICATION

R. B. DOW, Secretary-Treasurer
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