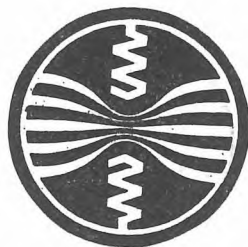


Two phase system

71, 73

Modern Developments
in Flow Measurement

BULLETIN



BRITISH SOCIETY OF RHEOLOGY

1972, No. 2, Vol. 15

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Hon. Editor:

JOHN HARRIS,
Schools of Chemical Engineering,
The University,
Bradford,
Yorks. U.K.



FOREWORD

At £30 to £35 per person including transport and accommodation in a good class hotel, Spain must be counted as a serious competitor to the conference venues in the U.K. except for the shortest of meetings and those like the B.S.R. gatherings which are deliberately pitched in the lowest possible price bracket.

Members, especially those interested in the rheology of suspensions, will no doubt make note of the conference in early 1973 which is advertised elsewhere in this issue of *Bulletin*, and which is sponsored by the Institution of Chemical Engineers. Offers of papers are invited and presumably more passive participation. Nor can it be anticipated as being unrelenting dedication to science for five full days if anything may be read into the phrase (including the weekend). We await with keen anticipation reports for the *Bulletin* from any of our members who are fortunate enough to sample Spain as a conference venue. There should certainly be no lack of potential support for it if the funds are forthcoming.

We are also interested to note that like Sport, the rather more nebulous activity called Research may at some time in the future be blessed with its own Minister. The organisation, although not the substance, of research may well go through a metamorphosis as a result of its less fashionable current image than heretofore. And in that period it will be valuable to have a head as well as a body.

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RHEOLOGY OF A FLUID WHOSE BEHAVIOUR APPROXIMATES TO THAT OF A MAXWELL BODY

F. N. Cogswell, J. G. H. Gray, D. A. Hubbard

The Maxwell body has a spring with rigidity modulus G in series with a dashpot of viscosity η . The steady flow behaviour of such a fluid is given by

$$\eta(\dot{\gamma}) = \eta \text{ (constant)}$$

$$G(\dot{\gamma}) = G \text{ (constant)}$$

where $\dot{\gamma}$ is the rate of shear. The dynamic elastico-viscous response is given by

$$\eta'(\omega) = \frac{\eta}{1 + \omega^2 \tau^2}$$

$$G'(\omega) = \frac{G\omega^2 \tau^2}{1 + \omega^2 \tau^2}$$

where ω is the angular frequency (radians/sec) and τ is the natural time of the fluid defined as η/G . η' is the real part of the complex viscosity and G' is the storage modulus.

Evaluating a particular sample of "Bouncing Putty" (a silicone polymer manufactured by I.C.I. Organics Division) at room temperature we observed the following behaviour:

1. Dynamic elastico-viscosity

Measured in a Contraves Balance Rheometer the values of $\eta'(\omega)$ and $G'(\omega)$ lay close to those predicted for a Maxwell body with viscosity 8.0×10^4 Ns/m² and modulus 2.6×10^5 N/m²—figure 1.

2. Steady state flow

Using cone and plate and capillary viscometry (corrected for die entry pressure drop) we observed a viscosity under simple shear of 8.0×10^4 Ns/m² independent of shear rate in the range 10^{-3} to 30 s⁻¹. We were unable to make clear measurements of modulus except to assert, from cone and plate recovery measurements, that the steady shear modulus is greater than 10^5 N/m².

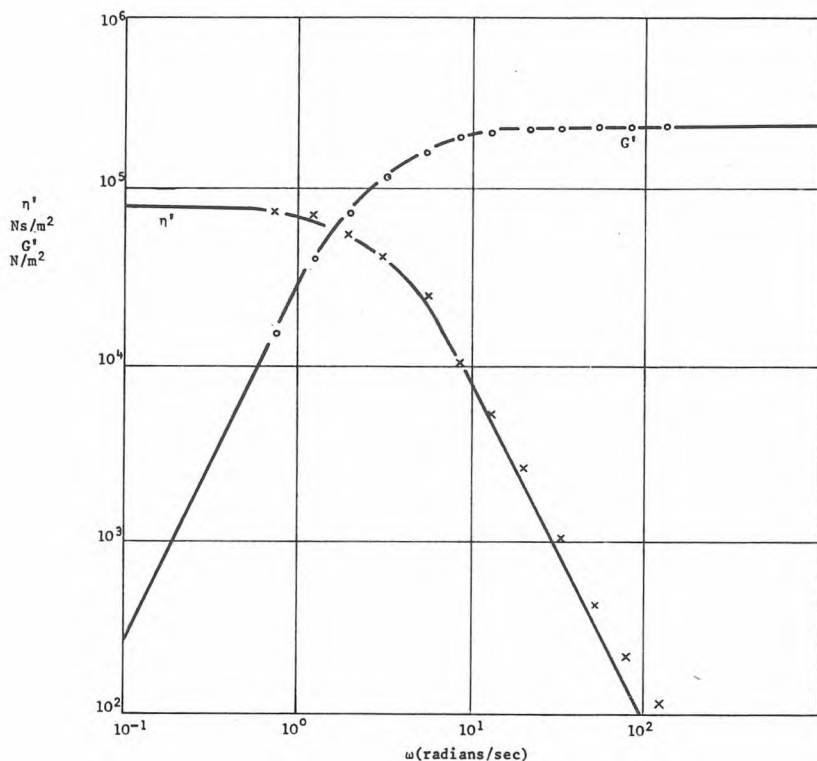
3. Additional observations

Post extrusion swelling during capillary rheometry was of the order 1.1:1. The die entry pressure drop (P_0) in capillary flow was 1.7 times the shear stress in the capillary for shear rates in the range 1 to 30 s⁻¹.

FIGURE 1

"BOUNCING PUTTY" @ 20°C
 STRAIN AMPLITUDE = 0.074

SOLID LINES ARE THEORY FOR MAXWELL
 MODEL OF VISCOSITY 8×10^{-4} Ns/m² AND
 MODULUS 2.6×10^5 N/m²



We noted two flow defects. Surface fracture ("sharkskin") was visible at linear velocities of extrusion of 2.0 mm/s (dies of 2, 4 and 8 mm diameter used). Non-laminar flow occurred at a shear rate of 30 s^{-1} —as witnessed in a die of zero length when the extrudate fragmented noisily. The onset of non-laminar flow was accompanied by a discontinuity in the graph of die entry pressure drop against shear rate, which is linear up to this point; at higher shear rates the die entry pressure drop is lower than anticipated.

The bulk modulus of this sample of "Bouncing Putty" at 20°C is $1.0 \times 10^9 \text{ N/m}^2$ and the density is $1.14 \times 10^3 \text{ kg/m}^3$.

Under simple tensile tests bouncing putty broke under a stress of about $1 \times 10^6 \text{ N/m}^2$ ($0.9 \times 10^6 \pm 0.2 \times 10^6$, 30 data) with no obvious dependence on time scale for loading times of 0.1 to 1 second (note $\eta/G=0.3 \text{ s}$).

We also studied behaviour under impact by dropping a steel ball on to a sheet of polymer. Factors such as ball diameter and weight, drop height, and sample thickness were varied. At low and moderate impacts the ball bounced with a coefficient of restitution of about 0.4 independent of impact velocity but increasing with specimen thickness. From the dent in the surface of the sample we calculated that the duration of the impact was of the order 5×10^{-3} seconds. At high impacts the sheet cracked and the coefficient of restitution was reduced. At very high impacts the sheet shattered and the ball did not bounce at all. The impact energy to cause cracking ($mgh = \text{mass of ball} \times \text{gravity constant} \times \text{drop height}$) is proportional to the thickness of the sheet (sheet thickness, d , 3 to 30 mm) so that $mgh/d = 0.20 \times 10^3$ ($\pm 0.03 \times 10^3$) J/m.

Although the rheology of this material appears to be simple the chemical composition is, in fact, complex. We have a small amount of our sample remaining if any other researchers would care to measure other properties.

VISCOMETERS WITH CURVILINEAR FLOW PATTERNS

Part III: Parallel Plate Viscometer

J. Harris, University of Bradford

1. Introduction

This part completes the series of three brief articles on the common types of viscometers with curvilinear flow patterns. Part I¹ treated the concentric cylinder geometry and Part II² the cone and plate.

The same aspects are considered here as in the prior articles namely; radial migration of particles in two phase (or component) materials. Also slip at the solid boundary, shear rate at the wall and normal stress measurement.

Brownian effects and secondary flows due to centrifugal effects are not considered.

2. Radial Migration of Particles

The basis of the treatment of radial particle migration is the same as that in Parts I and II.

Equations (1) and (6) inclusive of Part I are again of direct use, suitably modified for "radial buoyancy" effects if required as outlined in the Appendix to Part II². Furthermore since a cylindrical co-ordinate system is required for parallel plates then the continuity equations (7) in Part I apply for which the solution (8) applies, at least in the initial stages of migration.

3. Parallel Plates

The angular velocity profile, in the initial stages, will be given by (42). Where Z is the axial co-ordinate and h is the plate separation. The solution in this case is given by (29) where A takes on the form (43).

4. Effective Slip at the Boundary

Since the shear stress at the solid boundary is not immediately known in this case, it differs from the two previous cases considered. Therefore a flow curve such as that shown in figure 5 in Part II cannot be drawn from the raw data. In place of this a torque/rim shear rate curve for varying gaps (h) will suffice to show the possibility of slip. If slip is present then decreasing the gap width will have the same effect as decreasing the cone angle in figure 5.

The differentiation of data as shown by (44) will give the effective slip velocity at the rim.

5. Shear Stress at the Rim

Assuming that the shear rate distribution (45) holds true to a sufficiently good approximation. The shear stress at the rim may be obtained by a differentiation procedure, starting from the expression for total torque on either plate.

The shear stress is a function of shear rate (47). Using (45) and (47) then the independent variable in (46) may be changed from radius to shear rate (48). Differentiating with respect to the upper limit yields (49).

6. Normal Stress at the Rim

Using the radial equation of equilibrium (19) and writing the stress difference as a function of shear rate (50), and also changing the variable in (19). Simple integration yields, (51).

Finally differentiating with respect to the upper limit yields the expression (52) which is the normal stress difference at the rim.

7. Conclusion

In all three geometries treated in this series of articles, radial particle migration may be anticipated in two phase (or component) materials. The local concentration as a function of time is given in each case by (29), at least for small times, where the A appropriate to each geometry is given by Table I.

Further approximations may be evaluated as shown in section 11 of Part II.

8. References

1. B.S.R. Bulletin, 1971, Vol. 14, 70 (*J. Harris*).
2. B.S.R. Bulletin, 1972, Vol. 15, 1. (*J. Harris*).

VISCOMETERS WITH CURVILINEAR FLOW PATTERNS

Part III: Parallel Plate Viscometer

Formulae and Table I

$$w = \frac{\Omega Z}{h} \quad (0 \leq Z \leq h) \quad (42)$$

$$\begin{aligned} A &= A(r, Z) \\ &= \frac{K\Omega^2 Z^2}{rh^2} \end{aligned} \quad (43)$$

$$u_s = \frac{\partial(\Omega R/h)}{\partial(1/h)} \quad (\text{const. torque}) \quad (44)$$

$$\dot{\gamma} = \frac{\Omega r}{h} \quad (45)$$

$$T = 2\pi \int_0^R r^2 \tau(r) dr \quad (46)$$

$$\tau = f(\dot{\gamma}) \quad (47)$$

$$T = 2\pi \frac{h^3}{\Omega^3} \int_0^{\dot{\gamma}_R} \dot{\gamma}_R \dot{\gamma}^2 f(\dot{\gamma}) d\dot{\gamma} \quad (48)$$

$$f(\dot{\gamma}_R) = \frac{\Omega^3}{2\pi h^3 \dot{\gamma}_R^2} \frac{\partial T}{\partial \dot{\gamma}_R} \quad (49)$$

$$\frac{\partial \tau_{rr}}{\partial r} + \frac{(\tau_{rr} - \tau_{\theta\theta})}{r} = 0 \quad (19)$$

$$\tau_{rr} - \tau_{\theta\theta} = m(\dot{\gamma}) \quad (50)$$

$$\tau_{oo} = \int_0^{\dot{\gamma}_R} m(\dot{\gamma}) d\ln \dot{\gamma} \quad (51)$$

(τ_{oo} = Normal stress on the axis)

$$m(\dot{\gamma}_R) = \frac{d\tau_{oo}}{d\ln \dot{\gamma}_R} \quad (52)$$

TABLE I

GEOMETRY	FORMULA FOR A
Concentric Cylinder	$\frac{K\Omega^2}{r} \frac{(R_2 - r)(R_2 - 3r)}{(R_2 - R_1)^2}$
Cone and Plate	$\frac{K\Omega^2 \alpha^2}{\alpha_o^2} \left(3 \cos^2 \alpha + \frac{1}{2 \cos \alpha} \frac{\partial}{\partial \alpha} [\cos \alpha \sin 2\alpha] \right)$
Parallel Plate	$\frac{K\Omega^2 Z^2}{rh^2}$

FUTURE MEETINGS

HYDRAULIC TRANSPORT OF MATERIALS IN PIPELINES

An Intensive Short Course

17th–19th September, 1972

University of Warwick, Coventry, England
organised and sponsored by
B.H.R.A. Fluid Engineering

Object

Following the success of courses in other fields of fluid engineering, B.H.R.A. is now offering an intensive course in the theoretical and practical aspects of the hydraulic transport of materials in pipelines. The course forms a comprehensive introduction and is intended for professional engineers involved with pipeline and ancillary equipment used for the transport of materials.

Venue

The course will be held at the University of Warwick, Coventry, and accommodation will be provided in the University Halls of Residence. Full assembly instructions will be sent to students shortly before the course commences.

Course Fees

The inclusive fee covers tuition, a set of course notes and full board residence with accommodation in single study/bedrooms for the nights 16th, 17th and 18th September, 1972. Fee payable £75 (B.H.R.A. member firms £67.50). All reservations are provisional until receipt of course fee. No refunds can be given for cancellations made less than 3 weeks before the commencement of the course, but places are transferable.

N.B.—In order that students may derive maximum benefits from the course, the numbers attending will be limited and allotment of places will, therefore, be strictly in order of receipt of reservation forms. Employers are advised that in circumstances where this course is considered suitable for grant by the Industrial Training Boards, receipts and attendance certificates can be provided.

All enquiries should be addressed to: Course Organiser, Hydraulic Transport Course, B.H.R.A. Fluid Engineering, Cranfield, Bedford.

Syllabus

Introductory lecture: a historical outline; the classification of suspensions; flow regimes.

Flow characteristics: velocity and density of settling and non-settling suspensions; pressure losses due to friction; flow in bends and inclined pipes; incipient flow and minimum transport velocity,

Non-settling suspensions and slurries; non-Newtonian fluids.

Capsule flows.

Pumping, feeding and separation.

Pressure transient phenomena.

Wear, attrition and corrosion.

Applications of hydraulic transport in such areas as quarrying, mining, sewage and waste disposal, dredging, etc.

Economics of hydraulic transport.

More detailed synopses of the lectures will be provided on request.

The Hydraulic Transport of Solids in Pipes—A Bibliography

The volume of literature on the hydraulic transport of liquid-solid mixtures in pipes has grown rapidly in the past few years, and B.H.R.A. Fluid Engineering has long felt the need for a comprehensive collection of information on the subject. A bibliography containing some 1030 references, has now been compiled and includes abstracts of literature published up to mid-1970. Some features of the bibliography, which is bound in stiff covers, and includes an arrangement of entries by subject area (see over), subject and author indexes.

Price: United Kingdom £6.00; Overseas £8.25.

HYDROTRANSPORT 2

The Second International Conference on the Hydraulic Transport of Solids in Pipes

University of Warwick, Coventry, England

20th–22nd September, 1972

Sponsored and Organised by

B.H.R.A. Fluid Engineering

LIST OF PAPERS OFFERED

Fluid Mechanics of Suspension Flows

The drag coefficient of a particle and the voids fraction in a fluidisation or sedimentation assembly of particles. A. C. Bonapace (Fuel Research Inst. of South Africa, S. Africa).

Variation of Karman constant in pipe flows with solid particles in suspension. M. Alquier (E.N.S.E.E.I.H.T., France).

Mechanism of hydraulic conveying at high concentrations in vertical and horizontal pipes. M. Streat (Imperial College, U.K.).

Local and general pipe laminar to transition problems for viscous and non-Newtonian slurries in pipelines. C. B. Duckham (Univ. of Salford, U.K.).

Turbulent diffusion of heat, mass and momentum in solids suspension. J. R. Tyldesley (Univ. of Glasgow, U.K.).

Laminar boundary layer flow of a two-phase suspension along a vertical flat wall. S. L. Lee (State Univ. of New York, U.S.A.).

A study into the correlation of sediment motion in pipe and open channel flow. P. Novak (Univ. of Newcastle, U.K.).

Unsteady flow of suspensions of variable concentration. J. Litwiniszyn (Polish Academy of Sciences, Poland).

Pressure Losses

Flow of cement slurries—friction losses and start-up pressures. J. F. Raffle (Loughborough Univ. of Tech., U.K.).

Wall shear stress measurements on liquid-solid suspensions. W. H. Graf (Lehigh Univ., U.S.A.).

Drag coefficients of suspended spheres and sphere trains in a vertical tube. G. F. Round (McMaster Univ., Canada).

Influence of density ratio on the pressure gradient in pipes conveying suspensions of solids in liquids. R. A. Duckworth (City Univ. U.K.).

Study of pressures losses in sudden contraction and enlargement of hydraulic conveyor. T. Suu (Utsonomiya Univ., Japan).

Flow of slurries without deposit. J. J. Voadlo (Worthington (Canada) Ltd., Canada).

A method for assessing the thixotropic property of fluids carried in pipelines. D. C.-H. Cheng (Warren Spring Lab., U.K.).

The design of large pipelines for cement slurries. J. M. Kenchington (Univ. of Bradford, U.K.).

Pressure loss in hydraulic transport of solids in inclined pipes. R. S. Rai (Mosaboni Mines, India).

An experimental method to produce minimum pressure drop size distribution. T. Meggyes (Hungary).

Studies on three-phase flow in an inclined pipe—determination of entrance region of pipe and measurement of pressure loss. K. Noda, T. Kawashima and T. Masuyama (Tohoku Univ., Japan).

Experiences about applications of methods for friction losses. A. Szivak (State Planning Office for Civil Engng., Hungary).

Critical Velocities

Critical conditions determining saltation or suspension of particles in a stream. A. C. Bonapace (Fuel Research Inst. of South Africa, S. Africa).

A formula for the velocity required to initiate particle suspension in pipeline flow. K. C. Wilson (Queens University, Canada).

The pipeline flow of slurries; Transition velocities. G. S. Stevens (Techman Ltd., Canada).

Relation between critical speed in agitation and critical velocity in pipe flow of some settling slurries. T. Moro (Nat. Res. Inst. for Pollution and Resources, Japan).

A summary and comparison of known calculations of critical velocity of solid-water mixtures. W. Wiedenroth (West Germany).

Some experimental studies of the effect of fluid properties and particle size distribution upon pressure drop. W. Schriek (Saskatchewan Res. Council, Canada).

Suspension Properties

Properties of coal-water slurries. R. R. Faddick (Colorado School of Mines, U.S.A.).

The development of an accurate transport concentration meter for two-phase flow. R. Van-der-Veen (Ballast Nedam Groep NV., Netherlands).

Control of solids pipelines: continuous measurement of particle size. M. E. Charles (Univ. of Toronto, Canada).

Application of W. S. L. pipeline design method to settling suspensions. D. C.-H. Cheng (Warren Spring Lab., U.K.).

The influence of highly concentrated rigid particles on the macroturbulence characteristics in pipe flow. I. Kazanskij (T. U. Hannover, Germany).

Slip-model correlation of dense two-phase flow. K. C. Wilson (Queens Univ., Canada).

Pumps

The design aspects of centrifugal pumps for abrasive slurries. G. Wilson (Worthington (Canada) Ltd., Canada).

Estimation of wear of centrifugal pump parts in an abrasive slurry. V. N. Vasiliev and A. I. Zolotar (U.S.S.R.).

Slurry pumps—a review. E. J. Wasp, T. L. Thompson, R. J. Frey and N. T. Cowper (Bechtel Inc., U.S.A.).

Performance of hydrolift feeder. H. B. Sauermann (C.S.I.R., South Africa).

A new patented dredging system operated by compressed air. G. Faldi (S.I.R.S.I., Italy).

Applications and Economics

Economy of pipeline transport. I. Zandi (Univ. of Pennsylvania, U.S.A.).

Refuse collection from houses and flats by pipeline. R. G. Courtney (Building Research Station, U.K.).

Some applications of pipelines for the transport of solids. R. A. Duckworth (City Univ., U.K.).

A weather-stable system for ocean mining—systems, development and economics. D. Hody (E.T.H. Zurich, Switzerland).

The pumping of activated sludge as a tool for its settling characteristics. B. M. Novak (Switzerland).

High pressure hydraulic transport for coal and other mining materials with tube chamber feeder. L. Kocsanyi (State Planning Office for Civil Engng., Hungary).

In plant materials handling using the Marconaflo system concept. D. R. Rathburn (Dravo Corp., U.S.A.).

Low pressure gradients in capsule pipelines—preliminary results from a 4in. automated experimental pipeline. J. Kruyer (Research Council of Alberta, Canada).

Pressure and Couette flow in a capsule pipe system. J. Kruyer (Research Council of Alberta, Canada).

Some experimental results of a long-distance solids pipeline feasibility study to carry potash. W. Shriek (Saskatchewan Research Council, Canada).

Slurry pipeline pilot plant facilities, development and operation. W. Schriek (Saskatchewan Research Council, Canada).

Some effects of fitting pipeline capsules with collars. H. S. Ellis (Research Council of Alberta, Canada).

Miscellaneous

On the classification of flow patterns of sphere-water mixture in a pipe with respect to non-dimensional factors. K. Okuda (Muroran Inst. of Tech., Japan).

Pulsed slurry flow through pipelines. G. F. Round (McMaster Univ., Canada).

Theoretical and experimental investigation on the wear of pipelines caused by hydraulic transport. I. Tarjan (Hungary).

Control system for hydraulic transport of solids in pipes. R. S. Rai (Mosa-boni Mines, India).

Modelling the erosion mechanism caused by impacting particles. H. Brauer (T. U. Berlin, Germany).

Experiments on erosion caused by impacting particles. H. Brauer (T. U. Berlin, Germany).

Hydraulic design of slurry pipelines. G. H. Durham (Shelpac R. & D. Ltd., Canada).

Optimisation of very long distance pipelines. J. Koren (State Planning Office for Civil Engng., Hungary).

Erosion studies in solids-water pipelines. J. Postlethwaite (Univ. of Saskatchewan, Canada).

Mathematical model of the wear of rubber parts by the flow of slurry. V. N. Vasiliev and A. I. Zolotar (U.S.S.R.).

A review of instrumentation for measuring flow rate and solids concentration in slurry pipelines. R. S. Kakka (B.I.S.R.A., U.K.).

Materials Science Club

THE STRUCTURE AND TEXTURE OF FOOD

University of Surrey, Guildford, 6th and 7th July, 1972

This meeting is being organised jointly with the University of Surrey Food Research Group. The object of the meeting is to present some aspects of foodstuffs as materials to scientists and technologists engaged in fields other than food research. In particular we hope to stimulate discussion on testing methods and their interpretation.

The meeting is organised in three sessions, the first two are devoted to structure and rheology respectively and in the third the more elusive topic of correlation between objective and subjective assessment is tackled.

The speakers will be presenting their topics in a manner appropriate to a non-specialist scientific audience and will in particular emphasise those aspects which might benefit from cross-fertilisation with other disciplines.

The success of the meeting will be judged by the diversity of the audience and the discussion and the organisers trust that the Materials Science Club membership will respond accordingly.

There will be the opportunity during the meeting to inspect the facilities in both the Food Research Group and in Materials Science generally at the University of Surrey. Accommodation is available on site, and fees have been kept as low as possible.

Early registration would be much appreciated.

M. G. Bader,
Joint Organiser.

Hon. Sec. for the meeting:

Mr. J. O'Connor,
Dept. of Hotel & Catering Management,
University of Surrey,
Guildford,
Surrey.

The Structure and Texture of Food

Conference organised jointly with the University of Surrey Food Research Group.

Provisional Programme

- 6 July 12.00 Registration
12.30 Lunch
14.00 **Session 1. Food Structure**
Chairman: Dr. A. W. Holmes (Director BFMIRA)
The Structure of Meat by speaker from Meat Research Institute
Plant Tissues, Mr. G. G. Jewell (BFMIRA)
Tea
Cereal Foods, Dr. P. Wade (FMBRA Chorleywood)
Fats and Related Products, D. M. L. Meara (BFMIRA)
18.00 Conclusion of Session
19.00 Reception
19.30 Dinner. Speaker: Professor J. B. M. Coppock (Spillers Foods Limited)
- 7 July 09.00 **Session 2. Rheology**
Chairman: Dr. P. Sherman (Queen Elizabeth College)
Fundamentals of Food Rheology, Chairman's Introduction
Semi-Solid Foods, Mr. C. Roberts (Unilever Research Labs.)
Semi-Solid Foods—2, Dr. Haighton (Unilever N.V.)
Coffee
Fruit and Vegetables, Mr. S. D. Holdsworth (FVPRA)
12.30 End of Session
Lunch

14.00 **Session 3. Correlation between Objective Tests and Subjective Judgement**

Chairman: Prof. A. G. Ward (Univ. of Leeds)

Subjective Aspects of Texture, Mr. D. Palmer (Unilever Research)

Correlation between Objectives and Sensory Measurements on Food, Dr. G. W. Scott Blair

Tea

General Discussion

17.15 Conclusion of meeting

(Two or three contributions have still to be confirmed)

INTERNATIONAL COMMITTEE ON RHEOLOGY

CZECHOSLOVAK ACADEMY OF SCIENCES

Third Discussion Conference

GENERAL PRINCIPLES OF RHEOLOGY

Prague

11th-14th September, 1972

Topics

Part (A): *Rheological Material Functions*

Viscoelasticity, plasticity and flow phenomena

Relaxation and fracture phenomena

Modern experimental methods

Part (B): *Theoretical Rheology*

Mechanics and irreversible thermodynamics

Statistical approaches

Philosophy of Rheology

Part (C): *General Discussion*

Common language of rheology (equivalency of terms)

Perspectives of rheology in theory and practice

This Conference follows the Sixth International Congress on Rheology (Lyon, France, 4th-8th September, 1972).

Scientific Programme

The scientific programme of the Third Discussion Conference consists of invited lecturers and of discussion contributions only; the usual short communications will not be presented.

Discussions

The discussion contributions are expected to be of two types: (a) *questions and comments* (to invited lectures and to other contributions); (b) *thematic contributions* (to the Conference topics).

Questions and comments (usually not exceeding one to a few minutes) can be presented immediately after the lecture or discussion contribution on the invitation of the discussion leader without any further formalities. The question or comment should be as concise as possible.

Thematic contributions (usually not exceeding five minutes) should not have in any case the character of short communications, that is, all introductory and detailed experimental or theoretical parts are to be omitted. Each exposé should be concentrated on principal ideas only. Some details can be explained if this is asked by the audience (further necessary or useful data can be included into the abstract). All those wishing to present a thematic contribution (exposé of problems to be solved or discussed; brief survey of experimental or theoretical findings pertinent to the problems under discussion) are requested to submit its concise but exhaustive *abstract* (about 300 words or more if necessary); a short list of references closely related to the subject is recommended to be attached to the abstract. Only contributions, the abstracts of which will be submitted *prior to 1st June, 1972*, can be included in the programme. Contributions dealing with some interesting and unconventional problems or reporting new phenomena and important findings will be particularly appreciated.

Publications

The abstracts of invited lectures and discussion contributions will be published as a supplement to the Programme. No other Conference materials are foreseen; the authors are entirely free to decide where to publish their lectures or contributions.

Other Information

Registration: Since the number of participants is limited, completed application forms should be returned to the Secretariat as soon as possible, but *not later than 1 June, 1972*. The applications received will be confirmed; at the same time, visa forms will be sent to the participants.

Fees: The conference fee \$56 for an *active participant* includes: registration and reservation fees, Conference materials, "post-registration" programme, informal dinner, sightseeing tours with lunches and refreshments for four days.—The Conference fee, \$26 for an *accompanying person*, includes: "post-registration" programme, informal dinner, sightseeing tours with lunches for four days.—Conference fees, \$56 and \$26, should be remitted *before 1 June, 1972*, at the latest, either by cheque (addressed to the Secretariat) or by transfer of money directed to the account of the Institute of Macromolecular Chemistry at the Czechoslovak State Bank, branch office Prague 6 - Dejvice, No. 3-06-2021-5. In case of *cancellation* the Secretariat will return the whole sum, if received *before 1 July, 1972*, (\$6 are charged for cancellation after this date).—According to the official instruction, the payment of the Conference fees in Czechoslovak Crowns at the Registration Office is *not* admissible; on the other hand, the participants are *not* obliged to change their money on arrival to the country.

Address:

Conference Secretariat
c/o Institute of Macromolecular
Chemistry of the Academy
1888 Petřín
Prague 616, Czechoslovakia

FLUID-PARTICLE SYSTEMS

It is planned, if there is sufficient support, to hold a Spring Research Meeting in the early part of 1973 either in Spain or in the Balearic Islands.

It is expected that a five-day meeting (including the week-end) will cost about £30-£35 per person, using charter planes from London (and other centres if there is sufficient demand) and good class hotels in the area.

In addition to the technical meeting there will also be, if demand warrants it, a ladies' programme and a children's programme.

The charges given above are based on full board in good class hotels with twin-bedded rooms and bathrooms *en suite*. There will be an extra charge for single rooms.

Children will be eligible for a reduced rate if they occupy a room with their parents and their will only be a nominal charge for children in carry-cots who do not occupy a seat on the plane. A baby-sitting system and a nursery will be available at cost according to demand.

It is hoped that papers will be presented and discussed on the general topic of Fluid-Particle Systems, especially:

Conveying of Particles,

Mass and Heat Transfer Processes in Particulate Systems,

Fluidisation,

Rheology of Suspensions,

Filtration,

Sedimentation and Flocculation,

Flow of Dusty Gases,

General Papers not classified above.

Offers of papers are invited. Those offering papers are asked to send a synopsis (two copies, please, typed, double-spacing) of not more than 150 words to The Publications Department, The Institution of Chemical Engineers, 16 Belgrave Square, London SW1X 8TP. Papers from non-members will be welcome and will be treated equally as papers from members.

It will be appreciated that the nature of the travel and hotel arrangement will necessitate that those presenting papers will be required to pay the full fee.

If you are interested in attending this meeting would you please complete the enclosed Questionnaire Form "A" and return it to the Institution before 1st June, 1972. The completion of this form does not bind the Institution or the person completing it to this event.

THE BRITISH NATIONAL COMMITTEE ON MATERIALS

Press Release

The British National Committee on Materials consists of specialist representatives of thirty major Scientific and Professional Institutions and Societies, and at their 74th Annual General Meeting elected the following officers for the forthcoming session:

Colin C. Bates, CGIA, C.Eng., FIProd.E., FIGasE. (Chairman);
Dr. E. G. Stanford, M.Sc., Ph.D., MIEE, F.Inst.P. (Vice-Chairman);
A. R. Woodward (Co-Vice-Chairman);
Trevor L. Huxtable, Institution of Mechanical Engineers
(Secretary).

The Committee acts as the main co-ordinating authority in this vital and growing sphere of technology and science on both National and International affairs. It maintains a close liason with Government Departments, Universities, Research Establishments and Industry through its professional institutions.

At the recent Annual General Meeting current activities organised under its aegis were reviewed, and consideration given to spheres of technology that call for national attention in association with the training and education of Material Scientists and Engineers.

Among the many subjects under current review are:

- (a) The use of Polymers in the Transportation Industry.
- (b) Conservation and the effective use of Materials.
- (c) The education of the Designer in the use of newer materials.
- (d) The behaviour of Materials in the forming processes.
- (e) The selection of correct materials in Machine Design.
- (f) Materials in Medicine.
- (g) The potential uses of non-metallic materials—e.g. Glass.
- (h) Co-operation with European professional institutions.

The Committee's review on the state of education in materials' science, particularly for engineers, is still being assessed and collated, and it is hoped its report will be issued during the year.

Consultative Council of Professional Technological Societies (C.C.P.T.S.)

The following is the text of a press release issued on 17th February, 1972:

NEW PROFESSIONAL COUNCIL

Five professional organisations today formed the Consultative Council of Professional Technological Societies.

The Clothing Institute, the Institution of the Rubber Industry, the Plastics Industry, the Society of Dyers and Colourists, and the Textile Institute exist to set the standard for the education of professional technologists in the clothing, plastics, rubber, coloration and textile industries. They provide the information by which professional technologists keep themselves and their industries up to date.

Between them they represent 26,500 members.

Representatives of each of these organisations met in London and decided to form the Council. The objects are:

1. To review the standard and content of the education of technologists, both nationally and internationally.
2. To uphold the professional status and responsibilities of members of the constituent bodies.
3. To consider the effect of national and international legislation on the position of professional technologists and to co-ordinate representation to government and other agencies.
4. To develop means of closer co-operation, especially in the collection and dissemination of knowledge.
5. To promote co-operation with other bodies having similar objects and activities.

By coming together in this way the five societies will be able to increase their service to members and to advise industry and government in planning for the future education and use of technological manpower.

An impetus for the formation of this Council was the situation which faced the Institution of the Rubber Industry, the Society of Dyers and Colourists (a body founded in 1884 and incorporated by Royal Charter), and the PI when the *Council of Science and Technology Institutes (C.S.T.I.) declined to accept these bodies and others such as the Oil and Colour Chemists' Association into membership.

At the moment it is not possible for PI Graduates, Associates and Fellows, unless they are also members of one of the five constituent bodies of C.S.T.I., to join the trade union set up by C.S.T.I., the Association of Professional Scientists and Technologists (A.P.S.T.).

The view of C.C.P.T.S. is that any professional scientist and technologist should have the right to join A.P.S.T. and that the apparent restriction on membership is not acceptable. Equally, objection is taken to the presumption on the part of C.S.T.I. that technologists who have entered the service of specific industries are adequately served by what is essentially a Council of *Science* Institutes. Representations to this effect will be made to C.S.T.I.

* Royal Institute of Chemistry, Institute of Physics, Institute of Biology, Institute of Mathematics and its Applications, Institution of Metallurgists.

DIRECTORY OF CONSULTANTS FOR CHEMICAL ENGINEERING

The Information Service of the Institution of Chemical Engineers has prepared a new 48-page directory containing details of 50 consultants who are available to give specialist advice on problems connected with chemical engineering.

A comprehensive subject guide includes such aspects as: pollution control; safety; plant design; market surveys; pesticides; and plastics.

To meet any specific problems, the Information Service would provide a selected list of consultants on request.

Those wishing to hold a complete *List of Consultants* may obtain a copy from the Institution, 50p, post free.

Enquiries should be made to:

Dr. Ann Ralph,
Information Officer,
The Institution of Chemical Engineers,
16 Belgrave Square,
London, SW1X 8PT.

Tel. 01-235 3647.

THE 1970 SURVEY OF BRITISH RHEOLOGICAL RESEARCH

At regular intervals the National Engineering Laboratory conducts a survey of rheological research in Britain. The fourth of these surveys, covering work in progress during 1970, was published at the end of 1971 as NEL Report No. 493.

This is a completely new survey, not merely a revision, and contains about 50 per cent more information than its predecessor published in 1969, covering subjects ranging from medical research to plastics technology. It gives details of some 1,031 research projects being carried out in 581 laboratories and includes an index of 1,486 workers active in the field of rheology at the time of its compilation.

Copies of the survey may be obtained from the National Engineering Laboratory, East Kilbride, Glasgow.

WE WOULD LIKE TO HEAR FROM YOU

B.S.R. members are reminded that the Editor of the *Bulletin* is always interested in receiving informative articles, comments, news and other material which would help to make the *Bulletin* one of the more welcome sights in the flood of reading matter to which most of us are accustomed and resigned.

Suggestions of possible improvements in the *Bulletin* would also be welcome. So if you have a thought and a minute to put pen to paper why not let us hear about it?