

THE BRITISH SOCIETY OF RHEOLOGY

BULLETIN



1990, Vol. 33 No 3

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Hon. Editor

Dr P. F. G. Banfill,

School of Architecture & Building Engineering,

University of Liverpool,

P. O. Box 147, Liverpool L69 3BX.

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THE BRITISH SOCIETY OF RHEOLOGY
 OFFICERS AND MEMBERS OF COUNCIL
 190/91

- President:** Dr D. C-H. Cheng, Warren Spring Laboratory,
 Gunnels Wood Road, Stevenage, Herts SG1 2BX.
Tel.: 0438-741122 **Fax:** 0438-360858 **Telex:** 82250 WSL DOI G.
- Secretary:** Mrs C. A. Moules, Krüss UK Ltd, 5/6 Carrington House,
 37 Upper King Street, Royston, Herts SG8 9AZ.
Tel.: 0763-244280 **Fax:** 0763-244298.
- Treasurer:** Mr P. C. Anderson, Production Operations, BP Research Centre,
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Tel.: 09327-63351 **Fax:** 09327-62999 **Telex:** 296041.
- Membership Secretary:** Dr J. Hourston, Department of Chemistry, University of Lancaster,
 Bailrigg, Lancaster, Lancashire LA1 4YA.
Tel.: 0524-65201 **Fax:** 0524-63806 **Telex:** 65111 LANCUL G.
- Abstracts Editor:** Dr G. J. Brownsey, AFRC Institute of Food Research,
 Norwich Laboratory, Colney Lane, Norwich, NR4 7UA.
Tel.: 0603-56122 **Telex:** 975453 FRINOR G.
- Bulletin Editor:** Dr P. F. G. Banfill, School of Architecture & Building Engineering,
 University of Liverpool, P. O. Box 147, Liverpool L69 3BX.
Tel.: 051-794-2619 **Fax:** 051-708-6502 **Telex:** 627095.
- Ordinary Members:** Dr R. Buscall, Imperial Chemicals Industries PLC,
 Corporate Colloid Science Group P. O. Box 11, The Heath,
 Runcorn, Cheshire WA7 4QE.
Tel.: 0928-513632 **Fax:** 0928-576675 **Telex:** 629655 ICIMOH G.
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 2 Marshbrook Business Park, Marshbrook, Church Stretton,
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Tel.: 06946-466/7 **Fax:** 06946-468 **Telex:** 9312102287 CBG
Email: Gold 72: MAG31999.
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 University of Strathclyde, 245 Cathedral Street, Glasgow G1 1XL.
Tel.: 041-552-4400 **Fax:** 041-552-4775 **Telex:** 77472.
- Dr M. R. Mackley, Department of Chemical Engineering,
 University of Cambridge, Pembroke Street, Cambridge CB2 3RA.
Tel.: 0223-334784 **Fax:** 0223-334748
Telex: 81240 CAMSPL G.

EDITORIAL

I am pleased to take over the Honorary Editorship of the Bulletin and I hope to serve members' interests over the next few years and build upon the good work done by my predecessors. This issue contains the same sort of material as in the recent past but I propose to introduce some innovations including some things which will make an interesting diversion from the games available on computer controlled rheometers (see the Rheogram in this issue, kindly set by Dr Tattersall).

Accordingly I invite members to tell me what they would like to read in the Bulletin. In particular I aim to increase the amount of information about members in the Bulletin, so please send me items such as changes of job, promotions, honours etc. for inclusion in a personal news section. I would also like to revive the 'letters to the editor' section which can include comments, controversies, polemics and suggestions (constructive, if possible). The Bulletin is for members of the Society and should reflect their interests and opinions. It cannot do this without material so please write to me.

I start my term of office with a new editorial system so this issue includes some notes on the submission of copy.

NOTES ON THE SUBMISSION OF COPY

Copy dates are March 15th, June 15th, September 15th and December 15th and are rigidly enforced. The Bulletin is now prepared with an Apple Macintosh Desktop Publishing system and items for inclusion should be submitted as follows:

1. Copy typed or printed from a wordprocessor must be double spaced in clean and dark print using an electric typewriter, laser printer or a dot matrix printer in double strike mode.
2. Longer items should preferably be sent as disc files in one of the following formats:
 - (i) ASCII format as text only (i.e. no embedded formatting commands);
 - (ii) DCA-RTF, as supported by most PC-based wordprocessors;
 - (iii) Word Perfect;
 - (iv) Write Now 2 or other Apple Macintosh wordprocessor,on a 5 ¹/₂ DD (but not HD) discs or 3 ¹/₄ DD or HD discs. The disc should be accompanied by a hardcopy printout for checking.

THE DEVELOPMENT OF INTERNATIONAL RHEOLOGICAL MEASUREMENT STANDARDS

Nigel I. Heywood

Rheology Section, Marine Pollution and Bulk Materials Division
Warren Spring Laboratory, Stevenage, Herts, UK SG1 2BX

INTRODUCTION

A recent British Government report entitled "Measuring up to the Competition" (Cmd 728, July 1989) outlined the role and structure of the UK's National Measurement System (NMS) and its importance for trade both within the UK and between the UK and other countries, particularly those in Europe as the single market approaches by the end of 1992. The NMS is the technical and organisational infrastructure which attempts to ensure a consistent and internationally recognised basis for the measurement of a wide range of quantities in the UK. It is based largely on national measurement standards, which allow measurements to be traced back to primary standards such as mass, length and time.

An important link in the UK's NMS is the National Measurement Accreditation Service (NAMAS) which enables organisations to be recognised as having the competence to offer specific types of measurement, calibration and testing services which are traceable to national standards held by the National Physical Laboratory at Teddington (west London). There exists a mutual recognition agreement between NAMAS and four other European national accreditation schemes.

There are currently over 1,000 NAMAS-accredited laboratories in the UK offering a wide variety of different types of measurement. However, only some 15 offer a viscosity measurement service and only one offers a viscometer calibration service. By far the main emphasis in these services is the viscosity measurement of Newtonian fluids using glass U-tube viscometers. No laboratory has been accredited in the UK for either measurement or calibration services for other rheological properties apart from Newtonian shear viscosity.

Why is this? Is it because the demand isn't there in UK industry? Or is it because the procedure isn't available to meet both current, but in particular, future demand for such a service? I shall try to answer these questions later.

RHEOLOGICAL MEASUREMENT AND THE UK NATIONAL MEASUREMENT SYSTEM

For many years the National Physical Laboratory (NPL) provided a calibration service for glass U-tube viscometers. This was based on a viscosity scale which had as its starting point the viscosity of freshly distilled water at 20.00°C (refs. 1 to 3). The NPL also undertook an international round-robin exercise on the calibration of glass U-tube viscometers. In addition, standard Newtonian calibration liquids

(mainly oils) were provided. No similar standards have been either held or developed for viscosity measurement using any type of rotational viscometer or for the measurement of either non-Newtonian viscosity or other rheological measurements using either capillary tube or rotational viscometers. There is therefore much to be done in order that the scope of rheological measurement standards is widened internationally.

As part of the EUROMET agreement, the NPL service was transferred to the Physikalisch-Technische Bundesanstalt (PTB) at Braunschweig, Federal Republic of Germany. This particular arrangement within EUROMET is a bilateral agreement only, whereby the UK government recognises traceability for Newtonian viscosity measurement using U-tube viscometers to the PTB. Hence all requests, for instance, for standard calibration reference liquids which are received by the NPL are now directed to the PTB. The agreement guarantees that the PTB will provide certain specified rheological services for UK customers.

THE GERMAN POSITION ON RHEOLOGICAL MEASUREMENT STANDARDS

German federal law requires that a viscosity scale is maintained for the realisation and dissemination of the unit of viscosity. There is no official regulation with regard to other rheological measurements. However, the German Government believes it is important to respond to the German industry need for non-Newtonian reference liquids. Work on this is therefore in progress at the PTB and is said to be linked to standardisation work in various committees (DIN, CEN, ISO) dealing with rheological measurements.

The PTB plan to extend their work to viscoelastic fluids with emphasis on standards development for normal stress measurement. There is a strong recognition that rheology is becoming increasingly important in many industrial sectors.

WHAT NEEDS TO BE DONE?

Warren Spring Laboratory has considered this question in detail during the last year. There are essentially two sides to the coin — firstly, the development and supply of standard reference liquids covering a range of important rheological properties and their use in conjunction with standardised error correction procedures, and secondly, the development of standardised rheological test equipment. I shall deal with reference liquids first.

I have already mentioned that Newtonian reference liquids are available through the PTB to UK and other customers. In addition, there are a number of other suppliers of Newtonian reference liquids such as rheometer manufacturers, university departments and research associations. Some of these standard liquids will have viscosity values traceable to primary standards while others will not. The user will obviously have more faith in the stated values of the rheological properties if the supplier can demonstrate traceability. This is normally done in the UK by accreditation through NAMAS and this accreditation route is recognised by equivalent schemes in a number of other EC countries.

It is common practice to use these reference liquids to check or carry out the calibration of a wide range of rotational viscometer types. If the oils are used to check calibrations which have been carried out by some other means, such as the use of a pulley and weight system or linear displacement transducer to calibrate for torque combined with a tachometer to calibrate for rotational speed, discrepancies will commonly be found between the values of viscosity for Newtonian reference liquids and those obtained from the viscometer.

These discrepancies arise, of course, as a result of the many sources of error which affect data from rotational viscometers. For the occasional, perhaps non-expert, users of these viscometers, such discrepancies may suggest that either the reference liquid is in error or the original calibration of the viscometer was carried out incorrectly. More often than not the user may just be confused by this!

In fact, of course, often neither supposition is correct. But how many rotational viscometer users are aware of error sources such as end-effect, edge-effect, gap-setting error, the onset of secondary laminar flow, viscous heating, wall-slip, etc.? Any one of these error sources can lead to significant errors of 30% or more, but when combined, viscosity values can easily be in error by 100% or more. Currently there is no NMS standard that concerns itself with any of these error sources.

Then there are the "errors" arising from the physical properties of the test material. These "errors" should perhaps more correctly be referred to as "scatter". Again, how many people are aware that if they measure the viscosity of a suspension of $2\mu\text{m}$ particles at solids concentration of 60% by volume using a viscometer gap width of $200\mu\text{m}$, they should not expect to get anything like the same viscosity values for $40\mu\text{m}$ particles at the same 60% solids concentration? Scatters with factors of 5 or more are not uncommon for dense suspensions and some would argue that this scatter is a material problem and therefore an additional characteristic of the flow properties of the material.

The extent of the errors in rotational viscometry depends also on whether the materials under test exhibit non-Newtonian property. So how do people get on using Newtonian reference liquids in rotational viscometers before embarking on non-Newtonian testwork? Much of the available evidence suggests not very well! Evidently standard measurement procedures as well as non-Newtonian reference liquids need developing. The PTB is developing non-Newtonian reference liquids, but for the moment for shear viscosity only. The National Bureau of Standards in the US has developed a non-Newtonian Standard Reference Material 1490 (1977) which is a polyisobutylene solution in cetane. This has both certified viscosity and first normal stress difference values at 25.00°C .

Then, of course, there is the need for a standardised approach to the measurement of both Newtonian and non-Newtonian materials in extrusion-type tube viscometers which are subject to error sources not encountered when using standard U-tube viscometers.

requirement and the levels of accuracy and precision in rheological measurement which are necessary for the application.

For single phase fluids, all types and sizes of viscometric geometry should, after the data have been properly corrected for the various sources of error, provide the same results. So selection of suitable viscometric geometries is an issue only insofar as it relates to the requirement to cover the relevant shear stress and shear rate ranges.

However, where multiphase materials are of interest, such as solid/liquid suspensions, attention must be given also to viscometer geometry selection and the size of the most significant viscometer geometry dimensions as both these will in many cases influence the rheological data. Geometries and dimensions need often to be matched as closely as possible to those of the application, particularly in the case of dense suspensions. Sound selection can only be achieved through a systematic assessment of both the properties of the fluid of interest and the engineering requirement and this needs to be built into standards for use across industries.

Warren Spring Laboratory has observed a growing interest shown by UK process industries in rheological measurement and its application ever since it became involved in helping to solve industry's rheological problems back in 1959. The demand for standard methods which are focussed on the needs of a particular industrial sector, such as food, pharmaceuticals or adhesives, is obviously higher than the demand for standards which are national and applicable to a wider range of industries. But the demands for both are there. And, of course, there is the requirement that any standards developed for a given industry should be harmonised internationally with other standards developed in other countries.

I believe there is a case for more general standards which cover a range of industries. Measurement accuracy and precision levels, product formulation considerations and engineering requirements can often be similar across different industries.

Take, for instance, the problem of ensuring particles remain in suspension over a long period of time. This is of interest to those formulating medicinal products in the pharmaceutical industry, pesticides in the agrochemical industry and drilling muds in the oil industry, to name just three examples. The differences between them lie in the detail, not in the main thrust of the rheological measurement approach. In this case, should the material formulation be based on yield stress development and measurement or is the shear viscosity the more relevant parameter to measure? The answer to this and other questions can be expanded in a rheological standard of use to many industries.

An example of standards currently under development which is confined to one industrial sector concerns the physical properties of fluid fertilisers, including identification of suitable rheological properties for formulation purposes. This work comes under ISO/Cte 3/Working Group 2 (ISO/TC134/SC3/WG2). There will be a number of standards on the determination of apparent viscosity by rotational viscometer and

by gun rheometer. These will then be referred to in another standard on the assessment of stability in suspension fertilisers to provide data for calculating the size of particles that can be suspended.

CONCLUDING REMARKS

There is clearly a growing requirement which needs satisfying, both in the UK and on an international scale, for rheological measurement standards. Some will be concerned with accuracy and traceability while others will be concerned with strategies for rheological measurement for practical problems where measurement accuracy is less of an issue.

Much of the current and anticipated future interest in the ideas outlined above can be attributed to the provisions for the management of quality assurance procedures as detailed in BS 5750/ISO 9000.

Rheological standards will in due course go far beyond the confines of simple shear viscosity to many of the other rheological properties exhibited by materials of industrial importance.

The PTB and WSL intend to embark upon a joint programme of work, which, it is hoped, will be funded through the BCR applied metrology programme of the European Community and by the German and British Governments. However, we are also keen to collaborate with companies in a wide range of industrial sectors to ensure that their needs are met and to obtain additional financial support.

If you would like more information on the objectives of this work programme, please contact the author.

REFERENCES

1. Daborn, J. E., "The Viscosity Scale of the NPL." *Metrologia*, 1975, 11, 79-84.
2. Daborn, J. E., "The NPL Reference Oils for Viscosity." *Measurement and Control*, July/August 1985, 18, 226-232.
3. NPL measurement services booklet: "Viscosity", 1979.
4. Cheng, D. C-H., "Viscosity — Calibration and Standards". *Measurement and Control*, Part 1: March 1981, pp. 73-78; Part 2: April 1981, pp. 112-118; Part 3: May 1981, pp. 159-163.

EDITOR'S NOTE

Standard liquids for the calibration of viscometers are available from various sources including the Paint Research Association (contact Mr Falla 081-977-4427) and Strathclyde University (contact Dr Ferguson 041-522-4400) to name just two known to me. However not all suppliers' liquids can be traced to national standards and Dr Heywood has agreed to carry out a survey of the suppliers, the liquids available and their status in this respect, for publication in a future issue of the Bulletin. If your organisation supplies calibration fluids commercially please get in touch with Dr Heywood directly.

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THE EARLY YEARS OF THE SOCIETY (from the Archives)

In this Golden Jubilee year, I thought that members would be interested in a letter which was published in the Bulletin number 13 of the British Rheologists Club, December 1946. H. R. Lang was one of the triumvirate who founded the club in 1940, with G. W. Scott Blair and V. G. W. Harrison and we were delighted to hear Dr Harrison's reminiscences at the Conference Banquet during the Golden Jubilee Meeting in September.

My dear Scott Blair,

Some time ago you asked me to jot down my recollections of how the Club came into being, and something of its first few years. Please take these jottings as my hurried attempt to meet your request — I never could resist them. One can never tell who in the future will peruse these scribbles and what they will read into them. If they do no more than help to keep something of that delightful informal spirit with which we started, I shall be more than pleased. Here, then, is my own story: —

It was a fine summer afternoon in 1940 and, feeling somewhat exhausted by the difficult war conditions of evacuation to Reading, I went a little way into the country with my wife. Begrudging the few hours away from the temporary office of the Institute of Physics, I consoled myself by fulfilling a long-standing promise to visit Scott Blair's laboratory at the National Institute for Research in Dairying, at Shinfield, some three miles out of Reading. He explained to me the difficulty he was having in devising suitable instruments for measuring the rheological properties of the secretions from the uterine cervix of the cow, which he thought might prove a useful early test for pregnancy — a matter of great importance to the dairy industry during the war. It immediately occurred to me, from what he said, that this problem was very similar to V. G. W. Harrison's, who was trying to measure the rheological properties of printing inks. In the normal course of my work as Secretary of the Institute of Physics, I therefore gladly arranged for these two to meet. That meeting must be taken as the first meeting of the Club, that it was of mutual benefit seems certain, for they came to me and asked if there were not a few more interested in these problems, and that I should bring them all together. These were the paint industry people, the oil and tar people, and so on, and we thought there might be twenty or more who would like to lunch together two or three times a year to 'swop yarns' and to arrange to visit each other's labs. We three appointed ourselves a Committee, having decided to form a Club, which should have no rules and no formalities — indeed a Club, where one could speak as freely as in the lab. The Committee was to meet either in my attic room in the University of Reading (the old red building) or in Scott Blair's drawing room. The latter were the more successful meetings since we had the great advantage of Mrs. Scott Blair's wisdom and teas, not to mention Wolfgang, the dog, who was always present. Harrison came

over from Guildford on his motorbike — dressed as for Arctic exploration, which was no doubt necessary. The Board of the Institute of Physics permitted the clerical work for the Club to be done in its temporary office for the first few years of its existence, so long as it did not interfere too much with official work. When it did, Mrs. Lang came to the rescue and cut the stencils for the Bulletins and Abstracts, which were then rolled in my office. The Committee meetings were great fun — as we all had a goodly dose of Committee work in our daily work we were glad to have these most informal meetings, breaking all the rules of procedure. Later when we found that the Club was shockingly successful, and we were in danger of founding yet another scientific Society, with its publications and office problems, we thought it wise to make the Committee more representative of the Club, so Treloar and Broome joined us. They thought it time we had a chairman and I had the honour of being pushed into that office. This I was glad to accept, for I confess I used to try out techniques learnt from Chairmen I had seen at work during the last ten years. Perhaps some less biased pen than mine will record something of the Committees thereafter.

As the Club grew in numbers and status, its office work grew. There was the idea, for example, of producing duplicated copies of translations of original classical rheological papers; in particular one by Pochettino which ran to many pages of typescript. This was done in odd times in my office and was very troublesome. Indeed, in 1942, the time had clearly come to take the Club's activities more seriously before they became a menace and I discussed the matter with the Officers of the Institute of Physics and the Club. The upshot was that the Institute continued its support for another year when Scott Blair and Harrison agreed to carry on, with such help as they could get. The Club by then was the proud possessor of a Post Office Account and a rubber stamp, which were used effectively to persuade Miss Mary Milligan, a friend of the Scott Blairs, to do the office work for a very modest fee, but the Institute's duplicator and addressing machine continued to be of service to the Club for a while.

In the 'Reading' days the Club tackled such trying problems as 'Pi' and the classification of deformations of materials. It may have been a case of 'fools rush in where angels fear to tread' but we did enjoy ourselves! Exchange of views was frank and free and often I regret to say I felt that the experts knew no more about what was being discussed than I, as chairman, did — and said so. In view of the later developments, I am not so sure that the old adage 'there's many a true word spoken in jest' is not applicable in this instance!

I hope that Scott Blair and Harrison will add to these notes, and fill in the parts I have missed and modify many exaggerations. They must not fail to say something about the first week-end Conference when the Scott Blairs were able to re-live some early scenes of their Oxford romance in her old College — St. Hilda's — in which the Conference was held.

H. R. Lang.

GOLDEN JUBILEE CONFERENCE
AND
THIRD MEETING OF EUROPEAN RHEOLOGISTS
EDINBURGH SEPTEMBER 1990

My aim is to transmit some of the atmosphere of this conference to those who were unable to attend it. The three key words were "European", "Jubilee", and "Edinburgh". European, it certainly was but participants from Australia, Canada, Iran, Israel, Japan, Korea, Mexico, South Africa, and the U. S. A. greatly enhanced the stature of the meeting.

To the B. S. R., Europe has always been defined geographically rather than politically but one felt a sense of celebration in the air following the recent moves towards freedom in Eastern Europe.

More than 200 scientific papers were presented in five parallel sessions with eight keynote papers and three plenary lectures. With such a large number of papers the standard was inevitably mixed and the small amount of public discussion was unfortunate. In future meetings of this size it might be worth having poster displays to reduce the number of overlapping lectures, or using raconteurs to summarise groups of previously issued papers (posters are better than lectures for some subjects). In contrast to the lectures, there was ample opportunity to exchange views outside the lecture theatres.

The conference began with the first plenary session. This was the Courtaulds Lecture given by Professor Leonov entitled "Some inverse problems in rheology leading to integral equations".

After being presented with the Society's Gold medal Professor Sir Sam Edwards presented a stimulating lecture showing analogies between the behaviour of powders and certain thermal effects.

Following the receipt of another of the Society's Gold medals, Professor Giesekus gave a fascinating account of the mile-stones of his career in rheology.

The proceedings of the conference are recorded in a well prepared hardback book (three pages per lecture) edited by Ralph Oliver and published by Elsevier. We English speaking rheologists owe a debt of gratitude to the many participants who translate their papers and talks into our language. While the lecture sessions were in progress an exhibition of rheological instruments and textbooks was also displayed in the foyer.

The Golden Jubilee celebrations reached their climax at the banquet. Dr David Cheng presented the Society with a magnificent gold presidential chain with the names of past presidents engraved on it. For

the remainder of the evening this rested fittingly on the shoulders of Jim Ferguson. A most beautiful coloured glass vase from the Swedish Society demonstrated the makers artistic skills and dexterity in manipulating viscous liquids. A unique award was given by the Austrian Society in the form of hand written notes used by Boltzmann when at Graz.

The newly formed Bulgarian Society of Rheology had earlier presented an address giving their good wishes and this was also on display during the evening.

The Society's Annual Award for 1990 was presented to Dr David Heyes and the Scott Blair Scholarship was presented to Mr A. Nithiananthan by Dr Ferguson. After these presentations had been made the outstanding feature of the Golden Jubilee was the speech by Dr Vernon Harrison, one of the "gang of three" who started The British Rheologists' Club back in 1940. He recalled in detail the early days of the Society and the plans formulated with his colleagues Scott Blair and Lang. The fifty intervening years have apparently aged Dr Harrison very little.

Scottish hospitality was particularly evident during the social programme. This consisted of a reception at Stirling Castle for all participants and accompanying persons on Monday evening, a reception given by the President for sponsors and past presidents on Tuesday, six excursions on Wednesday afternoon, (I am told that the visit to Glenkinchie Distillery was most popular), and the Conference Banquet on Thursday.

All the organising committee and their helpers deserve our gratitude for ensuring the smooth running of this meeting. Special thanks must, however, be given to Chris Petrie for all the work he did both before and during this memorable conference.

John Benbow

EDITOR'S NOTE GOLDEN JUBILEE TIES AND BADGES

Carole Moules has available for sale a limited number of the ties and badges specially designed for the Golden Jubilee. The tie is blue with the Society's logo in gold while the badge is in gold (hallmarked) with the logo and can be used as a lapel badge, brooch or tie pin. They cost £10 and are available while stocks last from Carole at the address inside the front cover of this Bulletin.



At the Conference Banquet, Edinburgh, 1990,
Dr Jim Ferguson, President, with Sir Sam Edwards (left) and
Professor Hanswalter Giesekus (right), Gold Medalists.



Dr V. G. W. Harrison, founder member of the British Rheologists' Club,
addresses the Conference Banquet, Edinburgh, 1990.

AWARDS 1990

During the Golden Jubilee Meeting held in Edinburgh in September 1990, the President presented the Society's Gold Medal to Sir Sam Edwards and Professor Hans-Walter Giesekeus and the Society's Annual Award to Dr David Heyes.

SIR SAM EDWARDS

After the Mathematics Tripos at Cambridge, Sir Sam worked at Princeton and Birmingham before becoming Professor at Manchester University. He was head of the Science Research Council for four years and has been part-time scientific advisor to the Department of Energy. He is now John Henry Plummer Professor of Physics at the Cavendish Laboratory, Cambridge and Fellow of Caius College. His research interests include the shape of polymer molecules in solution, high energy physics of plasmas and turbulence. He is a Fellow of the Royal Society. The theory of reptation which he developed with Doi and published in 1978 as the molecular basis for the flow of polymers was a revolution in rheology and spawned a whole new industry within rheological research concerned with improving the theory.

Sir Sam Edwards gave the Gold Medal Lecture entitled "The Rheology of Powders" during the Golden Jubilee Meeting and the full text will be published in a future issue of *Rheologica Acta*.

PROFESSOR HANS-WALTER GIESEKUS

Professor Giesekeus has been one of the best known figures in rheology for many years, not only as editor-in-chief of the *Rheologica Acta*, but for his distinguished rheological work on the development of constitutive equations. Many of his ideas, published and unpublished, produced during the 1960's were ahead of their time and have been taken up again recently. He is the most distinguished of the Society's European members and it is appropriate that he should be the first non-UK recipient of the Gold Medal and that the award should be made during the Third meeting of European Rheologists. He retired recently from the University of Dortmund but continues to be as active as ever.

Professor Giesekeus gave the Gold Medal Lecture entitled "Carried along a pathline in modelling constitutive equations of viscoelastic fluids" during the Golden Jubilee Meeting and the full text will be published in a future issue of *Rheologica Acta*.

DR DAVID M. HEYES

David Heyes took a B. Sc. in chemistry at Bristol, followed by a Ph. D. at Manchester with a thesis entitled "Molecular dynamics of Solids and Surfaces". Currently David is a Royal Society (1983) Research Fellow at Royal Holloway and Bedford New College, London. He is shortly to move to the University of Surrey.

David has worked in the area of molecular simulation for nearly twenty years. Early work was on crystalline solids but latterly fluids have been his main concern. His current interests include rheology,

aggregation and gelation, and molecular motion in simple liquids. He has published eighty papers on these and other topics.

David is well-known to the rheological community for his application of Molecular and Brownian Dynamics methods to the flow of fluids. A summary of some of this work can be found in *Journal of Non-Newtonian Fluid Mechanics*, 27, 47, (1988). It is a mark of the impact of the work that several rheology groups around the world are now using algorithms developed by David to probe the origins of non-Newtonian behaviour, notably in colloidal system.

David's current plans include new work on aggregates, gels and polymer solutions, and the development of theories supported by simulation, of transport processes in simple fluids.

The Annual Award of the British Society of Rheology for 1990 is made to Dr David Heyes for his contribution to the elucidation of the molecular origins of non-Newtonian and viscoelastic behaviour by means of computer simulation.



Dr David Heyes collects his Annual Award and seems to be in a hurry to get back to work.

COMMENTARY ON THE 262nd COUNCIL MEETING AND THE ANNUAL GENERAL MEETING

Rheologists are used to dealing with stresses which vary with time, but officers and Council Members suffered from stresses due to the lack of time on Thursday, September 6th in Edinburgh. A hectic schedule had been laid down, as after completion of Sir Sam Edwards' Gold Medal Lecture and a five minute walk, the Council meeting began at 12.25 as a working lunch, to be completed by 13.25 for the five minute walk in the reverse direction for the presentation of the Gold Medal to Professor Giesekus. Similarly the A. G. M. was to be fitted into the space after the end of the afternoon's papers at 16.45 and departure (washed and changed) for the Conference Banquet at about 19.00.

While the Conference delegates ate downstairs we met in an upper room (called the middle reading room according to the notice on the door, but with no sign of any books) in Teviot Row House, surrounded by portraits of worthy men with past connections with Edinburgh University. We were able to practise our skills in simultaneous speaking, eating and writing.

All were present except Steve Aldhouse, who had injured his back whilst retiring from BP Chemicals. We cantered through the minutes of the last meeting and Jim Ferguson reported that the application to set up a permanent European School of Rheology using COMETT funding from the EC had failed. Roy Carter confessed that the agreed short history of the Society was still to be written and David Cheng had submitted an article in popular style called 'Rheology is Everywhere' to the *Guardian* for the Science page who had rejected it. He had subsequently sent it to *New Scientist* in the hope of publication to coincide with the current meeting but had heard nothing.

The proposed subscription increase generated much discussion about whether it was better to offer a reduction for those who pay by standing order and whether overseas members should not be disadvantaged because they do not have access to standing orders. The overseas postage costs on the Bulletin are more than the present subscription. The meeting agreed to set no differential but the item would recur later at the A. G. M.

The arrangements for the Gold Medallists, the Annual Awards and the Scott Blair Scholarship were all in hand, and citations would appear in the Bulletin. Peter Anderson briefly described our finances, which are healthy enough to cover losses on the Edinburgh Conference. Geoff Brownsey remarked that he was still desperate for abstractors, but had managed to produce more than 600 abstracts this year.

By the time we had briefly heard about past and future scientific meetings a worried look had appeared on Jim Ferguson's face and it was time to stop. While publication of the proceedings of the Warwick and Liverpool meetings is imminent, Tony Evans wondered whether the stress of producing camera ready copy was at odds with the 'club' image

of the Society, in that speakers were always talking about work finished a few months earlier. This is perhaps a valid point.

So at 13.20 Jim closed the meeting and left, just in time to introduce Professor Giesekus' Gold Medal Lecture. The rest of us, with weaker digestions, followed in time for the start of the lecture.

The Annual General Meeting convened at 16.45 with about 50 members present in a lecture room in the Appleton Tower to an accompaniment of the blustery winds of what the weather centre referred to as the remains of hurricane Gustav. I was glad to have caught only the remains.

Jim Ferguson gave his President's report (see elsewhere in this Bulletin). Peter Anderson presented the accounts and noted our present good financial position but was doubtful about it after the present conference as the Society had built up reserves to subsidise the Golden Jubilee Meeting. The organisers had not been able to say what the likely deficit would be. Members' subscriptions were lower because of the difficulties of collection and income from Rheology Abstracts down. In introducing the proposed subscription increase he pointed out that there had been no change since 1978 and that to avoid repeating the problems experienced by Council Members without administrative support, the Society wanted to break away from the 'club' atmosphere to be more professional in its operations, so that officers could have an allowance for secretarial expenses. After discussion and the tabling of two amendments the meeting agreed that the subscription should increase to £15 with effect from October 1991 with a reduced rate of £10 if paid by standing order and that the Council should be empowered to make arrangements which did not disadvantage overseas members.

Harry Schimanski and Geoff Brownsey presented their reports (see elsewhere in this Bulletin). In giving the Bulletin Editor's report, Peter Townsend said it is always a problem for the Editor to get information on conferences and appealed for people to submit information. From the floor Professor Kemblowski stressed how important conference information, both notices of forthcoming meetings and reports of those gone by, is to members. Finally Roy Carter gave his report (see elsewhere in this Bulletin).

The last item was the election of officers and Council members. In addition to Harry Schimanski, Steve Aldhouse had also tendered his resignation. Since two nominations, Nick Hudson and Malcolm Mackley, had been received, Roy Carter was left feeling sorry for the number of trees which had been converted into the stack of voting slips he had prepared, while the rest of us were glad that the meeting had finished at 18.15 without the delay of vote counting. Then it was a short trip on the thoughtfully arranged bus back to Pollock Halls to get ready for the Banquet.

A wearing day.

Phil Banfill

OFFICER'S REPORTS

PRESIDENT

1989/90 has been a mixed year, dominated by the Golden Jubilee Meeting and 3rd Meeting of European Rheologists. However, other Conferences have been uniformly successful and the Council has worked well together, but difficulties have arisen due to the pressure of other duties on Council officers. We must now ask ourselves if it is fair to expect Council office holders to take on the additional burdens we impose on them without some secretarial assistance. This inevitably means providing a reasonably substantial budget to the Membership Secretary, Secretary, Abstracts Editor and Bulletin Editor. It is the main reason for the Council approaching the A. G. M. with a proposal to increase the subscription to £15. Our financial position appears sound at present but looking to the next five years the £15 fee would let us hold this amount steady and avoid the problems caused by too frequent, smaller changes in subscription. We would be well placed to develop our services to members and we would hope to introduce new initiatives over the next year or two. Moreover, there is no guarantee that our income from Rheology Abstracts will continue. But for the strenuous efforts of our present Abstracts Editor, the Society might well have lost this major source of income last year.

As this is my last Presidential year I would like to record my thanks to Council Members for their unremitting support. This has made my tenure of office a great pleasure.

Jim Ferguson

HONORARY SECRETARY

Over the past year, the Society has again been very active in organising Meetings on a variety of subjects.

"Rheology of Food, Pharmaceutical and Biological Materials" at Warwick University in September 1989 was well attended, and covered a wide range of topics. The meeting was organised by myself, with help from Geoff Brownsey and Ralph Oliver. The Proceedings of this meeting were published last week.

"Rheology of Fresh Cement and Concrete" was organised by Dr Phil Banfill and his team, at Liverpool in March 1990, and was also successful with an impressive international list of contributors and delegates. The Proceedings of this meeting have also been published.

"Rheology of Polymer Latices" was a one-day meeting held in London in December 1989. The number of people attending the meeting was well over 100, which was a tribute to Dr Hourston's organisation and to the interest in the topic.

The Society was also involved in the organisation of a meeting, "Polymers in Motion", at Cambridge University in December 1989, and jointly with the Society for the Chemical Industry and the Institute for Food Science and Technology in May 1990 at Sutton Bonington on on-line rheometry in food processing.

I think that it is a healthy sign that the organisers are now trying to publish the proceedings of international conferences. After all, a lot of work goes into assembling delegates and papers representing the state-of-the-art in a given field, and I have always felt that it is a great pity if all of this knowledge is not recorded for posterity. Additionally, of course, the Society benefits from royalties on the sale of the proceedings!

For the future, after this present and magnificent Golden Jubilee Meeting, there will be a meeting on "Elongational Viscosity in Industry" at Strathclyde University on March 13th, 1991, and this is being organised by Dr Jim Ferguson. I am organising the annual meeting for 1991 which will be entitled "Engineering Rheology", and will be held in September, possibly in Bristol. Contributions for these two meetings would be gratefully received.

Beyond these meetings, the Council had a brain-storming session recently, and came up with a wealth of suggestions for future meetings. Naturally, any suggestions from the members would be greatly welcome.

The Society was bequeathed £10,000 by Mrs Scott Blair, wife of the late Founder. This sum was to be used for the upkeep of the Scott Blair Collection at the University College of Wales at Aberystwyth. £2,000 has already been passed to the Library there to fund the re-siting of the Collection from the archives to a more accessible part of the Library. Donations of books from authors would be a useful way of keeping the Collection up-to-date, and any such donations should be sent to Dr W. M. Jones, who has kindly agreed to sift any material destined for the collection in order to avoid duplication.

We still have a stock of the Olde Original British Society of Rheology ties, with a blue or a grey background, and these are available from myself at a price of £5.75 including VAT at meetings, or £6.33 by post within the UK.

This is my final report as Honorary Secretary, as I have been in the post for four years. It has been a privilege to serve the Society during the run-up to this Golden Jubilee celebration, and I hope that my successor as Honorary Secretary finds the post as interesting and challenging as I have done.

Roy Carter

ABSTRACTS EDITOR

The journal has had a relatively successful year during which many changes have been made both to its style and presentation. It was obvious to me last year that our existing publication procedures were in need of updating and I am extremely grateful to Pergamon Press for providing funds to enable the streamlining of this operation. I hope that the changes that have already been instigated, such as a subject index in each issue, are welcome and that those to follow, including reviews of recently published books and conferences will help to make the journal's coverage of rheology both relevant, comprehensive and up to date.

I must however, apologise for the rather inconsistent publication cycle, this will be remedied from the end of 1990. Thereafter, it is my intention that Rheology Abstracts be published quarterly rather than the situation that exists at present, namely, four times a year. All members

should receive the last two issues (3 and 4) of the current volume before the end of the year.

Problems of obtaining abstracts still exist and I think this is in some way reflected in the steady decline in the number of journals that Rheology Abstracts, through its members, has access to. In 1968 this was 102 whereas by 1988 this had fallen to 47. Please, if you are able to provide material that you consider should be included in Rheology Abstracts, forward it to me and if this can be done on a more routine basis then so much the better.

Finally, I would like to thank all those members who have contributed to the journal over the past year. Believe me, your efforts are much appreciated, both by me and I hope by fellow rheologists.

Geoff Brownsey

MEMBERSHIP SECRETARY

The membership of the British Society of Rheology at the end of July 1990 stood at 752. The table below summarises the changes during the past year. This list includes only those members on the active mailing list whose address is known and was updated in July in preparation for the publication of a new membership list which I hope to print and issue to members before the year end.

	UK	Overseas	Total
Membership July 1989	481	207	688
New Members	54	18	72
Resignations	5	0	5
Deaths	3	0	3
Net moves UK/Overseas	0	0	0
Net Change	46	18	64
Membership July 1990	527	225	752

Because of changed responsibilities in my work I regret that I am no longer able to devote the time needed to do the Membership Secretary's job as it should be done and I have decided to stand down a year early. I have enjoyed my term of office and look forward to helping the new Membership Secretary to take over as smoothly as possible.

Harry Schimanski

BRITISH SOCIETY OF RHEOLOGY

REVENUE ACCOUNT for the year ended 30th June 1990

Expenditure	1990	1989
Council Expenses	3,631	2,782
Bulletin Production Costs	4,626	3,624
Expenditure by officers		
Secretary	117	255
Treasurer	16	13
Membership Secretary & Circulation	<u>1,426</u>	<u>1,160</u> 1,428
Professional fees	176	167
Insurance	105	80
Awards	1,468	310
Miscellaneous	284	17
Depreciation		
Wordprocessors	905	155
Students Grants	—	600
	<u>12,754</u>	<u>9,163</u>
Excess of Income over Expenditure	<u>4,659</u>	<u>3,408</u>
	<u>£17,413</u>	<u>£12,571</u>
Income		
Annual Subscriptions & Entrance Fees	1,967	2,368
Publisher - Rheology Abstracts	3,490	3,327
Advertising	2,850	1,790
Bulletin Subscriptions	279	200
Sale of Ties	53	92
Bank Deposit Interest	2,928	2,597
Conferences - Net surplus per account below	<u>5,846</u>	<u>2,197</u>
	<u>£17,413</u>	<u>£12,571</u>
Conferences Account		
Surplus or (Deficit) after expenses		
Liverpool	3,451	—
Lancaster	732	—
Egham	—	1,938
Warwick	1,663	(90)
Birmingham	—	349
	<u>5,846</u>	<u>2,197</u>
	<u>£5,846</u>	<u>£2,197</u>

MEMBERSHIP NEWS

The following applications for membership were approved at the Council Meeting, September 6, 1990.

Mr M. A. Conway
Bohlin Rheologi UK Ltd.,
Blackstone Rd.,
Huntingdon.
(feab ABCDEFGHIJKLMNOP)

Mr J. Dale
Devro Ltd.,
Moodiesburn,
Glasgow.

Mr P. D. Doody
National Starch & Chemical Co.,
Slough,
Berks.
(feta CDG)

Mr S. Eggen
Statoil,
N-3960 Stathelle,
Norway
(fetsa D)

Ms L. A. Grace
Astor Chemical Ltd.,
Tavistock Rd.,
West Drayton,
Middx.
(pea DFG)

Dr I. F. Guthrie
Albright & Wilson Ltd.,
Whitehaven,
Cumbria.
(petsa FG)

Dr D. Hayes
Unilever Research,
Port Sunlight Lab.,
Bebington,
Merseyside.
(fetsa DFG)

Mr A. Heritage
Bohlin Rheologi UK Ltd
Blackstone Rd.,
Huntingdon.
(feab)

Mr A. Hoddle
Unilever Research,
Bedford.
(fetsa FGL)

Mr T. Holz
Physica GMBH
Vor dem Lauch 80,
Stuttgart.
(fesa LMN)

Prof. J-F. Jansson
Royal Institute of Technology,
Stockholm,
Sweden.
(pesa C)

Dr C. Klason
University of Lund,
Sweden.
(fetsa BCDE)

Dr M. Lal
Unilever Research,
Port Sunlight,
Wirral.
(petsa DFGL)

Mr G. B. Lowe
Morton International Ltd.,
Coventry,
CV4 7EZ.
(peta GK)

Prof. D. J. Morantz
1 Chestnut Lane,
Sevenoaks,
Kent.
(petsa NCDEFG)

Mr A. W. Mortimer
Smith & Nephew Medical Ltd.,
101 Hessle Road,
Hull.
(petsa DFG)

Mr M. Padmanabhan
1390 Eccles Avenue,
Minnesota,
U. S. A. 55108.
(fetsa L)

Dr G. Robinson
Krüss (UK) Ltd.,
Carrington House,
Royston,
Herts.
(feta FGLM)

Mr D. A. Shedden
ICI Explosives,
Stevenston,
Ayrshire.
(pea BCH)

Dr R. M. Spiers
ICI Explosives,
Stevenston,
Ayrshire.
(peta BEGHO)

Mr A. Sztchlo
Unilever Research,
Bedford
(petsa EFGL)

Ms P. A. Walters
Sunderland Polytechnic,
Sunderland
(pesa GO)

DEATHS:

The deaths of C. C. Mill and M. M. Cross have been reported.

MALCOLM M. CROSS

Malcolm Cross, a good friend of many in the British Society of Rheology, passed away on the sixth of July this year. He will be remembered not only for his now famous flow-curve equation, but also as a gentleman by all who knew him.

Malcolm was always associated with the Manchester area. After attending Cheadle Hulme School, he obtained his London University External Degree in Physics in the city. After army service and a spell working in the Shirley Institute, he joined ICI Dyestuffs Division in April 1948 where he continued working until 1980. He worked initially as a colour physicist before joining the Polymer Characterisation Group where his interest in rheology began. Malcolm rose to the position of Research Associate in the company, a mark of rare distinction.

Malcolm's external reputation grew particularly in the 1960s with the publication of a number of important papers (see below). His interest in constitutive equations resulted in his finding his now famous equation that describes the viscosity shear-rate behaviour of an amazing number of systems. Its usefulness has been shown in *An Introduction to Rheology*, Chapter 2, by Barnes, Hutton and Walters, where we also show simpler forms of the equation that give other useful laws.

As well as an interest in equations, Malcolm's training as a physicist gave him an interest in careful measurement of flow properties. This is illustrated in papers published on polymer solutions and melts and also suspensions. Further he was interested in relating the measured flow properties to the microstructure whether it be as manifested in the molecular weight distribution of polymers or the interaction of particles.

The majority of Malcolm's efforts of course were "in-house" and hence not publishable. Nevertheless general comments emerged from the company to the effect that he had solved a series of important practical problems. He was interested also in inter-company / university contacts and via this interest was a founder member of the Non-Newtonian Club, an ad hoc group now associated with the SERC that meets from time to time to discuss topics of general interest.

On his retirement from ICI Malcolm continued his interest in Rheology by becoming a research fellow at UMIST. His efforts there were rewarded with a Ph.D in December 1986 for work on the rheology of glass fibre dispersions.

His extramural interests included photography, birdwatching and walking; the latter were closely linked with his love of nature. His colour transparencies won prizes in internal ICI photography competitions. Among his other interests were swimming and woodcarving, the latter demonstrating a combination of his exceptional manual dexterity and patience. His patience was also highly appreciated by those with whom he worked, especially those to whom he introduced the mysteries of

rheology. He was always thought of as a gentleman, and someone who a junior colleague remarked it was a privilege to work for. To his rheology colleagues across ICI he was known as a painstaking scientist who could always be relied on and was ever-ready to give help. His well equipped laboratory was known as a model of a good combination of external published work and practical usefulness to the company.

To those of us who knew him from Society meetings, Malcolm was a quiet man, but one who always had something useful to say. On a personal note, I last saw Malcolm walking his dog near his home, unfortunately I was in someone else's car and they were in a hurry so we couldn't stop — a pity.

Malcolm leaves a wife (Anne), and a daughter Heather and a son Simon — our sympathy goes out to them. We can assure them that their loved-one's memory will live on and be cherished.

Howard A. Barnes

PUBLICATIONS OF M. M. CROSS

"Rheology of non-Newtonian fluids. A new flow equation for pseudo-plastic systems." *J. Coll. Sci.* 20 (5), 417-37, 1965.

"Analysis of flowdata on molten polymer." *Europ. Polym. J.* 2 (3), 299-307, 1966.

"Analysis of flowdata on polymer systems under steady and oscillatory shear." *Polymer Syst. Proc. Annual Conf. BSR* 1966, pps. 263-73.

"Use of flow equation for the rheological characterisation of pseudo-plastic systems." *Soc. Chem. Ind. (London), Monograph* 1967. No 26, pps. 381-94, discussion pps. 395-6.

"Rheology of Viscoelastic Fluids: Elasticity determination from tangential stress measurement" *J. Coll. and Interface Sci.*, 27 (1), 84-90, 1968.

"Viscosity, molecular weight and chain entanglement (of polymers)." *Polymer*, 11 (5), 238-44, 1970.

"Kinetic Interpretation of non-Newtonian flow." *J. Coll. Interface Sci.* 33 (1), 30-5, 1970.

"Relationship between viscoelasticity and shear thinning behaviour in liquids." *Rheol. Acta* 18 (5), 609-14, 1979.

"Rheology of polyols and polyol slurries in reinforced RIM." *Poly. Mater. Sci. Eng.*, 49, 531-5, 1983.

"Rheology of polyols and polyol slurries in reinforced RIM." *ACS Symp. Ser.* No 270 (Reaction Injection Molding), 97-110, 1985.

"Techniques for the viscometry of suspensions." *Polym. Eng. Sci.* 26 (2), 121-6, 1986.

"Simple procedures for obtaining viscosity/shear rate data from a parallel plate viscometer." *Polymer*, 28 (3), 435-40, 1987.

RHEOGRAM

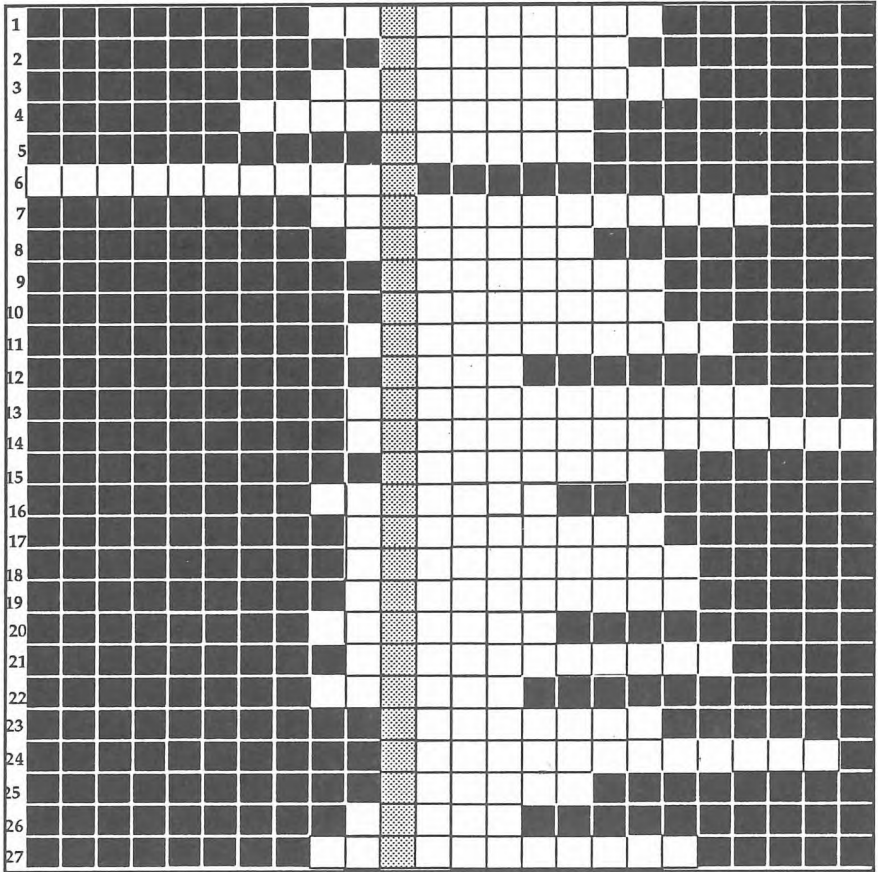
compiled by
G. H. Tattersall

The answer to each of the clues is a term used in Rheology and in most, but not all cases, the rheological reference appears in the clue. Enter the answers in the grid. The letters on the shaded bar, reading downwards, define another term that appears in B. S. 5168 Glossary of Rheological Terms. What is that term?

A prize of a BSR tie or a £5.00 book token for the first three fully correct solutions opened on or after December 15th 1990. Send entry to Dr G. H. Tattersall, 174 Millhouses Lane, Sheffield, S7 2HE. Envelope **MUST** be marked RHEOGRAM in top left hand corner. Photocopy of the grid and entry form is acceptable.

CLUES

- 1) Dance with a changed leader and to a different metre — but with an inappropriate instrument! (10)
- 2) Caught a European lark that lost a note in retreat. (7)
- 3) Sonia is disturbed to have cancer, possibly. (11)
- 4) Variable behaviour for man to disturb 'is shy sister. (10)
- 5) Scientist needs three points to begin negotiations for revised unit of mass. (6)
- 6) Poor chit taking in nine to tea, we are told, is upset and may become thinner. (11)
- 7) Reported to have taken legal action against love at 16. (13)
- 8) Sounds as if one may catch a Scot as a model. (7)
- 9) I listen to a song after illness, to achieve free movement. (8)
- 10) I land at Trondheim initially in a confused state, but expansive. (8)
- 11) It's a change to salute Cheri for promoting little Florence to the auditors. (11)
- 12) '... the father of Publius lay sick of a fever and a bloody — '(Acts - AV). (4)
- 13) A woman at fifty is very French on board ship. (6, 6)
- 14) May have a deleterious effect on the headmaster's hair. (9, 6)
- 15) Peerage whose leader retreats a step for ease of movement (8)
- 16) 'He fixed thee mid this chance of ——— circumstance'. (Browning) (7)
- 17) Fires the cops to control what sounds like dissent. (6, 3)
- 18) Sine qua non of a good investment. (5, 5)
- 19) Locus of resistance following its confused measure. (4, 6)
- 20) Poor actor accepts leading crooner as a model. (7)
- 21) Lair containing man-wolf is destroyed and rebuilt to minimise disturbance. (7, 4)
- 22) Part of a rotten sort of array. (6)
- 23) Eccentric tried Roman eggs in a mix. (8)
- 24) Sunset that inspired Newton? (7, 6)
- 25) Two pounds of matter? (6)
- 26) Egocentric pretence gives confidence. (5)
- 27) Internee shows hesitation to present popular song. (5, 6)



The term defined by the letters on the vertical shaded line is

NAME: _____

ADDRESS: _____

I am a member of the British Society of Rheology

signed: _____

I would prefer (please delete as appropriate) BSR tie (blue)/BSR tie (grey)/book token.

CONFERENCE ANNOUNCEMENTS

FIRST ANNOUNCEMENT

SEVENTH EUROPEAN CONFERENCE ON CLINICAL HAEMORHEOLOGY

The seventh of these biennial events will take place 16 - 19 July 1991 on the University Campus, Southampton. This is the only international meeting solely covering this field of research and is a major catalyst for stimulating the area. It is intended that it will provide wide ranging cover of all aspects of advance in the field. There are extensive facilities for trade exhibitors and a comprehensive social programme is being prepared.

For further details contact:-

Dr S. Roath, University Haematology, Room LF64, South Academic Block, Southampton General Hospital, Southampton SO9 4XY.

FIRST ANNOUNCEMENT AND CALL FOR PAPERS

INTERNATIONAL CONFERENCE ON ENGINEERING RHEOLOGY

The autumn meeting of the British Society of Rheology will be held in early September 1991 at a venue in the West of England (to be announced) and will have special emphasis on on-line process rheometry. Titles and abstracts of up to 200 words should be sent by February 28, 1991 to:

Mr R. E. Carter, Carter-Baker Enterprises, 2 Marshbrook Business Park, Marshbrook, Church Stretton, Shropshire SY6 6QE.

DIARY

DATE	PLACE	DETAILS
3-6/12/90	St. Etienne, France	'Experimental identification of the mechanical characteristics of composite materials and structures', contact: Prof. A. Vautrin, Dept. Mechanical and Materials Eng., Ecole des Mines de St-Etienne, 42023 St. Etienne Cedex 2, France.
7-12/1/91	Tucson Arizona U. S. A	'Third International Conference on Constitutive Laws for Engineering Materials: Theory and Application', contact: Prof. C. S. Desai, Dept. of Civil Engineering and Engineering Mechanics, University of Arizona, Tucson, AZ 85721, U. S. A.
15-17/1/91	Aussois France	'Response of shear flows to imposed unsteadiness', contact: Dr G. Binder, Institut de Mecanique de Grenoble, B. P. 53 X, 38041 Grenoble Cedex, France.
21-24/1/91	Villard-de-Lans France	'Extensional viscosity determination for the test polymer solution D5', contact: Prof. K. Walters, Dept. of Mathematics, UCW, Aberystwyth, Dyfed, U. K.

DATE	PLACE	DETAILS
8-11/4/91	Churchill College Cambridge U. K	'Deformation yield and fracture of polymers', contact: Conference Dept., Plastics & Rubber Institute, 11 Hobart Place, London SW1W OHL.
8-12/4/91	Sophia- Antipolis Nice, France	'International course on rheology, rheo-optics and processing of liquid crystalline polymers', contact: Dr Patrick Navard, Centre de Mise en Forme des Matériaux, Ecole Nationale Supérieure des Mines de Paris, Sophia- Antipolis, 06560, Valbonne, France.
21-24/4/91	Hamilton, Ontario Canada	Polymer Processing Society, Seventh Annual Meeting, contact: PPS-7 c/o Dept. of Chemical Engineering, McMaster Univ., Hamilton, Ontario, Canada, L8S 4L7.
13-15/5/91	Germany	German Society of Rheology, Annual Meeting, contact: Prof. K. Kirschke, Deutsche Rheologische Gesellschaft, Unter den Eichen 87, D-1000, Berlin 45.
16-19/7/91	Southampton U. K.	Clinical Haemorrheology, Seventh European Conference, contact: Dr S. Roath, University Haematology, Room LF64, South Academic Block, Southampton General Hospital, Southampton SO9 4XY.
15-18/7/91	Prague Czechoslovakia.	'Rheology of Polymer Melts', contact: PPM Secretariat, c/o Institute of Macromolecular Chemistry, 16206, Prague,
11-15/9/91	Capri, Italy	'International Conference on Dynamics of Polymeric Liquids', contact: Prof. K. Walters, Dept. of Mathematics, UCW, Aberystwyth, Dyfed, U. K.
15-18/9/91	Palermo, Italy	Polymer Processing Society, European Regional Meeting, contact: S. Piccarolo, Dipartimento di Ingegneria Chimica, dei Processi e dei Materiali, Viale delle Scienze, 90128, Palermo, Italy.
17-19/9/91	Leuven, Belgium	'Interfacial phenomena in composite materials '91', contact: Janet Miles, Conference Organiser, IPCM '91, Butterworth-Heinemann Ltd., PO Box 63, Westbury House, Bury Street, Guildford, Surrey GU2 5BH,
Sept. 1991	To be announced	International Conference on 'Engineering Rheology', Autumn meeting of the British Society of Rheology. contact: Mr R. E. Carter, Carter-Baker Enterprises 2 Marshbrook Business Park, Marshbrook, Church Stretton, Shropshire SY6 6QE.
17/10/91	London, U. K.	'Rheology of Building Materials', contact: R. J. Mangabhai, TH Technology, Maple Cross House, Denham Way, Rickmansworth, Herts.

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FRANÇAIS, ANGLAIS, ALLEMAND, ESPAGNOL
1990

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This dictionary is a selection of terms in current use in the field of rheology dealing mainly with relations between strains and stresses inside matter in isothermal conditions, although notions belonging to the other component also appear in it.

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In the body of dictionary terms are ranged into four columns each in one language and on the same line one finds the equivalent terms in each language.

These terms are distributed among six chapters ranged by degree of complexity.

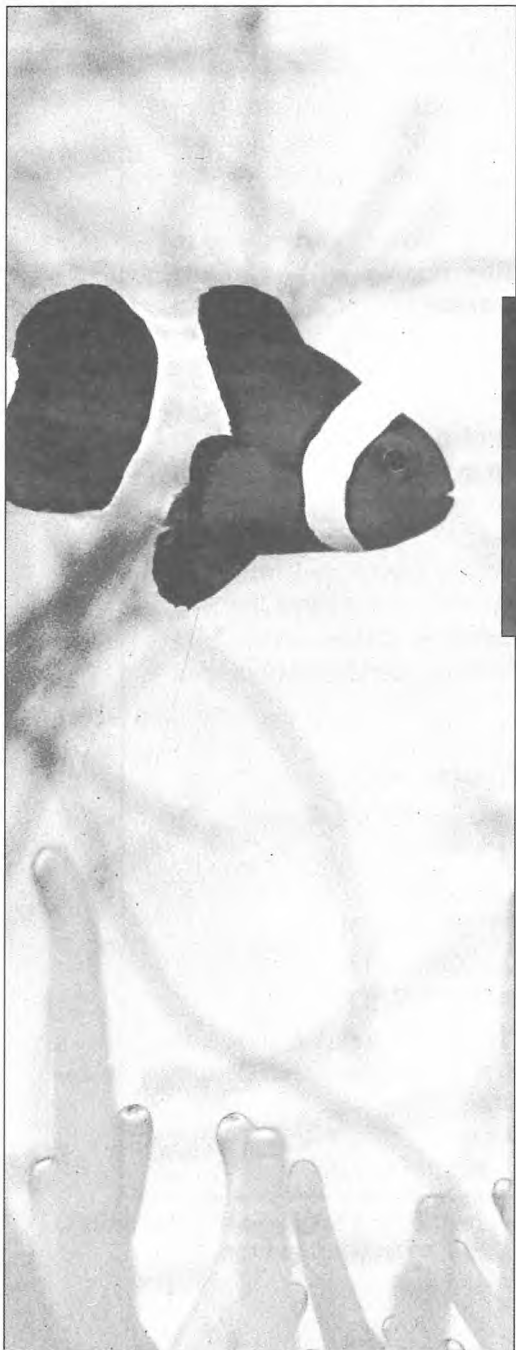
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II: RHEOLOGICAL BEHAVIOUR
III: ELASTIC BEHAVIOUR
IV: VISCOUS BEHAVIOUR
V: VISCOELASTIC BEHAVIOUR
VI: PLASTIC, ELASTOPLASTIC,
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Président of the French group of rheologists

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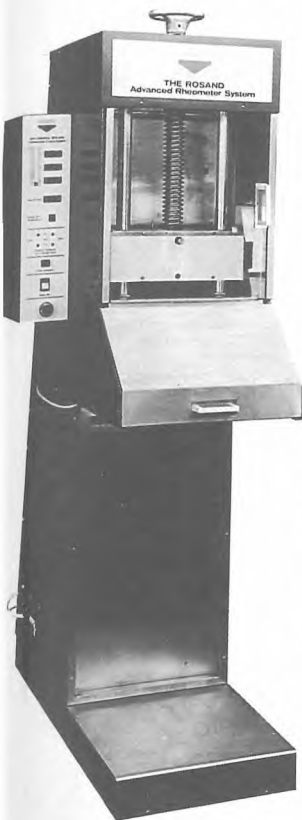
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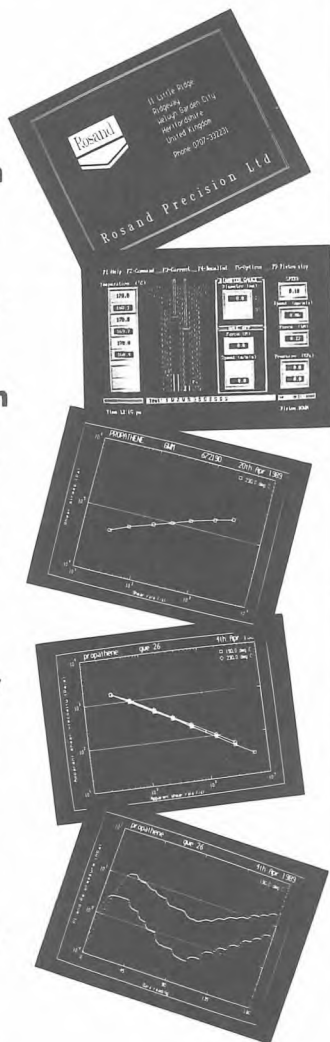
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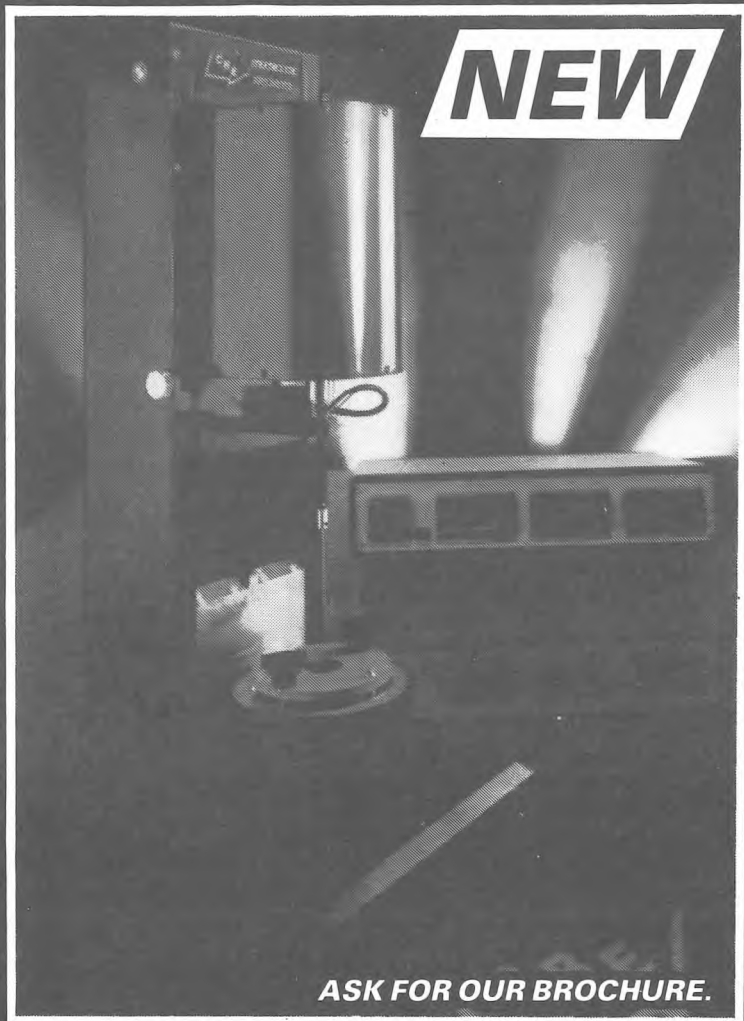


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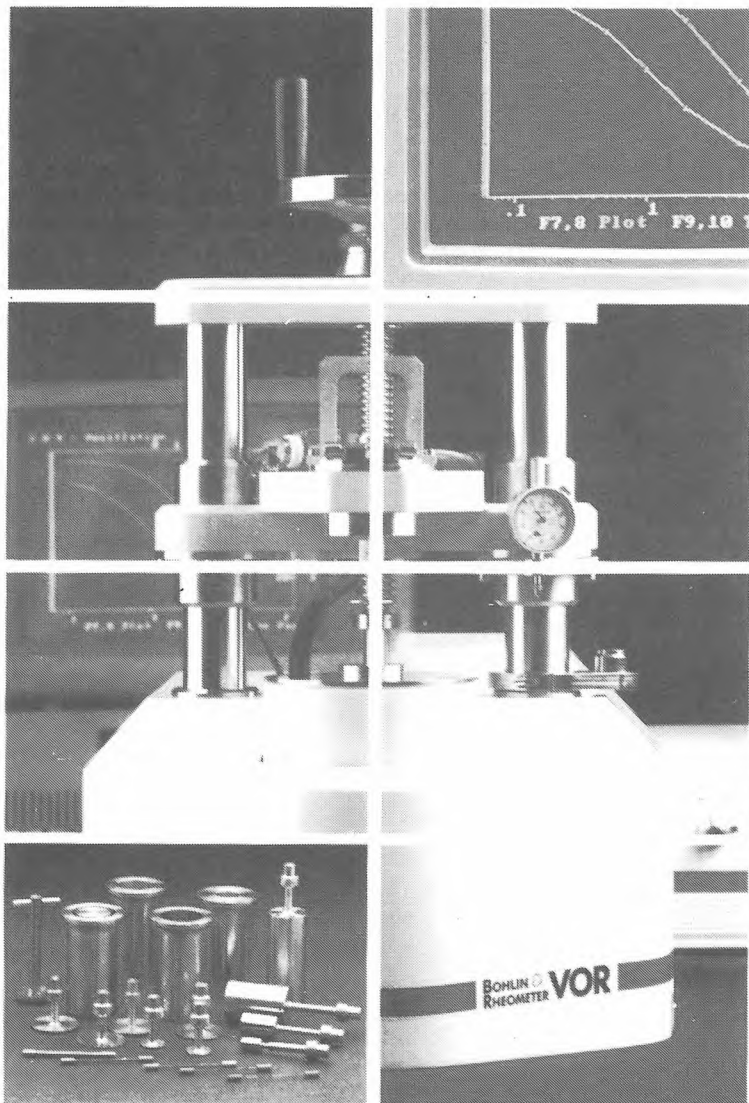
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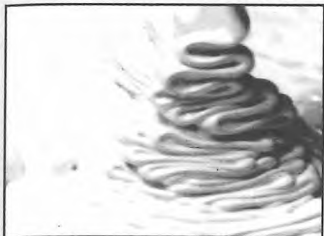
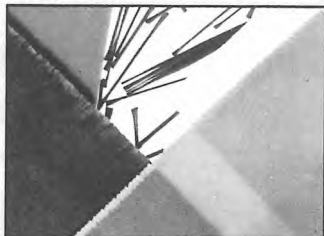
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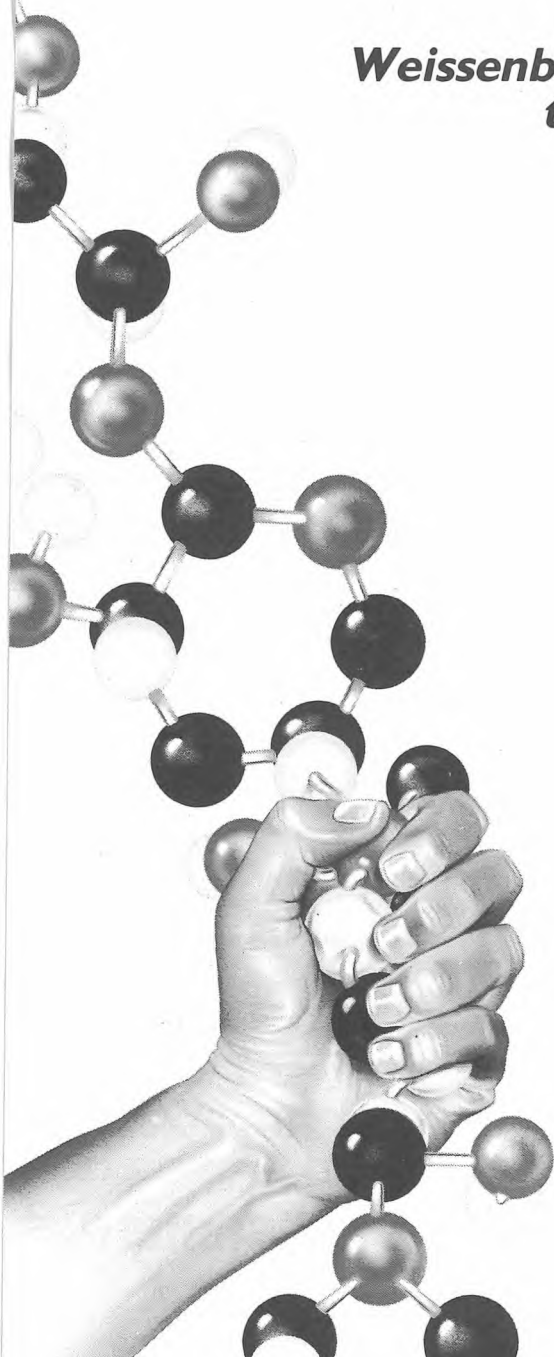
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