

BULLETIN



BRITISH SOCIETY OF RHEOLOGY

1969, No. 2, Vol. 12

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volume numbers).

Hon. Editor:

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

FOREWORD

Once again members of the Society will have received their copies of Rheological Research in Britain, 1968, which has been compiled at the National Engineering Laboratory, Glasgow. Publications of this sort will do much to develop and crystallize out Rheology as a distinct and widely known subject from the array of scientific research. It is also to be applauded on the excellent quality of the format, this aspect is also extremely important. Other than the brief introductory text of the first three pages, the other 110 are packed with vital statistics on the current state of rheological research in Britain when the report was compiled.

Some concern is apparent in the introduction to the report at the amount of university work connected with industrial processes in comparison to the total volume of university rheological research. The state of affairs as revealed by the histograms on pages 112 and 113 of the report is not altogether unexpected. In the first place university interest in processes is mainly concentrated in the Applied Science and Technology Departments which are themselves probably not conducting more rheological research than all other University Departments taken together. Secondly, Applied Science and Technology Departments are interested in the *structural* uses of materials at least as much as in their processing. No doubt a great deal of work in the field of structures, especially in Civil Engineering, still escapes the survey.

Placed in the above context, the apparent lack of practicality in the rheological work of the universities is much less acute than is implied in the survey. Perhaps there are certainly other factors to be taken into consideration before feeling serious anxiety over the situation.

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PROGRAMMING THE BULLETIN

1. Do we need the Bulletin?

Some members of the Society will already be aware of the fact that production of the Bulletin consumes a sum of about £450 annually, quite apart from postage costs which are not slight. This means that most of the Society's income from annual subscriptions is absorbed in issuing the Bulletin, and it is the main item of annual expenditure.

The Bulletin then is a relatively expensive item for the Society and the nature and function of the Bulletin requires careful analysis to determine one or two important questions such as:

- (i) Does the Bulletin need to carry articles on rheology and descriptions of conferences? These take up the bulk of the space at present.
- (ii) Would a reversion to the original type of stencilled sheets be justified, carrying a bare minimum of information?
- (iii) Has the Bulletin a function in the development of the Society in the future? If so, how is the Society likely to develop and how is the Bulletin related to this.
- (iv) Is the Bulletin to be developed further and to be opened up to subscription as the Rheology Abstracts of the Society are already?

2. The Editing Function.—A bus driver's holiday.

The lowest common factor of the Editorship of the Bulletin is simply to edit, not to write most of the material. The Bulletin is a vehicle of communication, with a driver, which may be hired—gratis—by members for quarterly tours. A full-time editor could no doubt provide a complete mystery tour every time for your enjoyment—but the Society does not at present operate like that.

A substantial invisible income to the Society—which retains the present phenomenally low annual subscription level—is the considerable sum of man hours invested annually in keeping the wheels turning. A recent suggestion shows that some of the functions could be bought out—but the annual subscription would treble overnight—and this would include just simple editing of the Bulletin.

Most bus drivers would just wait for a set of directions or if in public transport, drive round the same route until retirement. But who wants to go round in circles and pay for the same scenery?

3. Which way do you want to go?

The present policy is to accept a number of different categories of contributions.

- (i) Full technical papers.
- (ii) Full descriptive papers.
- (iii) Letters—either technical or descriptive.
- (iv) Project reports.
- (v) Computer information.

A satisfactory build-up of contributions under the above headings would certainly lead to the Bulletin becoming a substantial periodical and it would follow quite naturally that a subscription list would open and help the establishment of the Society as a more important scientific body. But until the Society has a voice—and something to say—it will remain a minor organisation, this conclusion is inescapable.

Which way do you want it to go?

WHY VOLUME 1, 1969?

The "Bulletin" has been a perpetual feature of British rheology ever since the early days of the British Rheologists' Club when it appeared as stencilled sheets containing a few foolscap pages of notes and a similar number of Rheology Abstracts at the end. The first issue of the "Bulletin" is dated January, 1941, why then start Volume 1 in 1969?

The "Bulletin" had already been issued for some 14 years before the amputation of the "Rheology Abstracts" section and its subsequent publication as an independent journal, and from the inception of an independent "Rheology Abstracts" it has been grouped in volumes. Volume Number 12 is currently being published in 1969.

In deciding to provide volume numbering for the "Bulletin" the position was not nearly so simple however. Firstly, it had a substantial history prior to the separate publication of "Rheology Abstracts," and to start now with the same number for both the publications might be rather confusing, not only because of the prior history but also because the first 11 volumes would have no number on them. Secondly, the "Bulletin" appears to have been issued only at irregular intervals, indeed there is a warning to this effect on page 1, No. 1, January, 1941, again it might be more confusing than useful to introduce Volume 29 in 1969.

Rather than introduce any problems such as those outlined above, Volume 1 has been allocated to 1969. Those who have not complete sets of "Bulletins" for the past 12 or 28 years can look forward to collecting a complete set from Volume 1.

It does not quite seem to be justifiable to ignore all the previous issues of the "Bulletin" before 1969 so we now include a specific reference on the front cover to the prior issues of the "Bulletin" and then—for the first time—the lineage will be indicated, and it is hoped all the interests and feelings on the matter will have been accounted for.

ARCHIVES

Dr. E. W. J. Mardles has very kindly released No. 1 issue of the Bulletin of the British Rheologists' Club dated January, 1941, together with a list of club members dated December 31st, 1941, and handwritten Minutes of the earliest Committee Meetings. These documents were passed to Dr. G. W. Scott-Blair who suggested that they should be photo-copied with a view to making copies generally available.

The Editor is able to offer Xeroxed copies of all the above documents at raw material and postage cost. Enquiries can be received at any time.

The following is a reproduction of the first Club Notes.

BULLETIN OF THE BRITISH RHEOLOGISTS' CLUB

Address for communications: c/o The Institute of Physics, at The University, Reading, Berks.

No. 1 JANUARY, 1941 Issued (gratis) to members of the Club only

CLUB NOTES

Inaugural Meeting

A very successful inaugural meeting was held at Reading on the 16th November, 1940, an account of which, reprinted in "Nature" is attached. Mr. Pryce Jones' opening paper is being published very shortly in the Journal of Scientific Instruments.

Membership

At the time of writing the club has 82 members which include engineers, physicists, chemists, biochemists, bacteriologists, etc. The materials in which members have expressed interest include: Adhesives, Blood, Cellulose derivatives, Ceramics and Clays, Dairy products, Emulsions, Flour, Food-stuffs in general, Glass, Ink, Metals, Muscle, Oils and greases, Paints, Enamel, etc., Pastes, Photographic materials, Plastics and resins, Rubber, Soils, etc., Starch, Tars, Bitumens, and Road materials.

Co-operation between members

Members are reminded that the club officers will always be happy to assist members to communicate with others working in their special fields.

The next Meeting

By kind invitation of the Director, arrangements are being made to hold the next meeting of the Club at Matra House, Robin Hood Court, Shoe Lane, London, E.C.4. It is proposed that the meeting shall start at about 11.30 a.m., the subject for discussion being "Rotation Viscometers and Thixotrometers" (provisional date, Saturday, February 22nd). Details of this meeting will be circulated to members in due course.

The Bulletin

Future issues of this bulletin will appear at irregular intervals. The Committee wishes to thank members who have so willingly co-operated by providing abstracts and articles. Further contributions and suggestions are invited.

RHEOLOGY IN INDUSTRY

1. **Rheology in the Printing Ink Industry**, by V. G. W. Harrison, B.Sc., Ph.D., A.Inst.P., Senior Physicist, Printing and Allied Trades' Research Association.

Printing inks consist essentially of a pigment ground into an oily vehicle. The purpose of the vehicle is twofold: first, it enables the pigment to be distributed easily and evenly over the printing surfaces, and secondly, it acts as a binding medium for attaching the pigment to the paper or material being printed. Vehicles are of two main kinds: (1) mineral oils, and (2) drying oils; such as linseed and tung oils. Inks made on a mineral oil basis are used mostly for printing newspapers and magazines in

MEMBERSHIP LIST 1969

To date there has been only a 25 per cent. response to the request for members to indicate their interests on the form provided in *Bulletin* No. 4, 1968. Publication of the Membership List cannot be delayed much longer, and those members who have not yet returned the form are requested to do so as soon as possible.

An analysis of the replies received before the end of March is given below.

	<i>Home</i>	<i>Overseas</i>	<i>Total</i>
Work mainly rheological (f)	38	15	53
Work only occasionally rheological (p)	57	17	74
Interests:			
Theoretical (t)	7	3	10
Experimental (e)	35	7	42
Both (et)	53	22	75
Pure science (s)	10	9	19
Technology (a)	33	9	42
Both (as)	50	11	61
Materials of major concern:			
Metals, alloys (A)	5	4	9
Composites (B)	14	2	16
Solid polymers (C)	24	11	35
Molten or dissolved polymers (D) ...	34	20	54
Natural fibrous materials (E)	13	6	19
Liquid-liquid systems (F)	24	11	35
Liquid-solid systems (G)	41	15	56
Particulate solids (H)	29	5	34
Glasses, ceramics (I)	7	3	10
Oils, greases (J)	11	5	16
Buildings and road materials (K) ...	14	4	18
Foodstuffs (L)	15	6	21
Biological materials (M)	11	4	15
Theoretical materials (N)	18	9	27

The response is disappointing, but probably reflects the true number of *active* members of the Society, as distinct from those who subscribe to the Society's journals.

It has been generally believed that the large majority of members are concerned only occasionally with rheology, but 42 per cent. of those replying state that their work is mainly rheological. This result occurs almost certainly because the latter are those who are more concerned with the Society because of their activity in rheological matters.

The distribution of replies between (i) educational establishments, (ii) government laboratories and research associations, and (iii) industry is close to the overall figure obtained from the previous List of Members, except for a slight bias in favour of category (ii) in

Britain and category (i) from overseas. Those differences represent, however, only a small number of replies.

The close correspondence between the figures for theoretical/pure science, experimental/technology and both (et)/both (as) suggests that people tend to relate these approaches in such pairs. What is gratifying to note is that well over half the members replying combine both theoretical and experiment on the one hand with both pure science and technology on the other in their work. Is this a healthy sign of the decline of the "suck-it-and-see approach"?

There are 260 total entries from home members for the materials of major concern classification, and 105 from overseas members, giving 2.7 classes per home member and 3.4 per overseas member; this latter result probably represents the relatively small proportion of overseas members working in industry.

By plotting the overseas figure versus the home figure for each of the classes A to N, the points are shown to bunch about the line of slope 105/260, indicating that despite the low overseas total of 32 the distribution of interests in each class appears to be representative and equal to the distribution for home members. Exceptions occur for: composites (B), where the overseas figure may not be significant; for molten and dissolved polymers (D), where the overseas figure is proportionately high; and for particulate solids (H), where the low overseas value may indicate a time-lag from the recent upsurge of interest in such materials shown in Britain in recent years.

As in the previous analysis of B.S.R. membership (*B.S.R. Bulletin*, 1967, No. 1) major interests occur in polymers and dispersed systems. The poor representation of those concerned with solids probably results from the mistaken identity of rheology with the flow of non-Newtonian fluids, forgetting that the term covers also the deformation of non-Hookean solids.

(The above preliminary analysis was performed by D. W. Hadley; comments are by D. C.-H. Cheng.)

RHEOLOGICAL RESEARCH IN FRANCE

The following notes are a free translation of a "Tour d'Horizon" printed in "Bulletin du G.F.R." for February, 1969. Further similar reports will appear from time to time in B.S.R. Bulletin as quickly as possible after their initial publication.

(1) The Mechanics of Solids Laboratory, Ecole Polytechnique.

(a) Theoretical studies.

J. Mandel has investigated the application of thermodynamics to viscoelasticity, and, in co-operation with L. Brun, has generalised the theories of Coleman and applied them to the study of the propagation

of discontinuous waves in viscoelastic and viscoplastic media. The last topic is also studied by D. Radenkovic.

L. Brun has presented a thesis on "Energetic methods in evolutionary linear systems," which tackles problems pertaining to elasticity, thermoelasticity and viscoelasticity. Drs. Jacod and Mandel have specified the stresses in the vicinity of the tip of a crack, and Bui has found a novel method of calculation for the case when certain displacements are imposed at the edge of a crack.

(b) Plasticity.

Salencon has resolved the problem of the quasi-static contraction of a cavity with cylindrical or spherical symmetry in an elastoplastic medium. He has been working also on complete solutions in perfect plasticity and has given original solutions for certain problems of point loading on heterogeneous media.

(c) Hardening of metals.

Bui has explained his experimental results in terms of the interaction of crystalline grains. Experimental and theoretical results are in general accord.

(d) Behaviour.

(i) Metals. Using the theory of dislocations as a starting point Zarka has shown that in the case of complex stresses one cannot write down relations between deformation rates, stresses and true stress rates, and it is necessary to introduce at least the density of dislocations as an auxiliary hidden variable.

(ii) Rocks. Morlier and Parate have specified the rupture criterion for rocks in the brittle domain.

Morlier has studied certain mechanical model systems as representations of rocks, particularly the porous model, and has also investigated the propagation of ultrasonic waves in rocks.

Habib and Maury have also investigated model systems: the former the fissured, and the latter the stratified, model.

(iii) Chaabouni and Radenkovic have been investigating the behaviour of irradiated graphite, and Bergues and Habib that of dry concrete.

(2) C.N.R.S.

The major study is a continuing investigation of a class of polymers (copolymers of acrylonitrile and acrylic acid, tripolymers of acrylonitrile, acrylic acid and acrylamide) which are able to form thermo-reversible gels in sufficiently concentrated aqueous solutions. The stage preparatory to gelling has been studied systematically as

functions of concentration, temperature and shear rate. A methodical study has been made of the composition of the solvent and the effect of additives.

Six new copolymers have been prepared. It has been found that the tendency to gel depends on molecular weight and on the disposition of COOH groups.

For the tripolymers urea, thiourea and imidazol are found to inhibit gelling and the rate of gel. The addition of poly (vinyl alcohol) intensifies gelling, and permits the solidification of otherwise non-gelling solutions, Poly (oxy ethylene glycol) has the reverse effect.

(3) Rubber Institute of France.

In co-operation with the laboratory of Professor Ferry (U.S.A.) the viscoelasticity of "pure-gum" vulcanisates is being studied for polyisoprene, polybutadiene, and a butadiene-styrolene copolymer, over wide ranges of deformation, temperature and time. The results will be applied both to industrial applications and to further the understanding of macromolecular structure, with the aim of achieving a statistical theory of elasticity in better accord with practice than is classical gaussian treatment.

BOOK NOTES

The latest book by Dr. G. W. Scott-Blair, one of the Society's founder members, is "Elementary Rheology" (viii and 158 pp.), published by Academic Press at 35s. The aim of the book is to give students a preliminary idea of the subject matter and experimental methods, as far as possible without mathematics; there are also short chapters on aspects of rheology of interest to the author. Equations for the main types of viscometer are given in an appendix, while another appendix (written by A. Graham) outlines the rheology of metals.

A considerably more specialised work is "Hemorheology: Proceedings of the First International Conference; Reykjavik, 1966" (XX and 849 pp.), edited by A. L. Copley and published by Pergamon Press at £14. The book gives a verbatim account of the conference, including all discussions. Part I contains the opening addresses and the three inaugural lectures; part II the ceremony of the Poiseuille award to Professor R. Fahaeus (since deceased); and part III the scientific sessions. These last were devoted to: theory; techniques; model studies; cellular and fibrin clotting; phase separation; plasma expanders; blood cellular elements; *in vivo* hemorheology; clinical work. In the final section the achievements of the conference are appraised.

A series of "Quarterly Literature Reports" has commended publication by Kogan Page Ltd. (distributed by Academic Press), at a

cost of £5 5s. per title per year. The volumes of most relevance to rheologists will probably be those devoted to polymers (edited by Dr. A. Jenkins, University of Sussex). It is the aim of the "Reports" to survey the main literature of the previous three months and summarise the important papers under several broad headings.

Finally, what could be an ominous sign. Publication has commenced in the United States of "Fluid Flow Abstracts." Although at \$38 per year it is more expensive than "Rheology Abstracts." There is no fundamental reason why if good enough it should not gain circulation at the Society's expense. I have not seen a copy of this new publication, so cannot estimate the possible likelihood of such a circumstance. Nevertheless, the appearance of the new rival means that all members of the Society who wish their annual subscription to stay at a low level should positively assist in the improvement of Rheology Abstracts, by volunteering as abstractors, to enable the achievement of a more comprehensive coverage of the relevant literature.

COMPUTER SECTION

Data Processing Service (I.C.L. 1909)

As a complimentary facility to the publication in the Bulletin of program abstracts it has been arranged that data processing for members can be accommodated in the Computing Laboratory at the University of Bradford. It is realised that many potential program users would wish to use their own facilities which are probably free and convenient, but a few may not be so well endowed and it is really with these users in mind that the service has been created as an alternative to obtaining a service at the original source of the program. With this facility in existence there should be scarcely anyone who is aware of an available program they would like to use and yet is unable to obtain a service.

Not all language facilities are available for use in the Computing Laboratory at Bradford; none availability will be indicated on the published abstract.

Standard charges at present operating rates for data processing are as follows:

1. Data preparation—£2 10s. per hour (it is preferable for users to prepare data themselves).
2. Computing—Commercial and Industrial users £60 per hour. Educational establishments by individual arrangement.
3. Graph plotting—£12 per hour.

Potential users of this service may contact:

Dr. R. J. Ord-Smith,
Computing Laboratory,
The University,
Bradford 7,
Yorkshire, U.K.
Tel. No. Bradford 29567, Ext. 217.

Coulter Counter Computer Program Library

Many of the essential features of the Computer Program Catalogue for the field of Rheology are already evident in the recently published Catalogue relating to Coulter Counter Programs. Copies of the Catalogue are available from Dr. R. J. Ord-Smith at the address given above.

The Catalogue is a collection of some 21 program abstracts from various sources, all relating to the Coulter Counter. Further editions of the Catalogue will be published from time to time as the accumulation of abstracts dictates.

Abstracts

The following abstracts are taken from The Computer Journal, 1969, Vol. 12, No. 1:

1. Polynomial curve fitting when abscissa and ordinates are both subject to error. P. 52. M. O'Neill (Independent Computer Services Ltd., Belfast), I. G. Sinclair (Short Bros. and Harland, Belfast), J. Smith (School of Physics and Applied Maths., Queen's University, Belfast).

An iterative method is described for the least-squares curve fitting of a polynomial to a set of points in two dimensions when both abscissas and ordinates are subject to error and when the weights of all the readings are known. The process converges, in general, to a polynomial giving the exact minimum of the "weighted" perpendicular distances onto the curve. It is shown that in practice Denning's method gives a solution close to this optimum polynomial.

2. Local smoothing by polynomials in n dimensions. P. 72.
A. S. Cole, A. J. T. Davie, Computing Laboratory, The University, St. Andrews, Fife.

A method of local smoothing of noisy data by making a least squares fit to a suitably chosen polynomial is described.

- 3 Numerical studies of prototype cavity flow problems. P. 88.
D. Greenspan, Computer Sciences Department, University Wisconsin, U.S.A.

A new digital computer method is developed for the Navier-Stokes equations. Finite difference smoothing and a special boundary technique are fundamental. The method converges in practice for all Reynolds numbers.

Have *you* a computer programme which would be of interest to B.S.R. members? Why not let them know about it by filling in the Publication Abstract?

BRITISH SOCIETY OF RHEOLOGY

Computer Program Catalogue

Publication Abstract

1. Author
2. Establishment
3. Program Abstract
- Input Data
- Output Data
4. Program date
5. Language
6. Computer requirements
7. Type of Input/Output
8. References
9. Related programs
10. Available for copy/data processing
- Tel. No.

Return to: Dr. J. Harris,
Postgraduate School of Chemical
Engineering,
University of Bradford,
Bradford, 7, U.K.

Additional blank abstract sheets are available as required from the above address.

LETTER TO THE EDITOR

June 3rd, 1969

Dear Sir,

I read with much pleasure and interest Dr. Hadley's account of the early history of the British Rheologists' Club given in the last issue of the Bulletin. In view of the appeal in the last paragraph, I suppose that, as one of the two surviving founder members of the Club, I should add a little by way of amplification.

Dr. Lang's account of the first days of the Club is accurate. He does not of course mention that we owed a great deal to him. Lang never claimed any specialised knowledge of rheology but he was a man of wide experience and sound judgement with an impish sense of humour and he possessed a wonderful gift of pouring oil on troubled waters. His encouragement and direct help were invaluable in such matters as organising meetings, seeing papers through the press, negotiating copyrights and other problems about which in those days George Scott Blair and I knew little: without this help I doubt whether we should have got very far. Lang took great delight in the word "SPINNBARKEIT" which he used to recite slowly and thoughtfully whenever a difficulty arose. It seemed to bring him comfort in the same way as the word Mesopotamia did to the old lady.

Mrs. Scott Blair's help has been mentioned. She somehow managed to prepare excellent teas for the Committee—I say somehow because these were days of rationing. The other member of the Committee, Wolfgang, was a Bedlington terrier having all the exuberant friendliness of his breed. His function on the Committee was not clearly defined but he was always present. I remember that on one occasion we arrived to learn that he had been cited by a local inhabitant as a "dangerous dog." Anything less dangerous than dear Woolly it would be hard to imagine and I recall that his case became a major item on the agenda for that afternoon.

In recording the early history of the Club, one must mention the good work of Dr. E. W. J. Mardles who later took over as Secretary from Scott Blair. It was largely through Mardles' enthusiasm that we found ourselves far afield, frequently in the West country visiting clay pits or odd beauty spots in Devon. Mardles had an unfailing knack of getting hilarious party games going in the evenings and we also had one or two amateur musical performances which enlivened the more serious technical discussions. My wife and I hold these occasions as very happy memories.

I still think that meetings in various parts of the country are useful. They were doubly welcome in those days as they enabled us to get away for a time from the difficulties and worries of the war and immediate post-war period. I suspect that Mardles was not altogether

disinterested in organising them as he is an excellent water colour artist and I think he usually combined rheology with some sketching.

With regard to the abstracts, it was always our intention to have them prepared by rheologists for rheologists. This was because information of rheological interest had a habit of turning up in obscure journals as incidental matter in papers which were not primarily concerned with rheology. Consequently information of vital interest to us could become overlooked, and for this reason we endeavoured to avoid authors' abstracts whenever possible. In short, we tried to achieve the widest possible coverage from the rheological viewpoint by our own abstracts, and to avoid the scissors-and-paste lifting of abstracts from elsewhere. We never achieved this ambition of course but, as Dr. Hadley is kind enough to point out, we did go quite a long way. We owed a lot to our abstractors as the entire work of preparing the Bulletin, apart from the actual printing, had to be done voluntarily in spare time, and no pressure could be brought upon the abstractors to perform if they did not feel so inclined.

For some reason, which is now obscure, I do not have a copy of Bulletin No. 1 and I do not know where we can get one. It would certainly be of interest after this length of time to see it.

In 1951-53 we all got heavily involved in the preparatory work for the Second International Congress on Rheology held at Oxford from July 26th to 31st, 1953. This was a major scientific conference attended by nearly 250 people from 15 countries. Fifty-five papers were read in three languages and the proceedings were eventually published by Butterworths. I think we allowed ourselves to become involved in this work simply because we did not know any better. How heavy it was is hard for anybody to imagine unless they have actually had to do something similar. I got saddled with the job of seeing the conference papers through the press and the task nearly killed me, even with the considerable help of Butterworths' technical staff. The final volume made up very well but I felt that I had a duty to perform for posterity and had it minuted that, in my opinion, no future conference proceedings on this scale should ever be attempted by anyone as a voluntary part-time job. I believe that this advice has been heeded and that no comparable rheological conference proceedings have been published since.

The Oxford Congress had some unhappy memories for me. It was a great disappointment to me that after 18 months of preparatory work, my mother was taken fatally ill just as the Conference opened and I was unable to attend more than Sir Geoffrey Taylor's opening address. To cap it all we received an unexpectedly large bill for authors' corrections for which no allowance had been made in the budget and this caused some pecuniary embarrassment and some troubled waters which I remember Lang was called upon to calm.

It is a great pleasure to me and I am sure to Scott Blair to see the healthy state in which the Society is after all these years. After a period away from rheology, I have again become involved in problems of formulating printing inks and I am once more taking an active interest in rheological papers. One has the feeling frequently of "this is where we came in" as many of the problems we used to discuss in the 1940's seem to remain unresolved today. However, it is obvious that a good deal of progress has been made and to this progress the British Society of Rheology has substantially contributed.

Yours sincerely,

V. G. W. HARRISON,
"Merrycourt,"
Church Road,
Great Bookham,
Surrey.

cc: Dr. George Scott Blair, Grist Cottage, Iffley, Oxford.

PERSONAL NOTES

Earl of Halsbury

The Society offers sincere congratulations to the Earl of Halsbury on his election as Fellow of the Royal Society.

Dr. Barbara Neumann

We are unfortunately not to have the benefit of the presence of our imperturbable Secretary at the Autumn Meeting in Glasgow, September 16th-18th. Dr. Neumann is current Chairman of the Clay Minerals Group of the Mineralogical Society of Great Britain and is to attend as an official delegate at the International Clay Conference to be held at Tokyo University starting September 5th, 1969.

Dr. Karl Weissenberg

Dr. K. Weissenberg has now taken up permanent residence in Holland at:

111, Ridder Laan,
The Hague, Holland.

British rheologists will regret having less direct access to such an important figure who unfailingly answers enquiries with a degree of courtesy which would be quite rare even in much more junior workers. We wish him a pleasant sojourn in Holland and look forward to his long future association with our Society.

CONFERENCE REPORT

Practical Rheology in Polymer Processing

A Conference was arranged in London on April 17th and 18th, 1969, by the Plastics Institute and the Society and attended by about 200 delegates with the intention of bringing about an exchange of information between those concerned with polymer processing at the shop floor level and rheologists attempting to analyse processes and predict the behaviour of materials of known properties. In the event the exchange of information was rather one-sided, very little being heard of the results of hard practical experience of attempting to relate rheological properties to processing behaviour. Whether this was due to diffidence, commercial secrecy, absence of any systematic investigation or lack of relevance of available theories was not clear. However, both sides implied that it was the failure of suppliers to provide data on polymer properties at processing temperatures which prevented proper testing of theories; this was hotly denied by the representatives of at least one supplier.

In his introductory paper A. Kennaway (Consultant) discussed screw extruders and pointed out that reasonable theoretical predictions of pressure-volume flow relationships were only possible for the melt zone. The approximate treatments of the melting zone and the solid zone gave poor agreement with experiment while at the output end it was not possible to calculate the flow pattern in even a moderately complex die. There was a great deal still to be learnt about such basic matters as the wall temperature of screw and barrel and the thermal conductivity of polymers at processing temperatures. He felt that the section of the industry which stood to gain most from work in this field was the fabricators since it should be possible to reduce the trial and error period for a new product.

The following paper by N. Cogswell and P. Lamb (I.C.I. Ltd.) opportunely filled some of the gaps in the provision of data. Comprehensive information on the rheological, thermal and thermodynamic properties of a low density polythene, an extrusion grade polypropylene and a moulding grade acrylic were given together with an analysis of various conversion processes. It was emphasised that extensional viscosity may be an important parameter particularly as it may increase with shear stress in, for example, low density polythene.

The remaining papers on the first day all dealt with extrusion and extruders from various points of view. J. L. den Otter (TNO, Holland) reviewed melt fracture mechanisms pointing out that at least three types of melt fracture occur even if one considers only various types of polyethylene. His extensive studies of the influence of die geometry on the onset of melt fracture and measurements of velocity profiles led him to eliminate slippage at the wall as an important cause of

this defect and to suggest that flow conditions immediately before entry to the die control the type of fracture. M. J. Stevens (Institute of Polymer Technology, Loughborough) illustrated his contribution with a film in which polyethylene glycol was forced through a perspex extruder to simulate the behaviour of polymers in the metering section of screw extruders. Melting occurred by mechanical action as well as by conduction and the molten material "overtook" the solid material giving considerable longitudinal mixing. In the following paper B. Martin (University of Cambridge) outlined the types of calculation which can be made to assist extruder design with special reference to the computer programmes which it is hoped to develop at Cambridge with the aid of a Ministry of Technology contract. It is now possible not only to analyse a system with a given screw geometry, speed, etc., and given material properties so as to predict flow rate, but also to reverse this process to calculate the screw geometry necessary for a given flow rate, permitting true design calculations.

Mixing during extrusion was discussed in the next two papers. R. B. Gregory (F. W. Egan & Co., U.S.A.) distinguished between "dispersive mixing" during which the shear stress in the major constituent disrupts the minor constituent and "distributive mixing" in which the ultimate very small particles of the minor constituent become randomly dispersed in the matrix. Dispersion occurs most readily when shear stresses are high, e.g. at low temperatures or high shear rates, while distribution depends on the ratio of pressure flow to drag flow as well as on shear rate. G. M. Gale (R.A.P.R.A.) discussed mixing during dry blend extrusion of rigid PVC. A single screw extruder was fitted with a hydraulic ram so that the screw could be removed, together with the PVC, from the barrel as soon as rotation of the screw was stopped. The PVC could then be unwound from the screw, cooled, sectioned and examined microscopically to determine the distribution of fused and unfused areas. The lubricant was found to be mainly responsible for deciding which type of fusion pattern occurred.

G. S. Glyde (Bakelite Xylonite Ltd.) giving the last paper of the day put the point of view of the fabricator who must of necessity make a down to earth approach to extrusion. He commented that computer results were unlikely to be of value to him until he had plotted his own graphs from them—perhaps even derived simple empirical equations—so that he would have a mental picture of what they meant. However, in many cases manufacturers must produce a fairly versatile screw so that high accuracy in the screw design process was only of value in special cases. Regarding mixing, the minimum degree of mixing compatible with a satisfactory product was the target because of cost considerations and he hoped that cost would be included in the extruder design optimisation calculations to be carried out at Cambridge.

The first paper on the second day, by J. A. Caton (Modern Plastics Machinery Ltd.), dealt with the rheological problems associated with the design of machinery for film production, particularly the tubular film process. The screw design must be a compromise between one requiring high energy input giving good quality film and one requiring low energy input resulting in a low melt temperature and possibly unsatisfactory quality. He felt that the theoretical treatments were not entirely reliable because of lack of rheological and thermal data, because of the necessary simplifying assumptions and in particular because of the lack of feedback from users to the machine designer. The paper was followed by such a theoretical treatment—of film blowing—by J. R. A. Pearson (University of Cambridge) and C. J. S. Petrie (University of Newcastle). The authors were anxious to know whether the relatively simple model for the process which they had adopted was found to be adequate. The paper and the subsequent discussion produced an interesting direct illustration of the need for liaison between the theoretician and the practical designer. The theory predicts that it is preferable to work at constant film tension rather than constant take-up rate; the tension is, however, so small that constant tension devices seem unlikely to be practicable.

D. A. Williamson (Shell Research Ltd.) discussed the use of high pressure polyethylene, low pressure polyethylene and polypropylene for film making. He considered the types of compromise necessary to obtain adequate optical and mechanical properties in the finished film and satisfactory shrinkage in the case of shrink films. In the following paper M. T. Dennison (Shell Research Ltd.) considered the same types of material in blow moulding. He was able to summarise requirements as follows: a high viscosity is required at low shear rates during the inflation of the parison while a low viscosity is required at the high shear rates during plasticisation and extrusion. This calls for a polyolefin of low melt index and wide molecular weight distribution.

L. T. Barrie (I.C.I. Ltd.) described a semi-empirical approach to the problem of injection moulding large area articles. The problem of flow between two large relatively cold plates is solved by assuming that a film of frozen material of constant thickness is formed on each plate. The evidence for this assumption comes from observations of the thickness of the unblown film when a compound containing a foaming agent is injection moulded. The resulting equations give reasonable quantitative predictions.

Perhaps the highlight of the conference for its intrinsic interest and technical quality was a film presented by T. Engel (Thomas Engel & Co.) of a process for forging and crosslinking polyethylene at ultra-high pressures. The humorous synchronisation of a musical background to the intermittent motion of the extruded tube did not

detract from the impact of this technical breakthrough. In the final paper F. Griffiths (Consultant) discussed the economics of the use of plastics for large components in the motor industry, pointing out that on a volume basis some polymers are competitive in price with steel, particularly if the high wastage in steel units is considered. It is a sad thought that a penny per pound difference in material costs can sometimes be far more important than all the efforts of rheologists!

R. W. WHORLOW.

Mechanical Properties and Design

A Conference with this title was organised jointly by the Society and the Materials Science Club on March 31st and April 1st, 1969, at the University of Surrey, Guildford. This was only the second conference to be held at Guildford and there was still a good deal of mud around but nevertheless about 60 people attended and appeared to enjoy the meeting.

It was the intention of the organising committee that speakers should discuss the extent to which it is currently possible to design components using solids whose behaviour cannot be represented by classical elasticity theory. Papers were presented on various plastics including poromerics, fibres and reinforced materials, on metals at high stresses and temperatures and on leather, ceramics and concrete. During discussion there was a significant interchange of information between workers with these various materials.

Summaries of the papers read will be published in Rheology Abstracts.

R. W. WHORLOW.

FIFTH INTERNATIONAL CONGRESS ON RHEOLOGY

About 180 manuscripts from the Congress held at Kyoto, Japan, October, 1968, will be published by the University of Tokyo Press. The proceedings are expected to run to about 2,000 pages and to become available late 1969 or early 1970.

It had been intended by the Editor that provision would be made in this Bulletin for publishing the titles of papers and names and addresses of authors (see Bulletin No. 1, vol. 1, p. 33) as a useful feature for Bulletin readers who may not have ready access to the Proceedings. These items will still be published, but in Rheology Abstracts and not in the Bulletin, following a decision at a recent Council meeting.

The Editor will collect publication information from Professor M. Horio, Department of Polymer Chemistry, Tokyo University, if requested to do so by members.

NEWS FROM THE SOCIETY OF RHEOLOGY, INC. (U.S.A.)

40th Annual Meeting

This is to be held at St. Paul, Minnesota, U.S.A., on October 20th-22nd, 1969. The Program Committee is under the Chairmanship of C. L. Sieglafl, T. R. Evans Research Center, Diamond Shamrock Corporation, P.O. Box 348, Painesville, Ohio 44077.

Winter Meeting 1970

The 1970 Winter Meeting will be held at the California Institute of Technology, Pasadena, California, on February 2nd-4th, 1970. The program and local arrangements committee is chaired by N. W. Tschoegl at Co. Tech., Pasadena, California 91109.

Autumn Meeting 1970

This is likely to be held at Princeton University. The dates and other information are not yet available.

Membership

In the Rheology Bulletin of The Society of Rheology, Inc., Vol. 38, No. 1, a membership of 800 was reported for 1968, an increase of some 60 members after an essentially no growth year in 1967.

DIARY

Meetings (1969)

16 and 17 September. Conference—Advances in polymer blends and reinforcement. Plastics Institute at Loughborough.

16-18 September. Conference—Advances in rheology. University Strathclyde, Glasgow. British Society Rheology.

24 and 25 September. Symposium—Two-phase flow joint I.Mech.E./I.Chem.E. meeting, Leeds University.

7 and 9 October. Conference—Ultrasonics for Industry by Ultrasonics for Industry, 32 High Street, Guildford, Surrey.

1970

7-9 January. Conference—Polymer chain flexibility. British Polymer Physics Group, Essex University.

19 and 20 February. Convention—The use of grease as an engineering component. I.Mech.E.

24 March. Conference—Product performance testing. Plastics Institute at Bath.

31 March-3 April. Conference—Physical and structural lines of the Guild, deformation and fracture of polymers. Joint I.P.P.S. British Polymer Physics Group, B.S.R., I.R.I., Matl. Sci. Club meeting at Cambridge.

5-11 April. A.G.M. and Symposia. Plastics Institute at Edinburgh.

16 and 17 June. Conference—Polymers in high-performance applications. Joint Society of Plastics Engineers and Plastics Institute meeting at Institute of Electronic Engineers, London.

- 29 September–10 October. Conference—Advances in polymer science and technology—No. 3. Chemistry of liquid and thermoplastic co-polymers. Plastics Institute.

Exhibitions

- 30 September–2 October, 1969. 4th International Synthetic Rubber Symposium and Exhibition.
- 25–28 November, 1969. Lubrication and Tribology Exhibition. New Horticultural Hall, London. U.T.P. Exhibitions Ltd., 3 Racquet Court, Fleet Street, London, E.C.4.

SITUATIONS VACANT

University of Nottingham

Department of Applied Biochemistry and Nutrition

Applications are invited for a research scholarship financed by the Potato Marketing Board in the Food Science Laboratories of the above department, commencing October 1st, 1969.

The project will be directed to the study of the viscoelastic properties of potatoes in relation to the incidence of physical damage. An important aspect will be the development of techniques for the measurement of appropriate properties and as such a training in the physical sciences will be highly desirable. Finance is available for the purchase of electronic components.

The project will also involve correlating physical measurements with the known variation in susceptibility to mechanical damage of different varieties of potatoes, and relating these aspects to problems of husbandry, storage and processing. Other aspects can be developed as the project proceeds.

The experience and training gained in such a project should prove a useful introduction to the field of texture measurement which is an active field of research in the food industry.

The scholarship is valued at £600 p.a. and the successful applicant will be eligible to submit for a higher degree.

Letters of application should contain full details of university training, type and class of degree, the names and addresses of two referees and be sent to:

J. M. V. Blanshard,
Food Science Laboratories,
Department of Applied Biochemistry and Nutrition,
University of Nottingham School of Agriculture,
Sutton Bonington,
Loughborough,
Leics.

University of Bradford
Schools of Chemical Engineering

RESEARCH APPOINTMENTS

Applications are invited from honours graduates in Engineering, Science or Mathematics for the posts of Research Fellow and Research Assistant in the Postgraduate School of Chemical Engineering.

These posts are financed by the Science Research Council. The work will be concerned with the characterisation of non-Newtonian fluids and a study of their behaviour in a range of engineering situations. Experience in this field would be an advantage but it is not essential.

Salary ranges: Research Fellow £1,240 x £115 — £2,045
(Ref. CHE/RF(S)/2)

Research Assistant £940 x £100 — £1,240 x £115
— £1,470 x £80 — £1,550
(Ref. CHE/RA(S)/2)

Further information, and application forms can be obtained from the Registrar, University of Bradford, Bradford 7, with whom completed applications should be lodged. (Please quote ref.)

Recent Elections

NAME AND ADDRESS	INTERESTS
R. F. Ginn, Ph.D., Westraco Research, John Hopkins Road, Laurel, Md. 20810, U.S.A.	Polymers, fibrous materials, liquid-solid systems.
A. J. Grace, B.Sc., School of Pharmacy, College of Technology, Park Road, Portsmouth, Hants., U.K.	Liquid-liquid systems.
M. A. Hayes, Ph.D., M.Sc., School of Maths and Physics, University of East Anglia, Norwich, U.K.	Metals, Polymers, polymer solutions.
J. M. Hobbs, B.Sc., Ph.D., National Eng. Lab., East Kilbride, Glasgow.	Polymers, liquid-liquid systems, oils and greases.
M. Ish-Shalom, Ing.Chim., B.Sc., M.Sc., Ph.D., Israel Ceramic Silicate Institute, Technion City, Haifa, Israel.	Suspensions, glasses, ceramics.
R. S. Jones, B.Sc., Ph.D., University College, Aberystwyth, Cards, Wales, U.K.	Polymers, liquid-liquids, liquid-solids.
G. A. Lewis, B.A., Chemistry Dept., Brunel University, Acton, London, W.1, U.K.	Polymer solutions, printing inks, biorheology.
N. J. Mills, M.A., Dp.Adv.Eng., I.C.I. Petro Chemicals and Polymer Lab., P.O. Box 11, Runcorn, Ches., U.K.	Polymer melts.
F. R. Morgan, B.Sc., Ph.D., F.Inst.P., F.I.M.A. The Cementation Co. Ltd., Research Dept., Maple Cross, Rickmansworth, Herts, U.K.	General, rubbers, polymers, polymer solutions, emulsions, sus- pensions, pharmaceuticals, etc.
J. Nebrensky C.Sc., Dept. of Chem. Eng., University College, Swansea, U.K.	General, rubbers, polymers, emulsion, suspensions.
K. Te N'Jenhuis, M.Sc., Lab. voor Fysische Chemie. Delft, The Netherlands.	Polymers.

NAME AND ADDRESS	INTERESTS
A. Plochocki, M.Sci., D.Sci., Tech., Warsaw 86, Krasinskiego 34 m 9, Poland.	Experiments, rubbers, polymers.
M. L. Richardson, B.Sc., A.R.I.C., M.R.S.H. Wick Pure Foods Ltd., Falcon Street, Oldham, Lancs., U.K.	Experiments, emulsion, suspensions.
G. M. Saunders, B.Sc., M.P.S., School of Pharmacy, College of Technology, Portsmouth, Hants., U.K.	Theory and experiments, liquid-liquids.
A. J. B. Spaul, B.Sc., Ph.D., Brunel University, London, W.3, U.K.	Printing inks.
M. J. Stevens, B.Sc., A.M.I.Mech.E., Institute of Polymer Technology, Loughborough University of Technology, Leicestershire, U.K.	General rubbers, polymers.
J. Ulbrecht, Chem.Eng., C.Sc., Institut of Chemical Process Fundamentals, Czechoslovak Academy of Sciences, Praha 6 - Suchdol.	General, rubbers, emulsions, suspensions.
E. W. Williams, B.Sc., Dept. of Appl. Maths., The University, Liverpool 3, U.K.	Theory.
B. Yates, B.Sc., Ph.D., A.M.I.Chem.E., Unilever Research, Port Sunlight, Ches., U.K.	Polymers, liquid-liquids, liquid-solids.

NOTICE TO INTENDING CONTRIBUTORS

The B.S.R. Bulletin is now available as a vehicle for several categories of communication by Members.

1. Technical papers (two copies required).
2. Descriptive papers of general interest.
3. Letters which may be either
 - (i) technical or
 - (ii) non-technical.

The technical papers will be refereed and so will technical letters but the latter only by one person. Descriptive and non-technical material will be published if it is of general interest.

In addition, Project Reports and Computer Information will be published.

It is hoped that B.S.R. members will find rapid publication sufficiently attractive to warrant submitting work.

Erratum

Useful formulae and techniques for the Weissenberg rheogoniometer.

P. 9, line 10, "convential" should be "conventional."

P. 15, lines 12 and 13, "Well above the resonant, frequency products of the upper frequency motion," should be, "Well above the resonant frequency products of the upper platen motion."

P. 15, line 17, and P.16, line 16, delete 2π