

THE BRITISH SOCIETY OF RHEOLOGY

BULLETIN



1991, Vol. 34 No 2

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THE BRITISH SOCIETY OF RHEOLOGY
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1990/91

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By the time members receive this issue of the Bulletin final details of the Autumn Meeting of the Society will have been sent out in a separate mailing. I would urge members to attend this meeting and to foster that personal contact on which the success of the Society depends. Please note also the date and time of the Annual General Meeting for which the necessary notice and minutes are in this issue.

Looking ahead somewhat, this issue also contains a call for papers for the 1992 Autumn Meeting and the conference diary has preliminary information on other meetings in 1992 and 1993. Please note the dates and topics.

In the last issue I mentioned the Society's two working groups. Please note that Howard Barnes, Unilever Research, is convening the group which is considering whether there should be more openness about the computer software employed by manufacturers of instruments to convert raw measurements to rheological parameters. If members have any views on this topic please contact him.

Copy date for next issue: September 15th.



ELECTRORHEOLOGY

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INTRODUCTION

The electrorheological (ER) effect describes the phenomenon in which the resistance to flow or to deformation of certain types of fluid can be changed by the application of an electrical field. Winslow¹ was credited with first describing the effect when he applied strong fields to non-aqueous silica suspensions which had been activated by a small amount of water.

Industrial interest in the application of ER fluids has grown at a remarkable pace during the last decade but, quite naturally, the rate at which information is reaching the open literature is falling because of the associated commercial sensitivity. A recent review by Jordan and Shaw² outlined not only the advantages of using ER fluids in mechanical devices but also highlighted the need for a closer assessment of the — +
fundamental principles involved in the ER effect. It is certainly true that in order that ER fluids may be used more successfully and reliably than hitherto, greater effort is required to understand the physical and chemical nature of the effect.

Since Winslow's discovery, many investigations have taken place into this dramatic reversible rheological change in a very wide range of ER fluids when electrically stressed. Block *et al.*³ have compiled an authoritative list of such fluids. Essentially all the fluids comprise a dielectric oil and a dispersed particulate. On application of an electrical field the solid phase forms chains roughly orthogonal to the electrodes (Figure 1) thus producing a pronounced structural inhomogeneity.

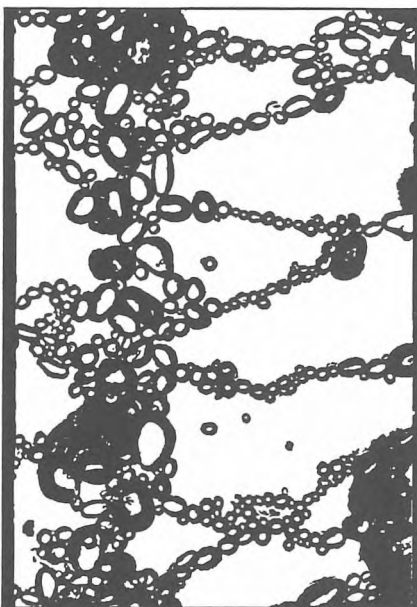


Figure 1. An ER fluid stressed by a D. C. field of 2 kV/mm. Electrode positions indicated. Particulate size in range 5 to 50 μ m.

There are, at present, several main areas of (potential) application of ER fluids and these are those associated with torque transmission, vibration damping, control of fluid flow and the general area of robotics. However, there are a multitude of other possible areas in which the objective is to control the response of a mechanical system in a manner which is intrinsically less complicated and less demanding in power than more conventional ways.

The results of some of the above applications have proved however rather disappointing, particularly in what might be generally described as heavy-duty automotive or industrial areas. This has occurred for four main reasons:

- (i) the inadequacy of the fluid strength when electrically stressed
- (ii) the relatively large fluid viscosity when electrically unstressed
- (iii) the increased electrical power consumption with increasing fluid temperature (typically doubling for a 6°C rise in temperature), and
- (iv) the limited operating temperature range of some fluids.

Worldwide efforts are being directed towards the solution of these problems and at the time of writing prospects look extremely promising.

PRINCIPLES AND POSSIBLE EXPLANATIONS OF THE ER EFFECT

As outlined above, the ER effect is evident as a rapid solidification (typically taking around a millisecond) of a two-phase fluid when stressed electrically by fields in the range 2 to 6 kV/mm, either D. C. or A. C.. The solid phase is typically in the size range 2 to $20\mu\text{m}$ and the liquid needs to be low in electrical conductivity. In shear, the fluids behave in a manner similar to that exhibited by a Bingham plastic in which flow occurs only after the imposition of a stress greater than the yield stress. In tension or compression the fluids behave rather more as though they exhibit a two-valued viscosity, one at small strain rates and another at higher strain rates. Typical static yield stresses at 20 kPa in shear and 50 kPa in tension or compression.

This so-called 'apparent

viscosity' of electrically stressed ER fluids is seen to increase with field strength and solid phase volume fraction (Figure 2) but to decrease with increasing shear rate. With

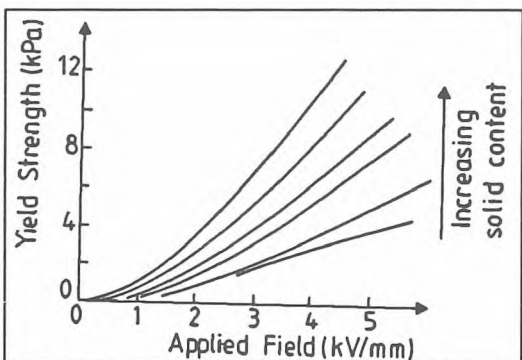


Figure 2. The effect of solid content and applied field on the yield strength of a typical ER fluid.

increasing temperature (Figure 3) it is normally found that the effect initially increases and then decreases. Because of the desirability, in commercial devices, of maintaining a low power consumption, ideally devices need an ER fluid which has a low bulk electrical conductivity. It is for this reason that much of the research effort currently in electrorheology is being directed towards chemical aspects of fluid development.

The need for a wider range of operating temperatures (preferably from -30°C to 140°C)

implies that ER fluids should be essentially 'dry'. The role of water has been the cause of much enquiry over the last few years since it has been shown by Yu *et al.*⁴ that for some fluids the ER effect increases to a maximum with increasing moisture content but then decreases with the further addition of moisture. However, the presence of water can often pre-dispose ER fluids to problems of electrical breakdown as well as equally undesirable effects associated with corrosion. Two possible reasons why the addition of water can enhance the ER effect are:

- (i) water might provide the carrier for mobile ions and the consequent creation of interfacial polarisation between the solid constituents, and
- (ii) the water might increase inter-particle activity because of increased particle permittivity. Block *et al.*³ have also investigated the effects of liquids other than water.

With regard to explaining the mechanism of the ER effect, Jordan *et al.*² provide a useful summary of some highly plausible alternatives and these are broadly classified into three main areas:

- (i) particle double-layer overlap and deformation
- (ii) simple particle field-induced alignment, and
- (iii) particle interaction

With regard to the first, the increase in mutual interference between double layers could explain the increased apparent viscosity but not yield stress. Also it is difficult to assess the attributes of the double layer since apparently those ions producing the thickest double layers also have the

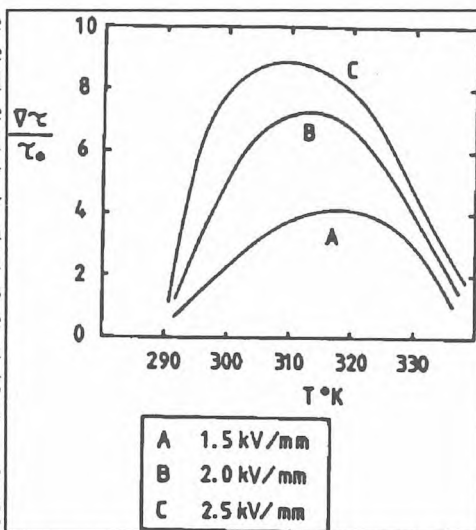


Figure 3. The effect of temperature on the change in non-dimensional shear stress.

greatest affinity for water. With regard to the second alternative area, it is well known that an increase in viscosity can be explained by field-induced particle alignment. However, whereas an increase in viscosity has been observed experimentally the second theory can predict no increase when spherical particles are employed. Finally, with the third alternative, the chain-building times are several orders of magnitude longer than the response time of ER fluids, so particle interaction *per se* cannot fully explain the effect.

THREE INDUSTRIAL APPLICATIONS

TORQUE TRANSMISSION

A recent experimental investigation by Sproston *et al.*⁵ was concerned with the measurement of the transmitted torque across a multiple-plate fluid coupling (Figure 4) specifically designed so as to allow the utilisation of an ER fluid instead of the conventional hydraulic oil. The device consisted essentially of 27 pairs of disc-shaped electrodes arranged in such a way that the alternate discs were carried by the central shaft and outer casing respectively. Particular attention was paid to ensuring equal gaps between adjacent electrodes. Electrical insulation between the outer (live) casing and the earthed central shaft was achieved by machined PTFE end caps.

Figure 4. A multi-electrode torque coupling device.

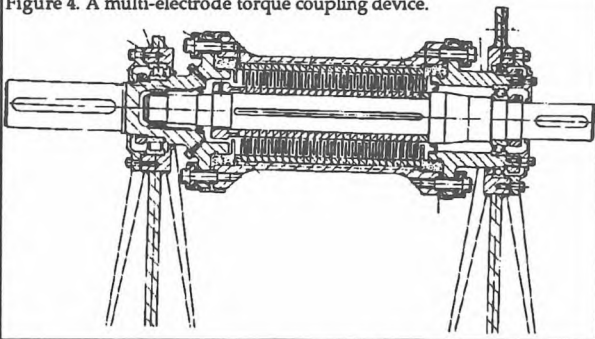
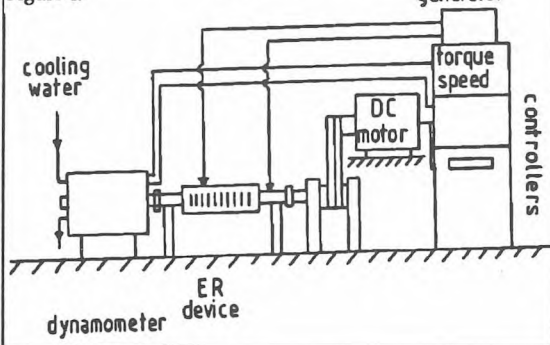


Figure 5 Torque measuring rig for device in Figure 4.



The device was mounted in a test facility (Figure 5) which facilitated the measurement of transmitted torque and the simultaneous measurement of device output speed, for a range of input speeds. Electrical excitation of the fluid was achieved by means of a spring-loaded carbon brush in contact with the outer

casing. In this way the fluid, in the inter-electrode spaces, could be energised with various electrical waveforms by means of a signal generator and high voltage supply.

It can be seen in Figure 6 that the device, when energised with a 50 Hz sinusoidal input signal of 3 kV r.m.s. between adjacent plates, is capable of transmitting a maximum torque of some 8 Nm when the input speed is 1500 rev/min. This torque is about an order of magnitude greater than that measured with no energisation. Also the fact that the output speed can be easily changed by a change in the electrical field strength makes the device an extremely versatile variable-speed coupling.

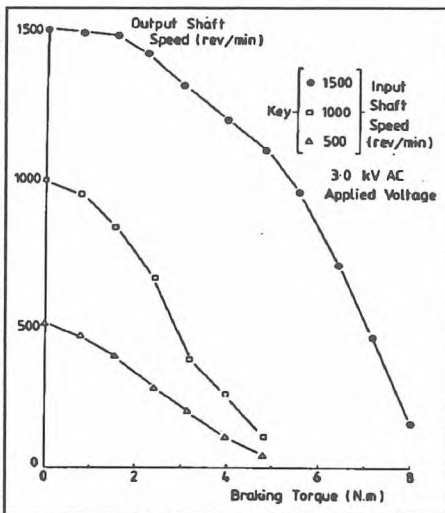


Figure 6. Speed-torque characteristics for device in Figure 4.

VIBRATION CONTROL

A simple (ER) vibration damper was built by Stanway *et al.*⁶ which consisted (Figure 7) of a nest of concentric cylinders forming the piston which was constrained to move in a vertical cylinder. As the piston reciprocated the ER fluid was forced through the annular spaces across which there was an imposed electrical field. The resulting increase in apparent viscosity of the fluid could thus be employed to control the flow rate of the fluid and hence the vibration damping characteristic.

For a sinusoidal mechanical input the response of the device can be seen in Figure 8 where attenuation of the displacement of the piston is shown as a function of the

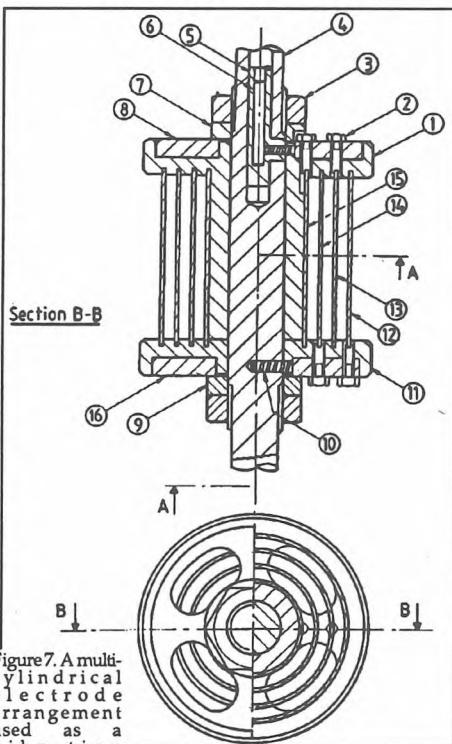


Figure 7. A multi-cylindrical electrode arrangement used as a vibration damper piston.

mechanical excitation frequency. As the applied potential is increased from zero to 5kV, so the attenuation of the output displacement increases, reaching a maximum attenuation ratio of about 13 to 1 at a forcing frequency of 3Hz. Thus the device is capable of providing a continuous variable damping characteristic as a function of the applied field. The device can be incorporated into a closed-loop system and is capable of providing a real-time control of damping

FLOW CONTROL VALVE

The feasibility of controlling the flow rate of an ER fluid in an hydraulic circuit was demonstrated by Stanway *et al.*⁶ in a simple prototype ER valve, the cross-section of which is shown in Figure 9.

Referring to Figure 9, it is seen that the valve consists essentially of a set of co-axial metal cylinders with a radial clearance of 5mm, held in position by perforated PTFE end-caps. The cylinders are raised alternately to zero and some high potential and can thus locally subject the flowing ER fluid to any desired distribution of electrical field strength.

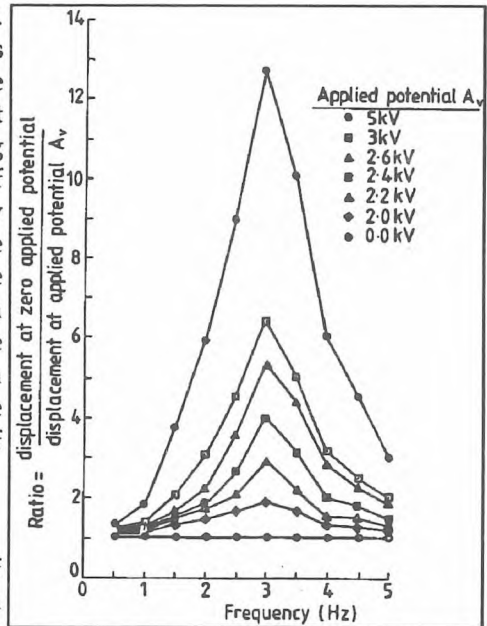


Figure 8. Frequency response of device in Figure 7.

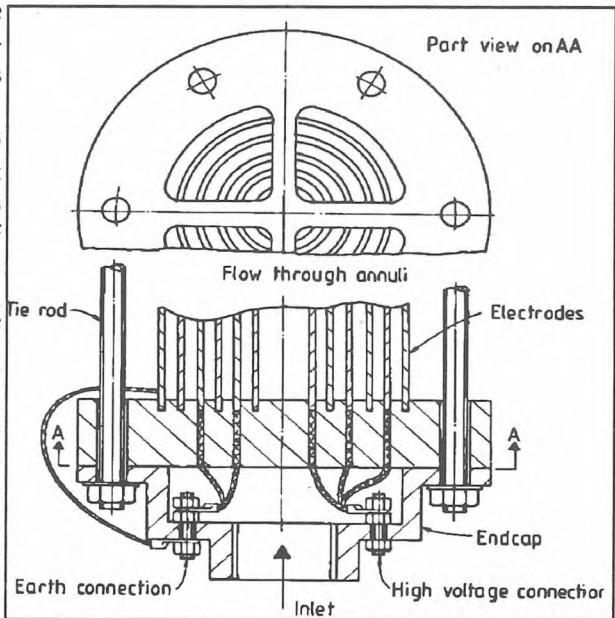


Figure 9. A multi-cylindrical electrode valve.

In Figure 10 it can be seen that the pressure drop across the valve increases with field strength, but decreases slightly with increasing flow rate. This type of valve can not only control the flow rate of electrically-active fluids but can also be used in place of a servovalve for the control of more conventional hydraulic

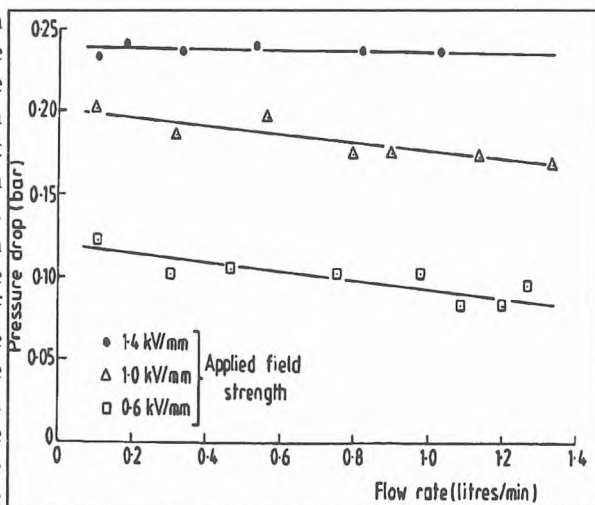


Figure 10. Pressure drop/flowrate characteristics for device in Figure 9.

Besides the present arrangement of co-axial cylinders, there are numerous other electrode configurations in which the applied field is orthogonal to the local flow direction. These have been extensively patented, e. g., automotive engine mounts, but all are essentially control valve applications in which flow rate (and therefore pressure drop) can be controlled by the applied field.

CONCLUSIONS

The increasing interest currently being shown in the commercial exploitation of ER fluids arises mainly from the successful development of fluids which are chemically stable and which combine the attributes of low conductivity and low moisture content. Coupled with a wider operating temperature range the future for electrorheology has never been so bright.

By its very nature electrorheology is a multi-disciplinary topic, particularly in the specific region of the interface either between the dispersed solid phase or between the solid phase and the energising electrodes. There is a need for collaboration not only in the modelling of dynamic systems where the ultimate intention is to control the output, but also in the physical and chemical sciences where underlying fundamental principles of the ER effect are considered. The rapid response of an ER fluid to an electrical signal opens up a wide range of device possibilities but the control strategies need detailed analysis and the significant non-linearities require careful analysis.

Although the subject has been in existence for a long time, there are obvious areas which have received little or no attention. In this respect, much, we believe, can be gained from the experiences of the rheology of electrically inactive fluids.

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- ⁶ R. Stanway, J. L. Sproston and R. Starkey, 'On the design of force actuators and sensors using electrorheological fluids', *Proc. 2nd Int. Tech-Transfer Congress, Actuator 90*, Bremen, Germany, June 1990.

OPUS 91A

Written in response to the news that the British Society of Rheology proposes to publish a Handbook with the object of explaining rheological terms to those previously unacquainted with the subject.

Heracleitus' 'panta rhei'
Is still applicable today,
But men came to realise
It's not enough to generalise
Exact relations are required
Or, at least, are much desired

In the service of this cause
Hooke and Newton stated laws
To stress proportionally relate
Either strain, or else strain rate
One constant only, no verbosity
Elastic modulus, or viscosity

Representation was the thing
Liquid dashpot, solid spring,
So all was simple, but alas,
Simple systems cannot last
Experience produced determination
To introduce some complication

Elements could be combined
By anyone who felt inclined
In a series or a parallel
And lots of other ways as well
Kelvin, Maxwell, others too
Had to see what they could do

Enter another mystery
Dependence on strain history
Thixotropy and hysteresis
Subject work of many a thesis
Then crisis came with the decision
To hand things to the theoretician

So vectors came to tax the brain
 But not just in a single plane
 To all the simple chaps' dismay
 They found, considering affray,
 An understanding of a tensor
 More difficult than joining MENSA

And so rheologists now find
 Industrial blokes are left behind
 When testing concrete, grease or cheese
 They poke and prod and smell and squeeze
 And then they make a guess inspired
 And hope they're right, or else they're fired.

G. H. Tattersall

ELONGATIONAL FLOWS AND THE CASE OF THE MISSING INDUSTRIALISTS

Holmes put down his copy of the Bulletin of the British Society of Rheology (volume 34, number 1), sniffed dispassionately, and reached for his pipe. I could tell that his great brain was occupied by the problem that I had drawn to his attention.

"It's a poor show these stone age industrialists letting down our starry eyed academics by not attending the meetings that they organise," I ventured. "Imagine what the poor devils must be up against when industrialists are so backward. No wonder that the country is going to the dogs!"

"This case" observed Holmes "has certain similarities with that of the dog that barked in the night."

Sometimes Holmes could be confoundingly oblique and I pressed him to explain further.

Holmes fixed me with a tired look. "But the solution, my dear Watson, is to be found within the very pages of this remarkable document. This excellent comment on the 264th Council Meeting, written with candour and imagination in a style that reminds me of the reports of parliament in an 18th century magazine, explains what are perceived to be the facts of the situation."

"The facts, Holmes," I interrupted, "are indisputable. An important scientific meeting designed to explain how a better understanding of elongational rheology can be used to solve industrial problems was deliberately sabotaged by industrialists failing to attend."

"The facts" observed Holmes dryly "are that this fellow Buscall is offering a second-hand elongational viscometer for sale, and he is doing so in a subtle manner that means he does not have to pay for the advertisement. Secondly, he declares himself to be an industrialist."

"By Jove, Holmes" I declared "you've cracked it: Buscall is the villain!"

"Not so fast Watson," Holmes continued, "from the text you will see that he had accomplices, who, like him, would not speak out in open forum."

"A conspiracy of silence!" I expostulated as I gazed in admiration at the great detective who could so easily penetrate the deepest mystery. "But" I ventured, "I still do not understand. Why were the industrialists too timid to speak out? Why should Buscall wish to sell his elongational viscometer? And what is the connection with the dog that barked in the night?"

"As to the timidity of the industrialists," observed Holmes, "the case is quite obvious. You will note that on page thirteen of this remarkable document there is a report on a meeting on Extensional Viscosity (the very same subject) held at the resort of Villard-de-Lans. Read carefully the opening paragraph wherein scientists are apt to declare their most important findings."

"The weather was sunny, the snow was white and powdery . . . ' Great Scott Holmes! This is startling stuff!" Remembering my scientific training in rapid reading I hastily scanned to the final sentence." "Should another meeting be held to discuss it?' What is it that is to be discussed — the whiteness of the snow? Gad Holmes, what is the meaning of this?"

Wearily Sherlock Holmes tore a spill from the journal and proceeded to light his pipe. Solemnly he puffed for a few minutes before turning to me. "The timidity of the industrialists who, I must remind you Watson, are the primary generators of the wealth of the nation is because they are too embarrassed to point out that, there are issues, such as the level of whiteness of the snow, which do not require further illumination so that they can be industrially useful. Now, as to the matter of the second-hand elongational viscometer for which Buscall seeks a buyer, it is clear that this is evidence that he is attempting to raise some monies in order to finance a meeting on a less exalted topic to be held in some exotic location like Widnes. Clearly this industrialist has no further use for elongational flow research and has some more important matter that he and his colleagues are vainly trying to raise."

This was too much for me. "My dear Holmes," I protested, "you cannot mean that elongational flow is not industrially important! And what is the connection with the case of the dog that barked in the night."

"Elementary, my dear Watson. In the case of the dog that barked in the night, you will recall that, on the night in question, the remarkable thing

was that the dog did NOT bark proving conclusively thereby that nothing happened. In this case there is a subtle difference: the complaint is that industrialists are so backward that they did not understand that this was a meeting which they should attend. Quite the contrary is the case. Any reading of the literature will show that some twenty years ago, before the subject became quite as fashionable in academic circles as it is today, industrial rheologists were urgently discussing such matters. Since Dr Buscall is willing to dispose of his elongational viscometer it is clear that he considers the research phase of this work to be complete and that such measurements are now routinely applied. You see Watson, the issue is not that the industrialists did not attend the meeting — they were there: it is simply a matter that the meeting was held twenty years too late."

"Great heavens, Holmes, you have done it again! I must write to the editor at once."

Sherlock Holmes knocked out his pipe in the fireplace. Slowly he turned upon me. "Save your scribbling Watson. You are too late already. You will notice that the timing of this Bulletin is most exquisitely arranged so that it arrives through our letter box on the very same day that the Editor describes as the copy date for the next issue. We just have time to catch the next train for Widnes where we shall undoubtedly learn what those matters are on which academics will be organising meetings in twenty years."

In this article I shall share some reminiscences which give a flavour of the Society in the sixties and early seventies.

In the fall of 1963, I and my wife drove from Canada, down through New England to Providence, Rhode Island, for my first international congress on rheology. I did not know that the B. S. R. had been attempting to arrange a charter flight for the event, but had failed because only three people had expressed interest in the trip! This was a period of erratic development by the Society, however, which in 1962 had 350 British members.

Topics covered by conferences were wide-ranging (emulsions, glasses, paints, fracture, lubrication, clays, powders and sugar cane crushing) so it is not surprising that the odd one fell by the wayside, such as Rheology of Metals in 1963 and Rheology in Aerospace Research in 1965. The latter was cancelled despite having had offers of 20 papers and a further 20 attendees — surely not sufficient cause for cancellation these days! In the same year, Scott Blair travelled to Paris to present a paper on dairy creams before the emergent Groupe Français de Rheologie. Back home, he wrote an obituary on founder member H. H. Lang which included the observation "his deep religious convictions did not allow him to travel by bus on Saturdays, so he would walk the four miles (to meetings) wet or fine".

In those days, New South Wales and Victoria were active branches of the B. S. R. and the Bulletin fully records details of their conferences and activities, with the Victorian Council normally recorded alongside the British. However, reports on the New South Wales branch dwindle until by 1971 it was stated that this branch was "virtually dead" although its sister branch was clearly thriving. By 1972, the Council was being listed as "Australian", though all the members came from Victoria. Things have now changed, the recent World Congress on Rheology having been held in Sydney.

A new constitution was adopted by the B. S. R. in 1966, and plans made for the design of an emblem. This first appeared on one side of the Gold Medal presented to Marcus Reiner at the Skindles hotel, Maidenhead in August, 1966. This was stated to "honour his eightieth year" and so made no reference to his wide-ranging work in the field of rheology! By 1967, the number of British members had risen to 500, and a detailed review of membership trends had been carried out by David Cheng and Denis Hadley. The views of theoreticians could perhaps be

summarised by a quotation from Longfellow (Ken Beazley):

"Use a vector or a tensor and you'll make him feel much denser" and the problems of the practical "men who know about flow" (Alan Haywood):

"When you shake the ketchup bottle, none'll come or else a lot'll"

In the same year, a Gold Medal competition took place for Applied Research in Rheology which produced seven papers of varied length and quality, but no award was made and the idea seems to have been dropped.

A Research Committee, chaired by Dr Roscoe and including Anthony Pearson, met six times in 1966 and 1967, but by 1971 the committee was disbanded on the grounds that the selection of Gold Medal winners was its only useful purpose. Talking shops beware! The highlight of 1968 was the International Congress on Rheology in Kyoto, Japan. A dedicated band of Britons met a larger group of Europeans in Frankfurt and then took the polar flight over the glinting awesome peaks of Alaska to Anchorage and Tokyo. In a dark alley in Kyoto we found a sign (in English) "Stranger, beware of the tempting lady who will smile at you from the doorway. Do not accept her invitation and avoid a dreadful experience. Signed Chief of Police". We wondered how he knew! Reg Meredith had his arm scalded by steam in the Japanese baths, which became a must for our contingent, including Ken Walters. The 1969 Gold Medal was awarded to Dowson and Higginson for their work on elastohydrodynamic lubrication: a bold move by the Council away from mainstream rheology. The Gold Medal paper was issued as a supplement to Bulletin 4 (1969).

The Council dithered in its first attempt to number the Bulletin: 1969 nos 1 and 2 were called "volume 1" but nos 3 and 4 were called "volume 12" and members were asked to change the volume numbers of the first two issues! The intention was to bring the sequence into line with that of the Abstracts, which started life as part of the Bulletin. Interestingly, a questionnaire in 1970 about the merits of a new international journal on rheology showed only 20 respondents in favour, 10 neutral and 41 against. Nevertheless the *Journal of non-Newtonian Fluid Mechanics* was first published six years later and has been an outstanding success. The abstracts were thriving at this time, 903 abstracts being printed between September 1970 and September 1971. The income from Pergamon press in 1971 was only £550, however.

A joint meeting with the Institute of Petroleum and the Institution of Mechanical Engineers in summer, 1972, was unusual in that the proceedings were published (non-standard for B. S. R.). Later that year, the International Congress took place at Lyon. I can still hear the

classical jingle which was played when speakers over-ran — and the laughter of the audience when John Hutton ignored it completely. And the food at Chez Henri was a big improvement on the fare on offer at the conference.

European developments occurred at this time: the first meeting of the Italian Society of Rheology at Sienna (1971) was followed by a joint meeting with the B. S. R. on rheometry at Shrivenham in early 1975. Another joint meeting between the B. S. R. and the Dutch Society of Rheology had been held at Lunteren in April 1973. We can certainly claim that our joint meetings, developed at this time, paved the way for the European meetings which began to slot between the International Congresses in 1982. At this time also, the Japanese Society of Rheology was formed by the amalgamation of the rheology committees of their Polymer Society and Society for Material Science.

Professor Weissenberg's 80th birthday was marked by the publication of a series of essays, written by eminent rheologists, on normal stress, elasticity, crystallography, biorheology, rod-climbing, the Weissenberg hypothesis, and the rheogoniometer. Perhaps somewhat eccentrically, these were published by John Harris in Nairobi!

Another watershed of this period was the report of the B. S. I. Committee on Rheological Nomenclature — there had been much discussion on this topic in prior years — and the first B. S. R. conference devoted largely to elongational flow. (Norwich 1973). This new subject was to increase in importance in the next few years. A further change in 1975 was to introduce camera ready copy production of the Abstracts, providing a large increase in publishing revenue with little loss of product quality.

The death of Sir Geoffrey Taylor at the age of 89 was marked by a full obituary in the Bulletin. Many people will have forgotten that he was the first President of the British Rheologists Club; his discoveries in applied mathematics, physics, engineering science and aeronautics make him one of the most notable scientists of this century.

In conclusion, I hope these notes have given some insight into the activities over quite a busy time when the Society's development continued steadily. I understand that a future article will bring the story up to date.

D. R. Oliver

RECENTLY PUBLISHED BOOKS

Physical networks: polymers and gels, W. Burchard, S. B. Ross-Murphy (eds.), Elsevier Applied Science, ISBN 1-85166-413-0, pp. 417, 1990, £70.

This book is based on a conference in West Germany in 1988 and is concerned with the structure and viscoelastic properties of cross-linked systems formed from synthetic and biological macromolecules. After an introductory review chapter by the editors the book is an account of the physics and chemistry of various network systems described by leading authorities in the field.

Measurement of Transport Properties of Fluids, Experimental Thermodynamics Volume III, W. A. Wakeham, A. Nagashima, J. V. Sengers (eds.), Blackwell Scientific Publications, Oxford, ISBN 0-632-02997-8, pp. 464, 1991, £75.

This volume in the *Experimental Thermodynamics* series continues the theme of the two earlier volumes by considering non-reacting systems and concentrates upon the measurement of properties characteristic of the relaxation of a fluid from a non-equilibrium state—the transport properties. The volume contains a valuable summary of a wide variety of experimental techniques applicable to the measurement of the transport properties of fluids and their mixtures including viscosity, thermal conductivity, diffusion coefficients, thermal diffusion factors and thermal transpiration coefficients.

Now available in Paperback. *Theory of Simple Liquids*, 2nd edition, J. P. Hansen, I. R. McDonald, Academic Press, Harcourt Brace Jovanovich, ISBN 0-12-323852-8, pp. 568, 1990, Paperback £24.50.

This book gives a comprehensive account of the theory of simple liquids. It presents the main ideas of modern liquid theory in a way that is both instructional and self-contained.

COMMENTARY ON 265TH COUNCIL MEETING

The sun was shining but there was a stiff breeze blowing from the Dee estuary as council members gathered at Ness Gardens, the University of Liverpool's Botanic Gardens in the South Wirral countryside of Cheshire. There was just enough time to see the late azaleas and the herbaceous borders and to pop into the conservatories before the start of the meeting. But where was David?

Having drunk coffee and admired the Bulletin Editor's complete collection of bound Bulletins, the Treasurer's gleaming new 'zapper' for embossing credit card payment slips, and the view from the conference room out over the gardens it was time to begin. But where was David?

Never mind, Tony's moment of glory comes when as elected Chairman he deputises for the President. This time the minutes have initials printed in the margin showing those members who were supposed to have taken action. Have I done it? What should I have done? Worry, worry. We have corrected the errors in the minutes when David arrives — a victim of the public transport from Liverpool main line station. (Everyone else came by car or on foot).

Everyone agreed that having initials for action is a good way of prolonging the meeting because it gives us a chance to go through the matters arising twice — once for the actions and once for other matters. However after over an hour we have discussed the problems of keeping track of reference collections of the Bulletin, *Rheology Abstracts* and running the Scott Blair Collection in a positive way. We fulminated on the trouble of keeping in touch with other societies and exchanging their bulletins. We grumbled about the quality of envelopes provided by the publishers of *Rheology* to send their magazine out with the Bulletin.

There was then enough time only to discuss David's suggestions for closer contact with the Society of Rheology before lunch. In future members would be invited to attend meetings of that Society in the U. S. A. on the way to or from their holiday in Disneyland and subsequently to make a report on the deformation properties of Mickey Mouse's ears for the Bulletin. Globetrotting members should look for further announcements.

After lunch in the restaurant, under the benevolent gaze of A. K. Bulley, founder of the Gardens and noted collector of plants, and his wife and daughter, who gave the Gardens to the University after his death, we returned to matters financial. Who haven't paid for their adverts in the Bulletin? How much can we afford in support of travel grants to students? Can we afford the present size and scope of the Bulletin? What will happen to the income from *Rheology Abstracts*

now that Robert Maxwell has sold Pergamon Press to Elsevier so he can try to buy a football club?

We saw the gift from the Czech Society of Rheology in thanks for our Golden Jubilee Meeting. This is a tool for pressing the Society's emblem into sealing wax —ideal for certificates. A suggestion that it might be used for embossing credit card payment slips was quickly suppressed. We heard about the new computer for membership records and admired Doug's printout folder. Now we just need to get the membership list up to date. With 919 files at five minutes each that works out at nearly 75 hours work. Who will do it?

By the time we have grumbled about the charges Universities make for conferences and considered every possible permutation of words derived from the roots experiment- rheometric- and measure- for the title of the next meeting we have arrived at an action plan for the next few years' meetings. What is so attractive about Cambridge?

The clock ticked on, the sunshine moved round so we could see David's expression instead of only the outline of his head, tea came and went, but still we had not discussed item 9, the Scott Blair Collection. Peter pointed out that accrued interest meant that we now have more in the fund than Mrs Scott Blair's bequest and we still have no acquisitions policy. Perhaps we should establish another office, that of archivist/librarian/ acquisition officer? At last we agreed to draw up a job description for consideration and at 5. 30 the meeting closed.

All that remained was for the local organiser to explain what rheology is to the office staff. Then I could walk home. Perhaps we'll hold meetings at Ness in June again, it's certainly convenient for me.

Phil Banfill

NOTICE OF THE ANNUAL GENERAL MEETING

The 51st Annual General Meeting of the British Society of Rheology will be held on Tuesday September 10th 1991 in Wills Hall at the University of Bristol, starting at 4.45 p.m..

Members are reminded that, under rule 7(b), the business of the meeting includes:

- (a) The election of Officers and Council Members for 1991-92.
- (b) The receipt of a report and audited accounts from Council.
- (c) Dealing with matters raised by Council or by any Member, and receiving suggestions from Members for consideration by Council.

Arising from Mr R. E. Carter's wish to stand down from Council there is a vacancy.

Nominations received to date are as follows:-

(President:	Dr D. C. H. Cheng)
Honorary Secretary:	Mrs C. A. Moules
Honorary Treasurer:	Mr P. C. Anderson
Membership Secretary:	Dr D. J. Hourston
Bulletin Editor:	Dr P. F. G. Banfill
Abstracts Editor:	Dr G. J. Brownsey

Ordinary Members of Council:

Dr R. Buscall
 Dr A. Evans
 Dr N. Hudson
 Dr M. Mackley
 Prof. P. Townsend

Nominations for Council or for any of the Offices are invited. Nominations should be sent to the Secretary or may be made at the meeting (see rule 5(b)).

The Secretary would be pleased to receive notice of any matter that any Member wishes to raise.

C. A. Moules
 Honorary Secretary

MINUTES OF THE 50TH ANNUAL GENERAL MEETING

Held on Thursday 6th September 1990 in The Appleton Tower,
University of Edinburgh

The meeting started at 16.45 hours with over 60 members present.

APOLOGIES FOR ABSENCE

Apologies had been received from S. T. Aldhouse.

MINUTES OF THE 49TH AGM

Mr Carter said that the Minutes had been published in Vol. 32, No. 4 of the Bulletin. Mr J. Hutton proposed that the Minutes be accepted as read. This was agreed and they were duly signed by the President.

MATTERS ARISING FROM THE MINUTES

There were no matters arising.

REPORTS OF THE OFFICERS

Dr Oliver asked if the subject of member's subscription could be discussed under the Treasurer's report. This was agreed.

PRESIDENT'S REPORT

This report was published in Vol. 33, No. 3 of the Bulletin. There were no questions.

TREASURER'S REPORT

The Treasurer, Mr P. C. Anderson, tabled the Audited Accounts for 1989/90 which were printed in Vol. 33, No. 3 of the Bulletin. He said that the Society was in a strong financial position with the income from advertisements in the Bulletin increasing such that the production costs would soon be covered. Income from Pergamon was down 10% but he hoped that with the new Abstracts Editor it would increase again. Subscriptions from members were down, approximately 400 members had paid up although there were well over 700 members registered. The subscriptions accounted for about 15% of the Society's expenditure.

Due to the large amount of money passing through the account from the Golden Jubilee Conference the Society had been obliged to register for V. A. T..

Mr Whorlow asked why there was no mention of the Golden Jubilee meeting in the present accounts. Dr Petrie said he had provided details up to the end of the financial year but the auditors had not included them. Mr Anderson said that until the proceedings are finished the

accounts are not submitted and this took the present meeting outside the 1989/90 financial year. Dr Evans asked for an approximate figure for the cost of the Golden Jubilee to the Society. Mr Anderson said that £5K had been spent on guests of other Societies. Dr Petrie said there was no cause for anxiety, the turnover had been in excess of £100K but he hoped to stay within the limit set by the Council.

Dr Cogswell proposed that the accounts be accepted and this was seconded by Mr Whorlow. There was unanimous acceptance. Dr Hourston proposed and Dr Ferguson seconded that Alfred Simmons & Co. be re-appointed as auditors. This motion was carried unanimously.

Dr Ferguson then introduced the motion put forward by Council, he explained the need to increase subscriptions. He said that the Society was living off the proceeds of *Rheology Abstracts* and conferences. There were difficulties with Pergamon and the Society was under threat from loss of income for the Abstracts. Pressure of work on officers had led to some jobs not being carried out as well as possible and paid secretarial help could have prevented this. The proposal from Council was "That the annual subscription be increased to £15.00".

A full discussion by members present ensued, mainly about the question of incentives to encourage payment by standing order, thus increasing the number of fees gathered automatically.

Mr Hutton suggested direct debit as an alternative to a standing order as this method covered the change in amount of annual subscriptions. Mr Carter pointed out that the bank made a charge for this service. Dr Evans proposed an amendment to the original motion which was that the annual subscription for those paying by standing order be increased to £10 and for the rest £15, commencing October 1st 1991. Dr Oliver proposed a second amendment that the annual fee should be £15 for those using the standing order method and £20 for the remainder. These amendments were seconded by Dr Cheng and Dr Cogswell respectively.

A further discussion on the position of foreign members who were unable to use the standing order method was led by Prof. Kemblowski. Prof. Wolfe pointed out that it was possible to pay for several years in advance. Dr Cogswell pointed out that it cost the Society more to mail foreign members. Dr John Hinch suggested that overseas members should pay the lower amount if the fee was received within the first two months of the year and then revert to the higher amount. Dr Petrie said he thought no increases for anyone should be made while the Society was in a healthy position.

Mr Carter then read out two letters from Mr Morgan and Dr Jobling who both argued against an increase. Dr Ferguson called for a vote on the second amendment, with Dr Cheng and Dr Mackley acting as

tellers. There were 13 for and 29 against. The motion was not carried. A vote on the first amendment gave a majority vote in favour 25 for and 13 against, thus ruling out the Council's original proposal. A final vote on whether the annual subscription should be increased as proposed by the first amendment was carried 36 votes to 8.

Dr Ferguson proposed and Dr Thompson seconded a motion to empower the Council to look at the position of annual subscriptions for overseas members and fix a suitable fee. The motion was carried.

MEMBERSHIP SECRETARY'S REPORT

Copies of the report were distributed and reproduced in Vol. 33, No. 3 of the Bulletin.

Mr Schimanski said that he was preparing a new membership list for publication and sending out demands for arrears of annual fees. Dr Cogswell pointed out that from the figures presented by the Treasurer 300 members were in arrears.

Mr Schimanski said that it might be necessary to consider the position of foreign members who were in arrears as postage was high, e. g. £1.78 to send a Bulletin.

ABSTRACTS EDITOR

This report was published in Vol. 33, No. 3 of the Bulletin. Dr Evans proposed a vote of thanks to Dr Brownsey for the vast improvement to *Rheology Abstracts* in 1990, which was endorsed by the meeting.

BULLETIN EDITOR

Dr Townsend said that the Bulletin was thriving, advertising had grown substantially and that if rates went up it would be self supporting. He said that the Bulletin was there to serve the membership and urged members to supply information such as conference dates and research assistant vacancies which would be published free of charge.

HONORARY SECRETARY

This report was published in Vol. 33, No. 3 of the Bulletin.

ELECTION OF OFFICERS

Mr Aldhouse, a nominee of the outgoing Council sent a message through Dr Ferguson, declining the nomination. Dr Ferguson proposed Dr Mackley in his place. Mr Carter seconded the proposal.

There were no other nominations from the floor and the Officers and Members of Council for 1990/91 were elected as follows:

OFFICERS

President	Dr D. C. H. Cheng
Honorary Secretary	Mrs C. A. Moules
Honorary Treasurer	Mr P. C. Anderson
Membership Secretary	Dr D. J. Hourston
Abstracts Editor	Dr G. J. Brownsey
Bulletin Editor	Dr P. F. G. Banfill

ORDINARY MEMBERS OF COUNCIL

Dr R. Buscall	Dr N. Hudson	Mr R. E. Carter
Dr M. Mackley	Dr A. Evans	Prof. P. Townsend

Dr Oliver proposed a vote of thanks to Dr Ferguson, the outgoing President. Dr Barnes proposed that this should be extended to include all members of Council. These received general acclaim.

ANY OTHER BUSINESS

Dr Ferguson said that Prof. Ivanov, from the newest rheological society, the Bulgarian Society, would present an illuminated address to the B. S. R. to commemorate its Golden Jubilee.

Mr Carter said the date for the 1991 AGM had not been set but that it would be in either the first or second week in September 1991.

There was no other business and the meeting closed at 18.00 hours.

Mrs C. A. Moules
Honorary Secretary

NEWS OF OTHER SOCIETIES

THE SOCIETY OF RHEOLOGY, JAPAN

The 18th annual meeting was held on May 20 and 21, 1991 in Kyoto. Fourteen lectures in rheology in general and 7 invited lectures in a "Symposium on Rheology of Biological and Bio-Related Materials" were delivered. The SRJ Award for 1991 was given to Dr Michio Kurata on "Studies on Structure and Solution Viscoelasticity of Polymers". The SRJ award for a young rheologist was given to Dr Kiyoto Koyama on "Studies on Elongational Viscosity of Polymer Melts".

For further information contact the Secretary: Prof. Kunihiro Osaki, Institute for Chemical Research, Kyoto University, Uji, Kyoto 611, Japan.

MEMBERSHIP NEWS

The following applications for membership were approved at the Council Meeting, June 12, 1991.

Dr T. W. Bates
Shell Research Ltd.,
Thornton Research Centre,
P. O. Box 1, Chester,
CH1 3SH.
(fea DJ)

Dr C. K. Chai
BP Research Centre,
Chertsey Road,
Sunbury-on-Thames,
Middlesex, TW16 7LN.
(fetsa BCDJN)

Dr M. Cheema
CTL, Centre for Product
Development,
Lenton Boulevard,
Nottingham, NG7 2BY.
(feta BDFGHJKMO)

Dr J. P. N. Haxell
Coates Electrographics Ltd.,
Norton Hill, Midsomer Norton,
Somerset.
(pea CDG)

Mr N. S. Hearn
Kruss GmbH (France),
38/40 Av. Jean Jaures,
Paris, France.
(fetsa)

Dr Y. Michopoulos
Shell Research Ltd.,
Thornton Research Centre,
P. O. Box 1, Chester,
CH1 3SH.
(pfsa DJNO)

Prof. H. Mizuguchi
Dept. of Civil Engineering,
University of Tokushima,
Z-1 Minami-jyosanijima,
Tokushima 770, Japan.
(peta K)

Dr S. Niedoba
BP Chemicals, Box 149,
11 rue de Veyrot, CH-1217,
Meyrinz, Switzerland.
(fetsa DE)

Mr M. Schmidt
Rheometrics Europe GmbH,
Hahnstra. 70,
600 Frankfurt/M71,
Germany.
(fetsa BCDEFGHJKLM)

Dr R. A. Stephenson
16 St Katherines Road
Henley on Thames
(pfsa FGK)

Mr R. S. Trim
Hampden Test Equipment,
Studland Road,
Northampton, NN2 6EB
(fet C)

Mr T. Wyatt
Instituto de Investigaciones
Marinas, Eduardo Cabello 6,
36280 Vigo, Spain.
(pets DEGMO)

Dr U. Zolzer
Institut für Physikalische
Chemie, Universität Basel,
Klingelbergstrasse 80,
CH-4056 Basel, Switzerland.
(fes DEFGJMO)

The following have resigned: S. V. Pennington, M. Sakuta.

Under Rule 3(d) the following were elected to Honorary Membership: Prof. Sam Edwards (Gold Medallist 1990), Prof. H. Giesekus (Gold Medallist 1990), Prof. P. Chadwick, Dr A. Jobling, R. N. F. Pinfold, Prof. Z. Rigbi, Dr F. R. Young.

Dr Howard Barnes, Unilever Research, has been appointed a Visiting Professor in the Dept. of Mechanical Engineering, University of Liverpool. Dr Jim Ferguson, Strathclyde University, has been appointed to a Personal Chair. Dr Malcolm Mackley, University of Cambridge, has been appointed Reader. Dr Phil Banfill, University of Liverpool, has been appointed Senior Lecturer.

OBITUARY

DR LEOPOLD DINTENFASS
1921-1990

Leopold Dintenfass PhD, MSc., FRACI, MIE Aust., MACPSM, FRSH, FICA, a pioneer in the field of clinical haemorheology, died in Sydney on August 4, 1990.

Born in Poland, Dr Dintenfass trained as a chemical engineer before migrating to Australia in 1950, where he gained his PhD in physical chemistry. His first rheological studies were in the paint industry, but he became convinced that the rheology of blood circulation was central to many medical problems and set out single-handedly to study blood viscosity.

He was appointed a Senior Research Fellow of the National Heart Foundation of Australia (1963-1969), and a Senior Research Fellow of the National Health and Medical Research Council of Australia (1969-1975), working in the Department of Medicine of the University of Sydney and the Kanematsu Memorial Institute of Sydney Hospital.

He was the Commonwealth Visiting Professor to the Bioengineering Unit, University of Strathclyde (Glasgow) and Senior Research Fellow in the Department of Medicine of the University of Glasgow at the Glasgow Royal Infirmary from 1970 to 1971, and Visiting Research Associate, Department of Medicine 1, Hadassah-Hebrew University Hospital, Jerusalem in 1974.

In 1976 he was appointed Clinical Haemorheologist and Director of Haemorheology and Biorheology, Medical Research Department, Kanematsu Memorial Institute, Sydney Hospital. Following the rationalisation of Sydney Hospital in 1982, he moved his laboratory to the Rachel Foster Hospital, Sydney, where he continued his research even after his formal retirement in 1986.

His work centred on the development of theoretical concepts and hypotheses in blood rheology, blood flow and circulation, and in the thrombus formation; and the application of these to clinical science and to diagnostic, predictive and preventative medicine. To do this he had to design methods, techniques and instrumentation for the study of blood viscosity factors such as red cell rigidity, aggregation of red cells and thrombus formation.

He studied blood viscosity factors in patients with a variety of disorders including myocardial infarction, hypertension, renal failure, diabetes and cancer. In the mid 1970's he became interested in sludge-

like red cell aggregates, and, together with Peter Osman invented an automatic silt-capillary viscometer to study these. This work led to his proposal to study red cell aggregation under zero gravity, a project which was accepted by NASA and flew on the space shuttle "Discovery" on January 24, 1985.

Dr Dintenfass was a prolific author, speaker and conference organiser. He wrote 6 books and more than 200 articles describing his work on blood rheology in a variety of diseases. He organised conferences in Europe, U. S. A. and Australia and presented his data at more than 50 international meetings. He was a fellow or member of 18 learned societies, including the British Society of Rheology and the International Society of Biorheology.

Leo's enthusiasm for his subject allowed him to overcome problems of lack of finance and lack of facilities which would have daunted many less dedicated researchers. This was perhaps best illustrated with his space shuttle project, which rapidly blew out from a relatively modest proposal to one requiring considerable injections of money and diplomatic manoeuvres at the highest level. Despite these problems, Leo carried the project through and his experiment remains unique in biorheological research.

His many colleagues in all corners of the world will miss his enquiring mind and unquenchable enthusiasm. He is survived by his widow, Irene, who was a tower of strength in his work.

Professor Paul Vincent MD, FRACP, FRCPA
Director, Kanematsu Laboratories

COMPETITION NO. 4

Competition No. 3 was to make as many words of 5 letters or more from the letters of the word 'Viscometer'. The entry from Dr N. E. Hudson of the Department of Pure and Applied Chemistry, University of Strathclyde, caused me to spend much more time than I had anticipated in squinting through a magnifying glass at the entries in my Compact Edition of the OED. His list of acceptable words was:

Cerise, cermet, certes, certis, citer, civet, comer, corset, corsive, corvee, cosier, coster, costive, coterie, cotise, cover, covert, covet, coveter, crest, crime, crome, emetic, emove, erect, erose, erosive, erotic, erotism, escort, esoteric, ester, estover, evert, evict, evictor, evite, isomer, isomere, merit, meteor, meteoric, meter, metic, metier, metis, metre, metric, metrics, metro, micro, miser, mister, mitre, moire, moist, moister, mores, morse, mortice, mortise, motive, mover, movie, oecist, osier, overset, overtime, recite, recto, remit, remote, remove, resect, reset, restem, restive, retie, resit, revest, revet, revise, revote, rivet, score, scoter, scree, scribe, scrim, scribe, secret, sector, seric, serve, service, servite, servo, sever, sieve, siever, smite, smiter, smore, smote, soever, soiree, somite, sorite, sortie, soviet, steer, stere, stereo, steric, stire, stive, stoic, store, storm, stove, stover, strive, strove, terce, tercio, termes, terse, ticer, tierce, timer, tiresome, toise, toric, torse, tremie, trice, triseme, vector, verism, verismo, verist, verse, verset, verso, verst, veriest, vetoer, victor, vireo, virose, viscometer, visor, voice, vomer, vomit, voter.

together with the following that are now classified as obsolete or as not having been fully naturalised:

corvet, coste, covetise, creme, escot, estoc, estro, mieve, misere, miter, reest, remise, rieve, roist, roset, siver, steem, stime, temse, trevis, vermes, vermis, vraic.

giving a total of 180 words, which makes Dr Hudson the runaway winner (even without his obsolete words.)

Competition No. 4 calls on different talents. It is to draw a cartoon, (black and white only) on a subject at least vaguely connected with rheology. The more amusing the better.

Entries to Dr G. H. Tattersall, 174 Millhouses Lane, Sheffield S7 2HE.
As usual, a BSR tie or £5 book token for the best.
Closing date September 15th, 1991.

CONFERENCE ANNOUNCEMENTS

ENGINEERING RHEOLOGY

THE ANNUAL CONFERENCE OF THE BRITISH SOCIETY OF RHEOLOGY
at The University of Bristol
September 9-11th 1991

It is still not too late to register for this meeting, although, by the time this appears in print, members should have received final details by separate mailing.

RHEOLOGY OF GELS AND MICRO-STRUCTURED FLUIDS, AND
GENERAL RHEOLOGY

THE ANNUAL CONFERENCE OF THE BRITISH SOCIETY OF RHEOLOGY
at Selwyn College, University of Cambridge,
September 15-16th 1992

CALL FOR PAPERS

Offers of papers are invited for this conference. Papers addressing any aspect of rheology are acceptable. It is intended however to devote a number of sessions to the rheology of gels and structured fluids, and so submissions in these areas are especially welcome.

Speakers will be allocated 30 minutes in which to present their contribution, including discussion. The proceedings will not be published but it is intended that abstracts will be made available to participants. Titles and abstracts (ca. 250 words) should be sent to: Dr R. Buscall, ICI Corporate Colloid Science Group, P. O. Box 11, The Heath, Runcorn, Cheshire WA7 4QE. As soon as possible, and at the latest by 1st December 1991.

Potential attendees may like to know that the conference is being held immediately prior to a meeting in Cambridge on the subject of "Colloids in External Fields (flow, electrical, magnetic etc.)", organised by the Colloid & Interface Science Group of the Faraday Division of the Royal Society of Chemistry for September 17/18th. Further details of both meetings will appear in a later issue of the Bulletin.

UNIVERSITY OF WALES INSTITUTE OF NON-NEWTONIAN
FLUID MECHANICS

The rheology research groups at Aberystwyth and Swansea led by Professors Ken Walters and Peter Townsend, together with a new group at Bangor are coming together to form the University of Wales Institute of Non-Newtonian Fluid Mechanics. A meeting to formally launch the Institute will be held on Monday December 9th at the University College of Swansea. Afternoon lectures by Professor M. J. Crochet (University of Louvain La Neuve, Belgium) and Professor J. R. A. Pearson (Schlumberger Cambridge Research) will cover computational and industrial aspects of Non-Newtonian Fluid Mechanics. These will be followed by a reception and a major public lecture by Professor Sam Edwards FRS of the Cavendish Laboratory, University of Cambridge. If you are interested in receiving further details of the Institute and/or the launch, please contact Professor Townsend at the address inside the front cover.

CONFERENCE DIARY

DATE	PLACE	DETAILS
9-11/9/91	Bristol, U. K.	International Conference on 'Engineering Rheology', Autumn meeting of the British Society of Rheology, contact: Mr R. E. Carter, Carter-Baker Enterprise 2 Marshbrook Business Park, Marshbrook, Church Stretton, Shropshire SY6 6QE.
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.
16-20/9/91	Udine, Italy	'Mechanics of non-Newtonian Fluids', contact: CISM, Palazzo del Torso, Piazza Garibaldi 18, 33100, Udine, 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.
18-20/9/91	Brugge Belgium	7th European Congress on Mixing, contact: c/o TI-K.VIV, Attn. Ms Rita Peys, Desguinlei 214, B-2018 Antwerpen (Belgium).
19/9/91	London, U. K.	'Interface phenomena in extrusion and forming operations', contact: Dr M. J. Adams, Unilever Research Laboratory, Quarry Road East, Port Sunlight, Wirral, Merseyside L69 3JW.
9-12/10/91	Beijing, China	China-Japan International Conference on Rheology contact: Chun Fan, Institute of Mechanics, Chinese Academy of Sciences, Beijing 100080, China.

23-25/10/91	Nagoya, Japan	Society of Rheology, Japan, 39th Rheology Congress, contact: Prof. Kunihiro Osaki, Institute for Chemical Research, Kyoto University, Uji, Kyoto 611, Japan
17-22/11/91	Los Angeles, U. S. A.	Annual Meeting of the American Institute of Chemical Engineers: Fundamental Research in Fluid Mechanics, contact: James C. Hill (meeting coordinator), Chemical Engineering Dept. 231 Sweeney Hall, Iowa State University, Ames, IA 50011-2230, U. S. A.
4/12/91	Newcastle under Lyme U. K.	'Dispersants, Suspending and Stabilising agents', contact: British Association for Chemical Specialities, John Marshall House, 246-245 High Street, Sutton, Surrey SM1 1PA.
9/12/91	Swansea, U. K.	Inaugural meeting of the Institute of Non-Newtonian Fluid Mechanics, contact: Prof. P. Townsend, Dept. of Maths and Computer Science, University College Swansea, Swansea, SA2 8PP.
16-18/12/91	Southampton, U. K.	'The Conformations of flexible molecules in fluid phases', Faraday Symposium 27, contact: Mrs. Y. A. Fish, The Royal Society of Chemistry, Burlington House, Piccadilly, London W1V 0BN.
18-19/12/91	Reading, U. K.	'Emulsions', contact: Conference Secretariat, Society of Chemical Industry, 14/15 Belgrave Square, London SW 1X 8PS.
9/4/92	London, U. K.	'Rheology of Building Materials', contact: R. J. Mangabhai, TH Technology, Maple Cross House, Denham Way, Rickmansworth, Herts.
17-22/8/92	Brussels Belgium	9th International Congress on Rheology, contact: Dr P. Moldenaers, Chemical Engineering Department, Katholieke University Leuven, W. de Croylaan 46, B-3001 Leuven, Belgium.
15-16/9/92	Selwyn College, Cambridge, U. K.	'Gels, microstructured fluids and general rheology', contact: Dr R. Buscall, ICI Corporate Colloid Science Group, P. O. Box 11, The Heath, Runcorn, Cheshire WA7 4QE.
17-18/9/92	Cambridge, U. K.	'Colloids in external fields', contact: The Royal Society of Chemistry, Burlington House, Piccadilly, London W1V 0BN.
4/1993	To be announced	'Experimental rheometrical measurements'
9/1993	Cambridge, U. K.	'Theoretical and general rheology'



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Porpoise Viscometers Ltd specialise in the design and manufacture of process control rheometers for, but not limited to, the polymer industry.

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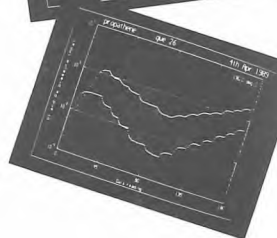
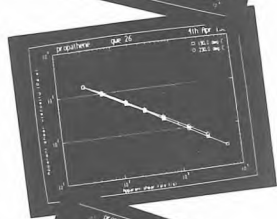
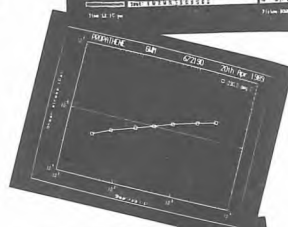
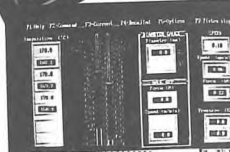
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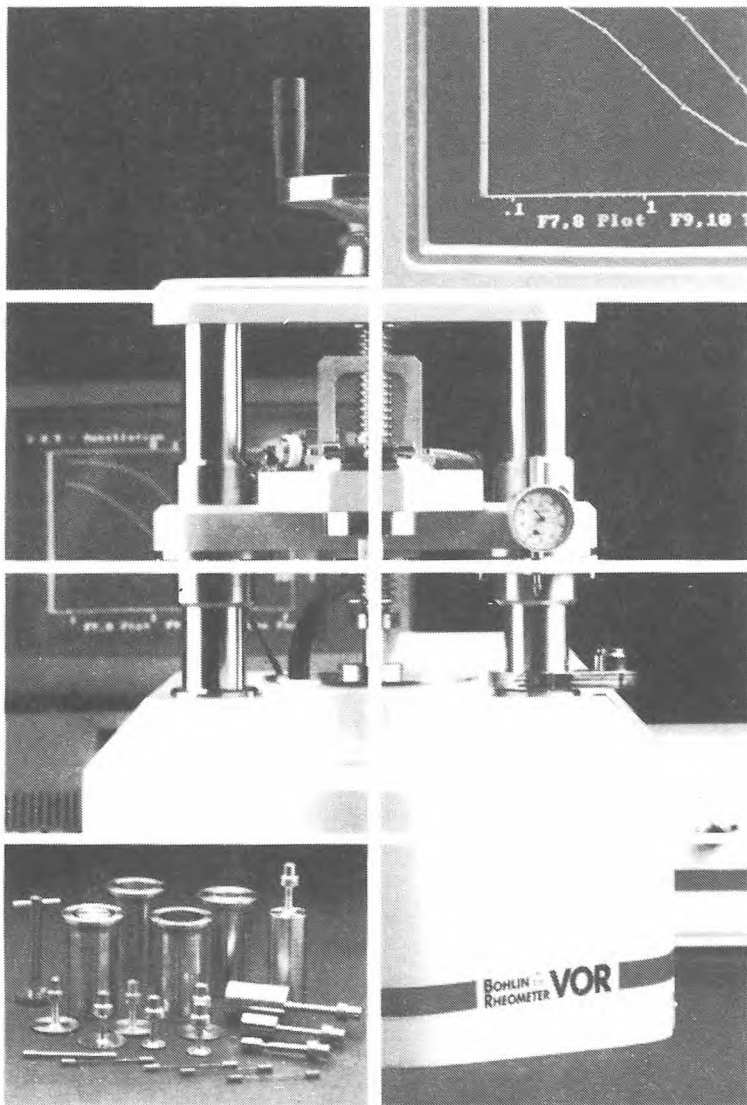
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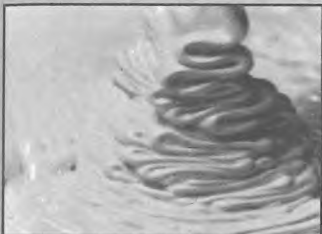
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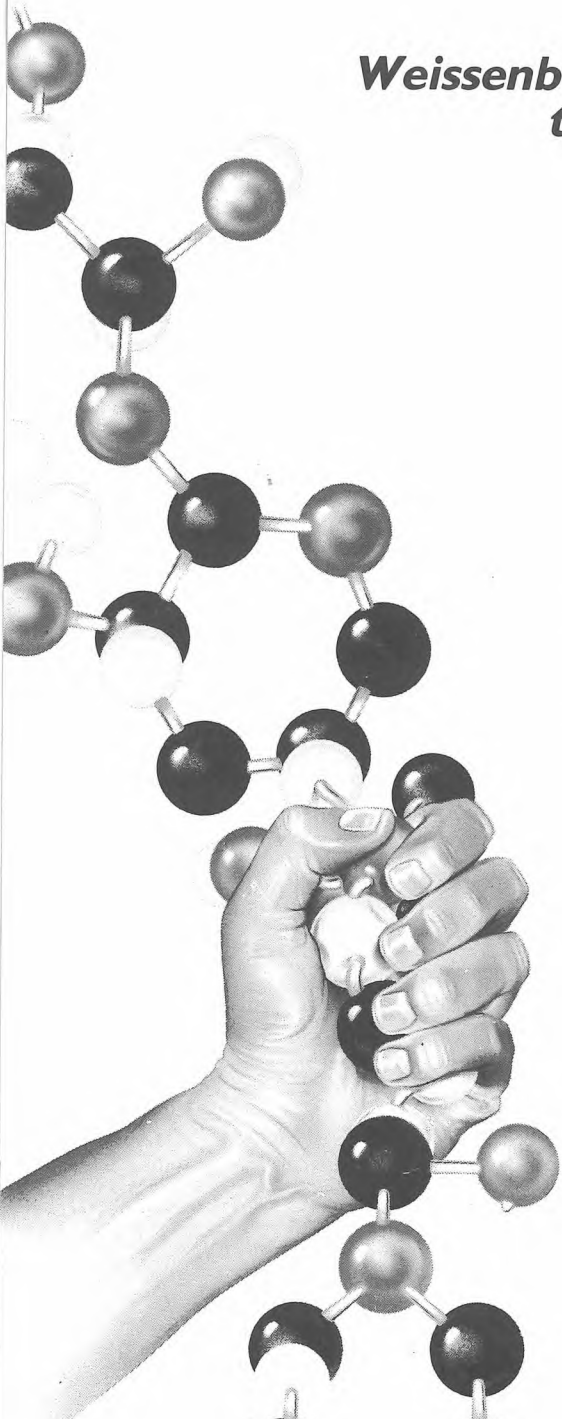
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