

BULLETIN



BRITISH SOCIETY OF RHEOLOGY

1978, Vol. 21, No. 3

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Hon. Editor:

M. CAMINA,

Paint Research Association,

Waldegrave Road,

Teddington,

Middlesex.



FOREWORD

Disasters involving industrial chemicals occur from time to time but compared to the total chemical usage they are fortunately infrequent and small. Nevertheless an accident where human lives are at stake is still a disaster however small. The seemingly irresponsible behaviour of those in charge, for example, those responsible for dumping chemicals which thirty years later produced sufficiently obnoxious fumes to affect the lives of a small community, needs to be considered.

One of the reasons for this behaviour is what could be called the sales syndrome. It consists in this example of arguments put forward by management in an industry to protect aspects of the industry which have been condemned by ecologists, even when the counter argument is to the general social benefit. Jean Jacques Rousseau once wrote that he would never make a judgement if he were to gain or lose by the judgement. This attitude could well be adopted with the now fashionable field of chemical pollutants.

OFFICERS AND MEMBERS OF COUNCIL 1977-1978

President: DR. J. J. BENBOW, I.C.I. Ltd., Agricultural Division, Billingham, Teesside.

Secretary: MR. F. N. COGSWELL, I.C.I. Ltd., Plastic Division, Welwyn Garden City.

Treasurer: MR. A. EVANS, Department of Surgery, Royal Victoria Infirmary, Newcastle upon Tyne.

Membership Secretary: DR. T. E. R. JONES, School of Mathematical Sciences, Plymouth Polytechnic, Plymouth.

Abstracts Editor: MR. J. ASTIN, Department of Applied Mathematics, U.C.W., Penglais, Aberystwyth.

Bulletin Editor: MR. M. CAMINA, Paint Research Association, Teddington, Middlesex.

Ordinary Members:

DR. D. C-H. CHENG, Warren Spring Laboratory, Stevenage.

MR. T. C. DAVENPORT, B.P. Research Centre, Sunbury-on-Thames, Middlesex.

DR. J. FERGUSON, Department of Fibre Science, University of Strathclyde, Glasgow.

DR. D. MARSHALL, Institute of Polymer Science, Loughborough University of Technology, Loughborough.

DR. D. R. OLIVER, Department of Chemical Engineering, University of Birmingham, Birmingham.

DR. C. J. PETRIE, Department of Engineering Mathematics, University of Newcastle upon Tyne, Newcastle upon Tyne.

Co-opted Member:

DR. M. SHERRIFF, The School of Pharmacy, London.

The British Society of Rheology
Annual Award for 1978
is presented to
Mr. R. W. Whorlow
of the University of Surrey
in recognition of
his outstanding services to the Society
for his work and in the teaching and science of Rheology

ANNUAL AWARD

The first annual award of the British Society of Rheology was presented to Mr. R. W. Whorlow for his services both to Rheology and to the British Society of Rheology.

Dick Whorlow obtained a first class honours in Physics at Imperial College in 1943. In 1949 he also obtained a first class honours in Mathematics which he obtained by private study while working first for the Ministry of Supply in SRD Signals at Christchurch and later at the British Rubber Manufacturers Research Association. It was in this latter post that he wrote his first rheological paper, with R. G. Newton and J. R. Scott, on "A note on the discriminating power of plasticity tests". This was presented at the 1st International Conference on Rheology in Scheveningen in 1948 and published in the proceedings. He is also a Fellow of the

In 1951 Dick joined the Physics Department of what was then Battersea Polytechnic and which later became Battersea College of Technology and, finally, the University of Surrey. In 1956 while at Battersea he started giving an annual series of post-graduate evening lectures on Rheological Techniques. These courses were admirably suited to industrial research workers, providing a good basic knowledge of rheological theory, together with an excellent review of available measurement techniques. These courses continued until 1968 when the University of Surrey moved from Battersea to its present home at Guildford. Many members of the BSR, and at least three members of the present council, gained much of their early basic knowledge from these lectures.

Dick became a member of the BSR in 1948 and a member of council in 1958. He continued as a member of council until 1974 serving for longer than any other member. During this time he was Editor of Rheology Abstracts from 1961-65 and Treasurer from 1969-73, and also helped to organise conferences editing the Proceedings of "Polymer Systems" held at Loughborough in 1966.

In addition to his teaching work he has continued his research on rheological topics. Following his early interest in rubber, his main research work has been on the rheological properties of suspensions of particles and more recently on polymer solutions and melts. He has maintained an interest in the accuracy of rheometers publishing interesting work on the end-effects of various types of viscometer showing that the conventional correction factors obtained with Newtonian fluids were not accurate when applied to non-Newtonian materials.

It is perhaps fitting that the year of his obtaining the first BSR annual award should see the publication of his book aptly titled "Rheological Techniques".

SCIENTIFIC ENQUIRY

A member asks: What is the definition of viscosity for highly anisotropic fluids?

An answer is offered below by D. C-H. Cheng of Warren Spring Laboratory, Stevenage, Herts.:

We need to go back to basic first principles to answer the member's question. In elementary textbook, viscosity η is defined by considering the shearing of an element of fluid and the shear stress τ (force per unit area) needed to maintain a shear rate of γ (velocity gradient). It is

$$\eta = \frac{\tau}{\gamma}.$$

In fig. 1 we have such an element of an anisotropic fluid. We imagine that the anisotropy is due to rods aligned in the manner shown. If this element is sheared at a shear rate V/L as in view A and the shear stress required is τ_{xy} , then the viscosity is obtained from the defining equation as

$$\eta_A = \tau_{xy} / \left(\frac{V}{L} \right).$$

On the other hand, if we imagine that the element is sheared at the same shear rate as in view B, the viscosity is

$$\eta_B = \tau_{zy} / \left(\frac{V}{L} \right).$$

Similarly,

$$\eta_C = \tau_{xz} / \left(\frac{V}{L} \right).$$

On inspecting the three views in fig. 1, we see that, because of the way the rods are arranged with respect to the co-ordinating system,

$$\tau_{xy} = \tau_{xz} \neq \tau_{zy}.$$

Therefore,

$$\eta_A = \eta_B \neq \eta_C$$

This means that the viscosity of an anisotropic fluid is different depending on how it is sheared. The fluid depicted in fig. 1 is only anisotropic in one direction, so to speak, so its viscosity is different when sheared in that direction (the zy-plane) compared with when

sheared in the other two directions (the xy - and the xz -planes). If it is sheared in some other direction, the viscosity would be different yet again, but it would be related to the viscosities $\eta_A = \eta_C$ and η_B .

In general, therefore, an anisotropic fluid will have three "principal" viscosities: η_A , η_B , and η_C , all different. If it is sheared in one of the "principal" directions, it will show a viscosity that equals either η_A or η_B or η_C . If it is sheared in a non-principal direction, it will show a different viscosity yet again, but this viscosity will be related to the three principal viscosities according to how the direction of shear is inclined relative to the principal directions.

We need to recognise that stresses (of which shear stress is part) and strain rates (of which shear rate is part) are tensor quantities if we are to discuss how the non-principal and principal viscosities of an anisotropic fluid are related quantitatively. In addition, tensor analysis is essential if we want to predict the behaviour of an anisotropic fluid when it is sheared in more than one direction simultaneously. The story of tensor analysis in rheology is a long one and will be left for another occasion. For the interested reader, however, I could suggest the book by R. R. Long, "Mechanics of solids and fluids", published in London: Prentice-Hall International, 1961, as an introduction to the subject.

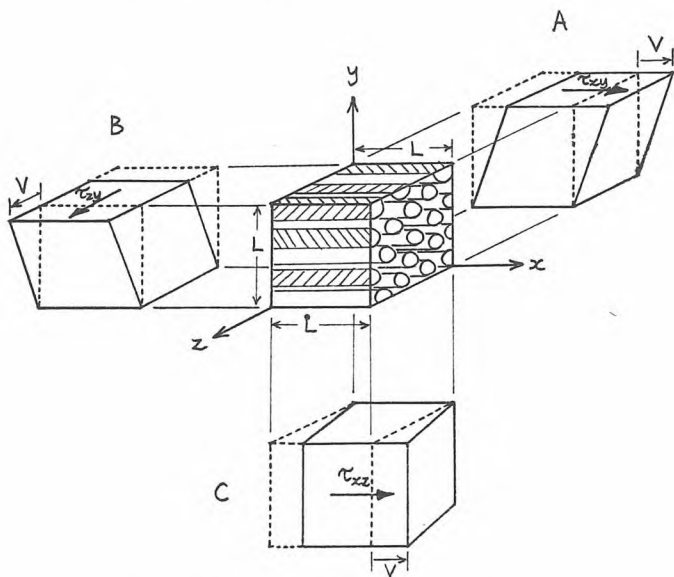


FIG.1 SHEARING OF AN ANISOTROPIC FLUID

THE BRITISH SOCIETY OF RHEOLOGY IN FIFTEEN YEARS

Council sought the collective wisdom of the Society concerning the likely future pattern of the activities of the Society and its members. Eighty-eight completed questionnaires have been received which represents 15 per cent of the membership, including nearly 18 per cent of the U.K. membership and 10 per cent of the overseas membership. Of this the response from Europe was as good as from the U.K., but (perhaps because of the later arrival of Bulletins (further afield) only five responses came from America, Australia and Asia altogether.

The responders described themselves, in response to the rest of question eight as follows:

<i>Age</i>	Under 30	6
	30-50	52
	Over 50	27
	Did not say	3
<i>Affiliation</i>	University	42
	Industry	36
	Government	5
	None	3
	More than one	2
<i>Approach</i>	Theoretical	12
	Empirical	46
	Both	5
	Other	16
	None	9

The self-confessed theoreticians were split 11:1 between university and industry and the empiricists 15:28. Overall this seems to represent fairly the pattern of the Society's membership, and on the whole the responses showed little evidence of differing views among the groups.

The questionnaire contained six sections and we report on these in turn.

1. Rheology of different material systems

Interest in multiphase liquids and polymers, which are areas of interest each to one third of the Society's members at present, is expected to increase. The responses (with percentages of 88 in brackets) were:

	<i>Increased interest</i>	<i>Same interest</i>	<i>Decreased interest</i>	<i>No comment</i>
<i>Multiphase liquids</i>	52 (59%)	21 (24%)	1 (1%)	14
<i>Polymers</i>	35 (40%)	35 (40%)	5 (6%)	13

In addition six areas of minority interest were listed and members were asked to select one or more as likely growth areas. There was strong enthusiasm for biological systems but little for theoretical materials or for some highly practical ones. The numbers supporting each area were:

Biological systems	54 (61%)
Foodstuffs	28 (32%)
Particulate solids	26 (30%)
Building and road materials	13 (15%)
Theoretical materials	11 (13%)
Oils and greases	7 (8%)

Several contributors drew particular attention to medical applications of rheology, indicating that this was an area which could be especially rewarding. No comments indicated significant support for any other area of interest.

2. Measuring the rheology of liquids

Interest in nine techniques was canvassed, with the following response (as to whether importance will increase, stay constant or decrease):

	<i>Increase</i>	<i>Stay constant</i>	<i>Decrease</i>	<i>No comment</i>
<i>Stretching flow</i>	49 (56%)	15 (17%)	3 (3%)	21
<i>Surface</i>				
<i>rheometry</i>	40 (46%)	22 (25%)	3 (3%)	23
<i>Oscillatory shear</i>	37 (42%)	29 (33%)	6 (7%)	16
<i>Bulk property</i>				
<i>measurement</i>	24 (27%)	31 (35%)	8 (9%)	25
<i>Complex geo-</i>				
<i>metry methods</i>	22 (25%)	23 (26%)	16 (18%)	27
<i>Normal stress</i>	17 (19%)	38 (43%)	16 (18%)	17
<i>Flow</i>				
<i>birefringence</i>	17 (19%)	29 (33%)	19 (22%)	23
<i>Capillary flow</i>	13 (15%)	37 (42%)	18 (31%)	20
<i>Steady shear</i>				
<i>(rotational</i>				
<i>methods)</i>	7 (8%)	48 (55%)	18 (21%)	23

This gives a clear indication of growth in importance of stretching flow, surface rheometry, oscillatory shear and possibly bulk property measurement, a continued steady interest in steady shear by rotational methods and a rather less certain future for the other techniques.

There was strong support (74 replies) for the expectation that improved versions of present rheometers will be in use and much

less either for the use of radically different techniques (22 replies) or for the abandonment of many of today's techniques (19 replies). In view of this confidence in the usefulness and capacity for improvement of today's rheometers, the Society could play a constructive role in reviewing areas where such improvement is possible and desirable.

3. The role of rheologists

Members were evenly divided in their views about this. Of the 88 responses 45 saw the interpretation of practical flow phenomena, 41 saw characterising materials and 37 saw the application of standard rheological information to design as the major role of rheologists. Other roles suggested were as part of an interdisciplinary team, in diagnosis within the clinical field, and in structural analysis and microrheology.

4. Approaches to rheology

Six scenarios were offered, describing possible developments in connection with the categories theoretical, structural, phenomenological and industrial. The responses to these were:

	<i>Likely</i>	<i>Unlikely</i>
(a) We shall be discussing much the same phenomena and theories at a more sophisticated level with an increasing polarisation between empiricists and theoreticians	41	10
(b) A significantly different range of materials will be under investigation with approximately the same balance between the different approaches	32	17
(c) A major new area of morphological rheology will have evolved	31	12
(d) Most known phenomena will be adequately represented by mathematical descriptions	24	29
(e) Rheology will only be considered within the broader framework of particular industrial flow processes	15	28
(f) The attempt to model flow phenomena with mathematical equations will have been abandoned in favour of empiricism	7	50

A slight relief from the depressing prospect of (a) is afforded by the fact that several of those who saw it as likely deleted the qualification concerning increasing polarisation between empiricist and theoretician. It was also commented that if polarisation does increase the Society will have failed, and it is clear that Council, and all members of the Society, must take active steps to avoid

the development of a schism which would be to the detriment of the Society as a whole. We can hope that the warning will be heeded (or that those making it are unduly pessimistic).

There was no indication that the support for scenarios (b) and (c) came more from those envisaging growth of interest in biological systems or foodstuffs, so perhaps members have a wide variety of new materials in mind. At least one member of Council is unable to understand what is meant by (c) and so awaits with interest the evolution of this new area of rheology. It may be worth noting that significantly more support from (c) came from industry than from universities. Theoreticians can take comfort from (d) and (f)—their job will not be complete, and neither will it have been deemed useless or irrelevant. However, the rejection of (f) may perhaps reflect the view that theoreticians will carry on regardless of success or failure, relevance or irrelevance.

5. The teaching of rheology

The next six scenarios relate to teaching and research in British Universities, and were ranked (in terms of votes expressing the view that they will be true in fifteen years):

- | | |
|--|----|
| (a) University research in rheology will be greater than at present | 64 |
| (b) Specialised courses in rheology at M.Sc. level will be available at several universities | 55 |
| (c) A British university will have a designated chair of rheology | 38 |
| (d) Half of all first degree science students will know the meaning of the word rheology | 35 |
| (e) Rheology will be a component of all physical science degree courses | 22 |
| (f) University research in rheology will be less than at present | 3 |

The response to (a) and (f) speaks for itself though (along with (b) and (c)) reflects more confidence in the continuing growth of university research and teaching than is felt by many in the universities. Slightly more support for (a), (e) and (c) came from industry than from universities and proportionately less from abroad (where fewer industrialists responded). The Society has at least eleven cynics who find (e) likely but not (d) though whether this is an implicit criticism of university students or teachers is not clear.

The expectation of continued strong growth of rheological research in the universities after a period of very rapid expansion in the last two decades shows a remarkable confidence. The expectation of M.Sc. in rheology courses as a regular feature of the

academic calendar also marks a particularly bright future for the academic rheologist. If the responses do reflect a feeling on the part of members that rheology should grow in all the ways indicated in universities, rather than a resigned acceptance of the propensity (albeit declining recently) of universities to grow unashamedly then we should ask in what ways the Society can help universities to make progress in the right direction, for the small and scattered pockets of rheologists in universities do not provide a powerful force for change from within the universities.

6. The role of the British Society of Rheology

The majority of responders (63) expect the membership of the Society to be about the same, as against 17 who expect it to be more than 50 per cent greater and one who expects it to be significantly less. Many wrote in the suggestions that a 20 per cent growth might be expected. In addition the proportion of overseas members is expected to increase by 35 responders and to remain constant by 33, with overseas responders represented proportionately in both of these figures, and nine responders (none from overseas) expect the proportion to decrease. This expected increase (from the present fraction of more than one third of our members) in overseas membership may account for all the expected growth in the Society, which does not seem to allow much room for growth in membership to parallel the anticipated growth in university activity.

One suggestion is that the Society does not attract many people who contribute to the growth of rheology because they do not see themselves as rheologists—a worrying conclusion which leads to the idea either that as a Society we are less flexible than would be desirable, or that our reputation as a serious scientific body is inadequately established.

Very few people foresee either the absorption of the Society into a larger group (7) or its fragmentation (5); the majority (53) see it as remaining much as it is now. A proportion of two to one (39:21) rejected the view that European Societies of Rheology might amalgamate, although many contributors urged greater collaboration. The overseas contributors were split evenly (7:7) on this question.

This question (or their own strong feelings) provoked very many contributors to write in and insist that the Society is about right as it is at present and that change is not to be sought for its own sake. This seems to be a clear and positive instruction to Council to leave well alone, and members are to be thanked for this expression of satisfaction (in contrast to a mere lack of too many complaints). The question concerning full time or other paid help in running the Society provoked a similar vote of confidence,

coupled with expressions of distaste for large impersonal organisations and perhaps some nostalgia for the days of the British Rheologists' Club. Nevertheless, a large number of responders (27) expected that the Society would have a full-time organiser, as against 11 who expected it to share the services of an organising bureau and 18 who expected neither. The other 32 responders include some who said no to the first of these questions and did not answer the second, and some whose comments clearly indicated their wish that the Society should not change in this way.

The communications revolution which we are led to expect is not expected to have much impact on the Society's publications. Nine responses indicated that the Bulletin, and five that Abstracts, might cease to be useful, while 32 expect both to continue to be useful. There was no noticeable difference in the response from overseas. A majority (31:13) expect the Bulletin to be much the same as today, while if it changes it may be expected to contain more feature material (28 in favour, two against). Rheology Abstracts has even more support in its present form (45:7) and of the two alternative developments offered more critical reviews received more support (19) than notes of programmes in progress (13). In view of the importance attached to Rheology Abstracts it is disappointing that the Editor should have difficulty in recruiting volunteers to do the abstracting.

The final explicit questions concerned the meetings of the Society, and we find a majority in favour of more conference (38:8) and shorter conferences (44:2), coupled with a conviction that conferences will be more important (held by 44 and disagreed with by eight). A slight majority (25:17) takes the view that the Society should not develop the social aspects of its meetings—we hope this means that this aspect is adequately developed; it has never been our impression that members are antisocial or even unsociable—social events are perhaps best if they have the appearance of happening by chance. No overseas member stated a preference for fewer conferences (or longer ones), and the response from overseas and from universities and industry were all basically the same.

Conclusions

The picture of the Society that this survey has left with one of the authors of this report is that, in looking fifteen years ahead, we see a Society about the same size as at present but catering for a more active community particularly at the universities. Teaching rheology will have expanded and in particular we shall see M.Sc. courses in our subject. The importance of multiphase systems will have increased and biological systems will be a more important area of study. On the techniques side development will continue

with the most significant advances in stretching flows and surface rheology. The one prophecy that it is hoped will not come true is that "we shall be discussing much the same phenomena and theories at a more sophisticated level with an increasing polarisation between empiricist and theoretician". Perhaps we should also look back and see just how much progress we have made in the last fifteen years.

The second author's crystal ball is less clear (a point made in more than one response to the questionnaire). There is clearly a strong feeling that the Society is about right as it is, and clearly any expansion must not be allowed to smother its good features. A modest expansion in overseas membership could almost certainly be achieved, and there is no evidence of any fears that this would alter the Society noticeably. The developments in rheology foreseen are also of a modest nature—which is probably all that a consensus as offered by this report will ever produce. The startling innovations will (by definition) take us all by surprise—let us hope that there will be some. Experience of past experiments does suggest that radical changes in the Bulletin and Abstracts will not be very successful. (What has happened to the punched card information retrieval system and the computer program library?) The desire for more (shorter) conferences, if met, would lead to more work on the part of organisers and, as with abstractors, we do need volunteers to help and to support our amateur tradition.

Action

It is for the reader to pick out the points from this review which are of particular interest to him or her, and this exercise will have greatly increased value if *readers react to this summary of their views* and write to the Secretary with expressions of opinion (whether or not they responded to the original questionnaire). For example, we should be interested in knowing whether the expected interest in biological systems reflects interest in one area (e.g. medical applications) or merely the very wide variety of biological systems which are of rheological interest. If there is a significant response we shall report on it in a later Bulletin. Council has taken note of the opinions and warnings, both explicit and implicit, in the responses, and will endeavour to continue to fulfil the wishes of members where these are known and not mutually contradictory.

F. N. COGSWELL.

C. J. S. PETRIE.

CALLS FOR PAPERS

NEDERLANDSE REOLOGISCHE VERENIGING

The Rheology of Associating, Structured and Biological Systems

Joint meeting of the British, Italian, and Netherlands Societies of Rheology, supported by the Polymer Physics Group of the Institute of Physics.

Amsterdam, 18th-20th April, 1979

Deadline for submission: 31st October, 1978

Submission of papers (title and one-page abstract only) is open to members and non-members of the three Societies and the Polymer Physics Group. Papers providing a link between rheological behaviour and structure of a wide class of systems, e.g., gels, liquid crystals and associating suspensions, will be welcome.

English is recommended as the language of the meeting. The abstracts should be sent to the secretaries of the respective Societies:

United Kingdom:

F. N. Cogswell, 67 Daniells, Welwyn Garden City, Herts.
AL7 1QT.

Italy:

A. Pavan, Istituto di Chimica Industriale del Politecnico, Piazza Leonardo da Vinci 32, 20133 Milano.

The Netherlands:

U. Daum, Industrial Organization TNO, Division of Technology for Society, P.O. Box 217, 2600 AE Delft.

The host organisation is the Netherlands Society of Rheology, whose President, Dr. H. C. Booij, Central Laboratory DSM, P.O. Box 18, 6160 MD Geleen, will be the chairman of the Organising Committee.

International Conference

Practical Rheology in Polymer Processing

26th/27th/28th March, 1980

at Loughborough University of Technology

The British Society of Rheology and the Plastics and Rubber Institute are jointly sponsoring the above conference which aims to review the practical application of polymer rheology in relation to processing and product performance, and to bring together practising rheologists, polymer engineers and industrial fabricators in an international forum to discuss how they may work together to solve problems of common interest.

Contributions of papers are invited, particularly in the following broad subject areas:

The effect of polymer rheology on product performance.

Machine design and process efficiency.

Rheological measurement techniques and their relevance.

Offers of papers on these and associated topics should be sent, preferably accompanied by a synopsis of approximately 250 words, by *1st December, 1978*, to:

Dr. D. E. Marshall, Institute of Polymer Technology, University of Technology, Loughborough, Leicestershire, LE11 3TU, U.K.

"Applied Rheology"

Conference to be held at Aberystwyth, 12th-14th September, 1979

Papers on any branch of Applied Rheology, particularly those of a biological nature, will be welcome.

Offers of papers, title plus abstract of about 250 words, should be sent to Dr. R. S. Jones, Department of Applied Mathematics, University College of Wales, Aberystwyth, by 1st February, 1979.

LETTER TO EDITOR

Dear Sir,

With reference to the reply of Dr. Cheng to our letter, which was published in Vol. 21, No. 1 of the bulletin. We would like to state that it was not our intention to criticise either the Warren Spring Laboratory, or Dr. Cheng, whose work we in any case admire.

The point of our original letter was to question the spending of public funds on the development of a type of instrument that was already commercially available, and also to suggest that such monies may find better use in the education of would-be rheologists.

It is quite true that the offer to loan an instrument to Warren Spring was made verbally to Dr. Cheng. And that it was declined on the grounds of there being insufficient time to fit it into their course. However, in his recent letter, Dr. Cheng has omitted the fact that the offer was unconditional. Advertising facilities were neither requested, or required. Also that no similar instrument was available to him.

We feel that the reference in his letter to cuts in the staff at Warren Spring should be considered in the context of our suggestion regarding the use of public funds, and the education of

would-be rheologists. In which case, the offer may appear as it was intended, a generous gesture, rather than a self-interested one.

Regarding the Deer Rheometer. Those of us who have been responsible for its development are proud of what has been achieved on something less than a shoe string. And grateful to our many customers for their support. At the present time, demand is such that we are unable to repeat our loan offer, even should it be requested.

Yours faithfully,

J. J. DEER.

B. Warburton.

Deer Rheometers Ltd.,

Registered Office: Gorse Lane Industrial Estate,
Clacton-on-Sea, Essex.

STRETCHING FLOWS

The proceedings of part of the British Society of Rheology Conference held in Edinburgh on 7th-9th September, 1977, are published as a special double issue of the Journal of Non-Newtonian Fluid Mechanics, Volume 4, numbers 1 and 2 (June 1978). This may be purchased from Elsevier at the normal price of Dfl. 75.00. Members of the British Society of Rheology may purchase copies at the special price of £7.50 (including postage and packing) if they order quickly.

Orders should be sent to: Miss R. M. Burke, Elsevier Scientific Publishing Company, Jan van Galenstraat 335, P.O. Box 330, Amsterdam, The Netherlands, *accompanied by a cheque* payable to Elsevier Scientific Publishing Company *not later than 5th November, 1978*. A similar offer is being made to members of the Society of Rheology in their Bulletin.

The special issue contains 164 pages (plus eight pages of preliminaries) and the contents are:

Introduction

C. J. S. Petrie

Extensional rheometers for molten polymers: a review

J. M. Dealy

Converging flow and stretching flow: a compilation

F. N. Cogswell

A constitutive analysis of uniaxial elongational flow data of a low-density polyethylene melt

M. H. Wagner

Stretching flows for thin film production. 1. Bubble blowing in the solid phase

J. R. A. Pearson and P. A. Gutteridge

Stretching flows for thin film production. 2. Film stretching over a conical mandrel

P. A. Gutteridge

Elongational flow and the wet spinning process

G. R. McKay, J. Ferguson and N. E. Hudson

Surface instabilities arising in drawing cylindrical specimens of low-density polyethylene melts

D. Acierno, G. Iorio, F. P. LaMantia and G. Marrucci

Flow singularities, polymer chain extension and hydrodynamic instabilities

M. R. Mackley

Some results in the theory of melt spinning for model viscoelastic liquids

C. J. S. Petrie

Short Communication

The existence of solutions for a stretching jet

N. D. Waters and C. J. S. Petrie

Dynamic Mechanical Analysis of Polymeric Material, by Takayuki Murayama, Monsanto Fellow, Monsanto Triangle Park Development Center, Inc., Research Triangle Park, N.C., U.S.A. Materials Science Monographs, 1. Elsevier Scientific Publishing Company, Amsterdam and New York.

The book presents the principles of the dynamic mechanical analysis of polymers, the identification and the interpretation of the dynamic mechanical data as properties evaluation, and application of the data to structure-properties relationships and various industrial problems. The book opens with a review of the principles and related concepts of dynamic mechanical analysis. This is followed by a discussion of the development of characterisation techniques for measuring dynamic mechanical properties. Next is a chapter devoted to the interpretation of dynamic mechanical properties at molecular level, followed by a discussion of dynamic mechanical analyses of structural units. An experimental relationship between dynamic properties and visco-elasticity is then dealt with. External variables which affect dynamic mechanical properties include various deformations, and the effects of these variables on dynamic properties are discussed in the final two chapters of the book.

In addition to its usefulness as a reference volume, the book will be a valuable text for senior and undergraduate level courses in materials or polymer science and engineering.

Contents: Chapter I. Introduction to Dynamic Mechanical Behaviour. II. Instrumentation. III. Molecular Interpretation. IV. Analysis of Structure Geometry. V. Dynamic Properties and Viscoelasticity. VI. Dynamic Anisotropic Behaviour. VII. Dynamic Properties in Gas and Liquid Media Appendix: Conversion Factor for Moduli, Stress and Viscosity. Author Index. Subject Index.

Polymer Rheology, by R. S. Lenk, Senior Lecturer in Plastics Technology, Polytechnic of the South Bank, London, England. 6 by 9in. (15.5 by 23cm.). xvi plus 375 pages. 214 illus. 1978. CIP: 668.4 TP1120. Price £30 plus £1.10 post and packing.

This is a practitioner's handbook in which three aspects of the subject are considered. The first two are the behaviour of polymers in processing and in service respectively. The third deals with fundamentals in a manner designed to present a consistent philosophy of material behaviour in general and of polymers in particular; it is inevitably intertwined with the other two. The editor has taken care to ensure that the theoretical treatment is limited to essentials so as not to tax the chemistry of the engineer or the mathematics of the chemist beyond what they normally acquire in their education and in their subsequent activities in the plastics industry. The first half of the book deals mainly with polymer melts, while the second half is principally concerned with the discussion of solid state properties and with the factors which lead to instantaneous or long-term failure of components. It is shown how to cope with the problems of material selection based upon the known intrinsic properties of specific polymers and of exploiting the property potential by optimisation of processing and design.

Of interest to: polymer scientists and technologists, rheologists, materials scientists, chemical engineers, mechanical engineering designers, producers of plastics materials.

Contents: 1. The characterisation of viscous flow. Viscosity shear rate and shear stress. 2. The time dependence of viscous flow. Thixotropy and rheopexy. 3. The temperature dependence of viscous flow. Free volume. 4. The influence of pressure on the viscosity of polymer melts. Viscosity and molecular weight. 5. Vectors and tensors. Fundamental equations. 6. The analysis of steady state flow in rectangular and cylindrical channels. 7. The Hagen-Poiseuille equation and the Rabinowitsch correction. Pressure drop in tapered channels. 8. Pressure drop in wire coating dies. Two-dimensional flow in extruder screws. 9. Coextrusion. 10. The effect of melt elasticity on extrusion and other polymer processing operations. 11. The rheology of calendering. 12. Stretching flows. 13. The rheology of injection moulding. 14. Deformation in the solid state—small strains. 15. Deformation in the solid state—large strains. 16. Deformation in the solid state—cyclic strains. 17. Critical strain.

18. Critical strain: The effect of processing history and associated factors. 19. Critical strain: An engineer's view of the energy balance during deformation. 20. Rheo-optics. 21. Rheo-optical techniques. 22. Rheology and morphology. Index.

List of contributors: I. T. Barrie, ICI Plastics Division, Welwyn Garden City, England. F. N. Cogswell, ICI Plastics Division, Welwyn Garden City, England. R. S. Lenk, Polytechnic of the South Bank, London, England. J. Pohrt, BASF, Ludwigshafen, West Germany. F. Thamm, Technical University, Budapest, Hungary.

Mechanics of Non-Newtonian Fluids, by W. R. Schowalter, Princeton University. Pergamon Press.

An up-to-date and thorough treatment of rheology, which shows how mathematic descriptions can be used to describe, predict, and explain a variety of physical phenomena. Numerous examples are provided which illustrate the application of fundamental concepts to problems of practical interest.

Contents: Linear transformations. Vector spaces. Vectors. Tensors. The conservation equations of continuum mechanics. Deformation. Principles governing formulation of constitutive equations. Simple fluids and simple flows. Measurement of the Viscometric functions. Nonviscometric flows of simple fluids: Constitutive equations. Elementary models. Constitutive equations. Generalisations of elementary models. Nonviscometric flows revisited. Applications. Suspension rheology.

Of interest to: chemical engineering students and researchers; university, polytechnic and technical college libraries.

SECOND RHEOGONIOMETRY COURSE

Ross Priory, Loch Lomond, 2nd-4th May, 1979

Following the highly successful course on Rheogoniometry held at Ross Priory on Loch Lomond during May 1978, a broadened course will be held at the same venue during 2nd to 4th May, 1979. The course will once again be sponsored by Sangamo-Weston Controls Ltd. The course will be concerned with rotational rheometry, and is aimed at users and potential users of the Weissenberg Rheogoniometer and similar instruments. In addition techniques for measurement in the rapidly expanding field of elongational viscosity will be dealt with. The lecturing team will be broadened to include Mr. J. Hutton, as well as Professor K. Walters, Dr. J. Ferguson and K. Knowles of Sangamo Weston.

The programme will include the following lectures: Fundamentals of steady shear; oscillatory measurements, new developments in rheometry; specialised techniques for suspensions, polymer melts, biological materials, solutions, etc.; data treatment; elongational flow techniques and their interpretation.

Group Clinic sessions will also be held to discuss particular flow problems and consider case studies.

Those attending the course will meet in Glasgow on the morning of 2nd May, 1979, and be taken to Ross Priory by bus. The house itself is situated in 55 acres of policies at the south end of Loch Lomond. Parts of the building date back to the 14th century. Accommodation is limited and those attending will be expected to share a room as all the bedrooms are double.

The course will disperse after breakfast on Thursday, 4th May, when members will be returned to Glasgow.

The course fee has not yet been fixed but will be approximately £65 including full board.

Those wishing further details should complete the form below and return it to Dr. J. Ferguson, Department of Fibre Science, University of Strathclyde, George Street, Glasgow G1 1XW.

I wish (a) more information*, (b) to attend* the Rheogoniometry Course. Please send Course details to:

NAMES (Mr. Mrs., Miss, Dr., etc.)

ADDRESS

.....

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POST CODE

TELEPHONE NO.

* Delete whichever is inapplicable

APPLICATIONS FOR MEMBERSHIP

JUNE 1978

Peter Cameron Anderson, M.Sc., B.Sc. f,et,a,G,F,G,J,K.	Specialities Branch, BP Research Centre, Chertsey Road, Sunbury-on-Thames, Middlesex.
Dr. Malcolm Hulatt, Ph.D., B.Sc. f,et,a,D,H.	T.S. & A., R. & D.D., BP Chemicals Ltd., Hayes Road, Sully, Penarth, S. Glamorgan.
Mr. J. C. Latham, B.Sc. e.	Deimos Ltd., Simmonds Road, Wincheap Industrial Est., Canterbury, Kent.
Jeffrey C. Mumford, B.Sc. p,et,a,G,H.	Boc-Murex, Waltham Cross, Herts.
Jean-Marie Pierrard, Ph. D. (Prof). f,a,et,A.	Institut de Mecanique de Grenoble, B.P. 53, 38041 Grenoble, S. France.
George David Smith, Ph.D., M.Sc., B.Sc. f,et,sa,O.	Dept. Mathematical Physics, University College, Belfield, Dublin 4.
Prof. Raffi M. Turian, B.Sc. f,t,sa,F.	Dept. Chem. Engineering, Syracuse University, Syracuse, New York 13210, U.S.A.
Donald Milne Turner, M.A. f,et,sa,C,D,M.	Avon Rubber Co. Ltd., Melksham. Wilts. SN12 8AA.
Kurt F. Wissbrun, Ph.D. f,e,a,B,C,D,F,G.	Celanese Research Co., Box 1000, Summit, New Jersey 07901, U.S.A.

RESIGNATIONS

Dr. P. Thirion, Dr. G. Kraus. Dr. R. Jongepier, Dr. Papenhuyzen.

The British Society of Rheology

Australian Branch

The following have been accepted by the Committee as new members of the British Society of Rheology (Australian Branch):

Mr. V. M. Markus
Mr. P. H. Dawe
Dr. D. R. G. Williams
Mr. D. T. Hornsby
Mr. J. V. Parekh
Mrs. Hang Nguyen
Mr. G. Sarmiento
Mr. R. Chhabra
Mr. L. Barro

DIARY

1978

October 25-27. "Rheometry Conference", Heverlee, Belgium.

1979

January 5. "Measurement and Control of Rheological Processes", London.

April 18-20. "The Rheology of Associating, Structured and Biological Systems", Amsterdam.