

THE BRITISH SOCIETY OF RHEOLOGY

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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
1993/94

- President:** Dr D. R. Oliver, School of Chemical Engineering, University of Birmingham, P. O. Box 363, Edgbaston, Birmingham B15 2TT
Tel.: 021-414-5310 Fax: 021-414-5324.
- Secretary:** Mrs C. A. Moules, Camtel Sciences, 27 Alexander Road, Stotfold, Hitchin, Herts SG5 4NA.
Tel.: 0763-244280 Fax: 0763-244298.
- Treasurer:** Mr R. E. Carter, Polymer Laboratories Ltd, The Technology Centre, Epinal Way, Loughborough, LE11 0QE.
Tel.: 0509-233300 Fax: 0509-234905 Telex: 341383
- Membership Secretary:** Dr D. J. Hourston, The Polymer Centre, University of Lancaster, Bailrigg, Lancaster, Lancashire LA1 4YA.
Tel.: 0524-65201 Fax: 0524-63806 Telex: 65111 LANCUL G.
- Abstracts Editor:** Dr G. H. Meeten, Schlumberger Cambridge Research Ltd., P. O. Box 153, Maddingley Road, Cambridge CB3 0EL.
Tel.: 0223-325204 Fax: 0223-467004 Telex: 818872 SCHLUM 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: 051-794-2605 Telex: 627095.
- Ordinary Members:** Mr P. C. Anderson, 32 Queensway, Feltham, Middlesex TW13 7NS
Tel.: 081-890-6586.
- Dr G. J. Brownsey, AFRC Institute of Food Research, Norwich Laboratory, Colney Lane, Norwich, NR4 7UA.
Tel.: 0603-56122 Telex 975453 FRINOR G.
- Dr N. E. Hudson, Department of Pure & Applied Chemistry, University of Strathclyde, 295 Cathedral Street, Glasgow G1 1XL.
Tel.: 041-552-4400 Fax: 041-552-5664 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.
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Tel.: 0792-295398 Fax: 0792-295708 Telex: 48358 ULSWAN G
- Dr N. D. Waters, Department of Applied Maths and Theoretical Physics, University of Liverpool, P. O. Box 147, Liverpool L69 3BX.
Tel.: 051-794-4004 Fax: 051-794-4061 Telex: 627095.

The Autumn Meeting of the Society always provides an opportunity to reflect on the year's activities and, as usual, the reports of the Society's officers presented at the A. G. M. are printed in this issue. They paint a mixed picture of our activities with some successful events and the occasional disappointment. The Council is carrying out an important review of the Society's activities at its next meeting in December, and needs your input. If you have any views about the direction the Society should take, get in touch with the President or Secretary as soon as possible.

Also arising from the A. G. M. are some changes on the Council. Roy Carter takes over from Peter Anderson as Treasurer and Gerry Meeten takes over from Geoff Brownsey as Abstracts Editor. Tony Evans retires from Council after 24 years continuous service and is replaced by Dr Neville Waters, a short biographical note on whom appears in this issue.

This issue has a technical article by David Cheng on a topic of perennial interest — suspension stability, yield stress and elasticity.

Spurred by the Weissenberg Meeting and its reminiscences in July, Alan Jobling has written about his memories of postwar research in Britain. I am sure that other senior members of the Society have memories in a similar vein and I shall be pleased to print them in future issues

Copy date for next issue, December 15th.

DOES ELASTICITY SUSPEND SOLIDS?

D. C.-H. Cheng

Consultant in Applied Rheology

191 Icknield Way, Letchworth, Herts SG6 4TT

Many industrial and consumer products, as well as medical ones, contain solid particles in suspension. They have to be prevented from settling under gravity. If a product contains lighter emulsion droplets or gas bubbles, these have to be protected from rising to the surface, i.e. creaming. It used to be considered that these materials should possess a yield stress to prevent settling or creaming. Then it was said that it is a high value of zero-shear viscosity that is required. I have reviewed these ideas in a report¹ and given guidelines on what to do in what I call rheological design for suspending solids. I thought everything was nice and tidy.

Now a new thesis is circulating. When in Stockholm giving a rheology course, I heard that it is elasticity that does the trick. One should have large G' to suspend solids. When this was repeated at the Royston seminar, it sounded serious and needed investigating.

In fact, I first came across the idea in Saddle Brook about five years ago. I was shown a bottle of salad dressing with fine pieces of herbs. The liquid contained an additive that imparted a distinct elasticity which was clearly seen when the bottle was rocked. It was said that it was this elasticity that kept the herbs in suspension. The Germans do not like to have to shake the dressing before use and the vinaigrette had been specially formulated for them. A few years later, I was given a Rheometrics Application brief² in Karlsruhe entitled "Predicting the storage stability of aqueous pesticide dispersions using the RFS II". It showed that samples having $\tan\delta$ values between 1.0 and 2.0 were the most stable and concluded that the $\tan\delta$ be determined to predict stability. Maybe this is the origin of the new thesis that elasticity can be used to relate to storage stability, but it all sounded to me like the promotion of oscillatory rheometers.

The curious thing is that the rationale of the Rheometrics brief actually says the opposite. It argues that particles settle faster if they form into larger aggregates. The agglomeration arises from particle-particle interaction which imparts elasticity and causes $\tan\delta$ to be low. If there were no interaction and therefore, little elasticity, $\tan\delta$ would be high. The particles would be dispersed and settle slowly. An unstable pesticide was made stable by the addition of a surfactant

which increased $\tan\delta$ from 0.3 to 1.0. It was asserted that the dispersions with moderate $\tan\delta$, between 1.0 and 2.0, have optimum storage stability. It was low elasticity that was equated with stability. Just the reverse of what is now gaining currency in popular rheology. Do we have another myth here?

I have been thinking about this problem and I would like to explain my ideas in this note. I imagine a particle being put onto a rubber sheet. The sheet will sag a bit but it will support the particle. The sheet will sag to a greater or lesser extent depending on its elasticity or, rather, rigidity. Once the elastic forces and particle weight are balanced the particle will not sink further. So elasticity could be said to suspend solids. If the rigidity modulus, G , is small there will be a lot of sag. The particles at the top of a bottle may drop down to the lower regions and this may appear to be settling. However, this soon stops and the settling does not continue indefinitely. Nevertheless a clear layer will form, the thickness of which can be calculated by elastic analysis. So the higher the value of the G the better it is for suspending solids.

As an aside: here is a curious quirk of the language. When we talk about a liquid A being more viscous than B we mean that the viscosity of A is higher than that of B. But if you agree with me that rubber is more elastic than steel we find that the rigidity modulus of rubber is actually lower than that of steel. This shows that we use the word elasticity to describe compliance. The more compliant, and therefore less rigid, a material is the more it is said to be elastic. In this sense high elasticity is detrimental to sedimentation and we need low elasticity for stability.

Now scene two: the rubber sheet has a breaking point if it is stretched too much. When this happens the particle will fall through. It will break through successive sheets until it reaches the bottom of the container. Sedimentation in this case is determined by the elastic limit, in other words the breaking strength or yield stress. If we assume ideal elasto-plasticity we will be able to predict the size of particles that a rubber sheet with a given yield stress will support. In this scenario it is not elasticity as such that suspends solids but a high yield stress.

There is more to it if we imagine the sheet to be viscoelastic (VC). Equating the weight of a particle to constant stress I can liken the deformation of the sheet by the particle to the creep curve that we can obtain in a CS rheometer. We are interested in the creep/sagging at long times and there can be two types of behaviour (Fig. 1). The sagging will either tend to a constant value or it will continue indefinitely. I will denote

the former as a "viscoelastic solid" and the latter as a "viscoelastic liquid". (In the 1950s, viscoelastic liquids were described as elasto-viscous, but the terminology is no longer used these days.) So, in a material that is a viscoelastic solid particles will not settle indefinitely but in one that is viscoelastic liquid they will.

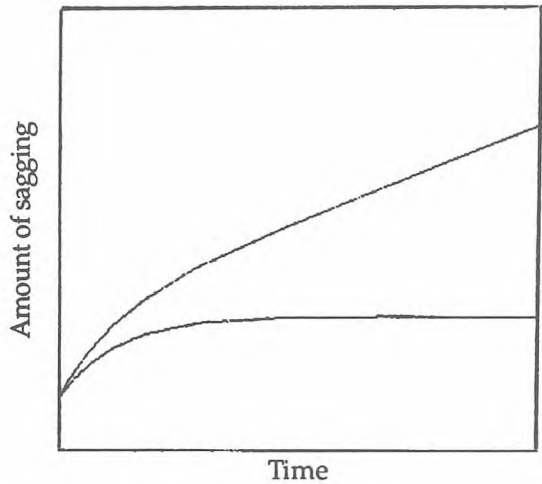
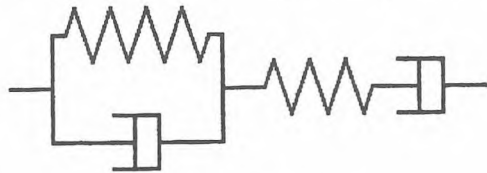


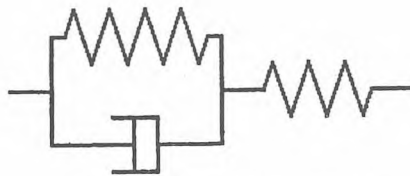
Fig 1. Sagging of viscoelastic liquid (upper curve) and viscoelastic solid (lower curve).

Maybe we say that a viscoelastic solid is more elastic than a viscoelastic liquid, but that is just playing with words. Now, VE solids suspend particles, but VE liquids do not. So if we equate solid with elasticity we can still say that elasticity suspends particles. The question now is: how do we recognise a VE solid by oscillatory testing to measure complex dynamic modulus? To answer this I examine how a VE solid behaves under oscillation in contrast to a VE liquid. The two sagging/creep curves in Fig. 1 were generated by the two spring-and-dashpot models of Fig. 2. Their complex dynamic properties are shown in Figs. 3 and 4.

In Fig. 2, the liquid (A) and viscoelastic solid (B) behaviour.



(A) Burgers model



(B) degenerate Burgers model

Fig. 2 Spring and dashpot models showing viscoelastic

Burgers model⁴ is composed of a Kelvin element in series with a Maxwell element. It is a VE liquid and gives the sagging/creep curve that continues indefinitely on Fig. 1. The degenerate model does not have the Maxwell dashpot. It is a VE solid and gives the curve that sags only so much and no more. The calculations and plotting for Figs. 1, 3 and 4 have been easily done with the aid of the MathCAD software and the ASEASY spreadsheet. Contact me if you are interested in how this is done.

We are interested in sedimentation over long storage times. This is equivalent to low frequencies and it is here that the oscillatory behaviour is the most informative. For the VE

liquid in Fig. 3, $G'' > G'$, $\tan\delta$ is high and η^* tends to a finite zero-frequency value which is the same as the zero-shear viscosity. In contrast, in Fig. 4, the solid has $G' > G''$, low $\tan\delta$ and η^* tends to infinity as frequency decreases. Clearly, therefore, if we are using oscillatory testing or complex modulus measurement to assess sedimentation, we will be looking for the VE solid characteristics as shown on Fig. 4.

This scenario implies that we are searching for a dispersion to suspend particles. We may be varying the additive in a fluid to convert it from a VE liquid to a VE solid. So far, I am thinking of the dispersion behaving either as a VE solid or as a VE liquid. But we know that in practice materials are more complicated. Their behaviour changes from VE solid to liquid as shear stress is increased. In the creep test the behaviour is illustrated by Fig. 1 just as well. The lower solid curve

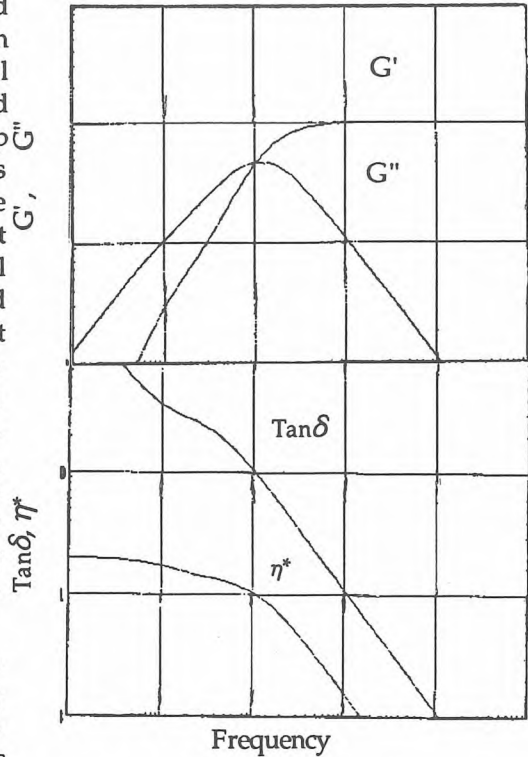


Fig 3 Complex dynamic properties of a viscoelastic liquid

would be obtained at low shear stresses while the upper liquid curve at high stresses. I need now to consider how this change reveals itself in oscillatory testing. I need to introduce another complication into the discussion, namely shear strain or shear stress amplitude dependence of dynamic moduli and talk about nonlinear viscoelasticity.

I can imagine that the response under oscillatory testing remains sinusoidal up to high amplitudes but the dynamic moduli change smoothly from VE solid to liquid. However, I have not seen any experimental data presented in this way in the literature. If I do I know how I would interpret them to predict sedimentation. I would calculate the shear stress for the particle and look for the corresponding zero-frequency η^* to equate to the zero-shear viscosity (ref. 4 p. 72) and use that to calculate the sedimentation velocity.¹

In the literature the discussion of nonlinear behaviour is conducted in the context of a yield stress material [see reviews⁵ & ⁶]. At low amplitudes, below the yield stress or strain, the response is expected to be linear and the complex moduli independent of the applied amplitude. Whether this is exclusively VE solid behaviour, as one might expect, or whether there can be VE liquid behaviour also is not known. Above some critical amplitude, the response develops flat tops, or can even show sharp peaks (which happens when there is structural destruction or thixotropy). The yield stress, τ_y determined from the steady shearing flow curve has been correlated with complex dynamic properties⁶. One correlation links τ_y with the zero-frequency shear-stress. Another equates τ_y with the oscillatory stress at the critical strain for the onset of nonlinear behaviour. This means that we can calculate yield stress

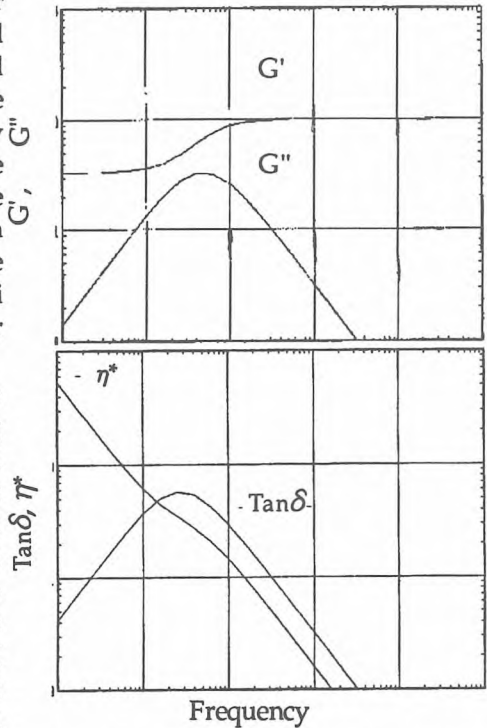


Fig. 4 Complex dynamic properties of a viscoelastic solid

from oscillatory testing and use it to predict the suspending capability of dispersions.¹ A word of warning however: the correlations may be material specific.

I will now try to sum up. The analyses of the behaviour of rubber and viscoelastic sheets show that there can indeed be a basis for saying that "elasticity" can be correlated with sedimentation stability of dispersions. But just to say so in a qualitative and loose sort of way can lead to confusion. We can have a material, such as the Burgers model, which shows elastic characteristics, but behaves as a liquid at long times and, if the steady shear viscosity is low, it will not keep particles in suspension. We have to be rather strict in defining what we mean by "elasticity" and I suggest that it should denote "solid behaviour as defined in this note. In creep tests this is given by a creep curve that tends to a constant strain at long times. In oscillatory tests it is given by the low frequency characteristics illustrated in Fig. 4.

For quantitative prediction of sedimentation stability we need to use either the yield stress or the zero-shear viscosity approach.¹ Either the creep or the oscillatory test can be used. Depending on the dispersion, both will give either the yield stress or the zero-shear viscosity. They are alternative methods for assessing stability but they are also equivalent.

The conclusion described in the Rheometrics Application Brief² is indeed the opposite to this conclusion. It suggests that $\tan \delta$ values greater than 1.0 (ie. $G'' > G'$, or more viscous than elastic) are conducive for stability but it is not at variance with the above analysis. It applies when the mechanism for particle sedimentation is different. In the above analysis the property of the suspending medium through which the particle is sedimenting is considered and elasticity or solid characteristics in the medium are desirable. In the Rheometrics example the elasticity arises from agglomeration of fine particles to form larger aggregates which then sediment at a faster rate; in this case elasticity of the sedimenting species is undesirable.

For the final summing up, I find that, as is often the case with rheology, anything can happen. Sometimes elasticity can lead to good storage stability in dispersions but on other occasions it does not. It all depends on what mechanism is operative. It is therefore wrong to claim or expect one way or the other. As users of rheological knowledge, trying to interpret practical measurements to relate to product performance properties, we should be very wary about following glib rules of thumb. We need to understand our materials better and rheological instruments are tools to help us do that. After that we can use rheological measurements correctly in industrial applications.

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PERSONAL MEMORIES OF POST WAR RESEARCH

In view of current groans about the lack of support for academic research, members may be interested to have a short account of the vicissitudes of carrying through a piece of rheological research in the immediate post-war years.

I returned to my old department at the Royal College of Science (Imperial College) in the autumn of 1946 to do research after three years in the Army. During the war years, pure research had almost ceased and the department was just starting again to set up lines of academic research. I had very little idea of what I wanted to do and suggestions for research topics were not forthcoming. I told the head of department that I was interested in the viscosity of liquids, based solely on an undergraduate dissertation that I had written, so he put me with Dr (later Professor) A. S. C. Lawrence on the strength of his having worked on flow birefringence of tobacco mosaic virus systems in Rideal's department at Cambridge before the war. Lawrence was not on the academic staff but was still working for the Royal Navy Scientific Service from a small lab in R. C. S.. He suggested one or two topics on stability of emulsions but I couldn't get my teeth into these.

I eventually found my own research topic while lying in a chair at home feeling very ill with 'flu. It was generally recognised that the variation of the viscosity of simple liquids with temperature is not well represented by the simple Arrhenius plot and many modified equations had been proposed, some just introducing extra arbitrary constants and others introducing various functions of density or volume to take account of the fact that the liquid is also expanding with increasing temperature. I wondered what the result would be if one sealed a liquid in a vessel so that it could not expand and then measured its viscosity as a function at constant volume. I decided to find out.

The final design consisted of a falling-cylinder viscometer built into a pressure vessel immersed in a thermostatted oil-bath. There were three fall-tubes and the fall of the cylinders was timed by observing the pulses produced by magnets in the cylinders falling through coils wound round the tubes. These signals were displayed on one beam of a double-beam oscilloscope with the second beam carrying the mains frequency as a timing signal. (At that time the mains frequency itself was not all that constant and had to be checked against a clock). The oscilloscope signals were recorded by a moving film camera.

It sounded quite simple except that absolutely nothing was available. I was extremely fortunate to get an introduction to Mr W. R. D. Manning, an engineer who had worked on the original ICI polyethylene development at Winnington. He designed and tested the pressure vessel for me and also provided some of the special glass-insulated seals which had been developed by ICI for taking electrical connections through pressure vessels. Lawrence was able to persuade one of the Admiralty engineering laboratories to supply the special high-tensile steel required and to fabricate the pressure vessel. I saw a second-hand double-beam oscilloscope advertised in *Wireless World* by someone in Blackpool, travelled up and bought it with my demobilisation money and lugged it home. I applied for a research grant and was repaid some eighteen months later. The oil-bath was a lagged domestic dustbin and the camera had to be bought new on (from memory) a year's delivery.

The magnets were obtained from the brother of a friend, who worked for a Sheffield company making special alloys. The screened electrical connections were made from war-surplus equipment purchased in Lisle Street behind Leicester Square, at that time a real treasure house for researchers before it became part of Chinatown. The viscometer tubes, falling cylinders, and a succession of pressure seals were turned with great skill by the department's one workshop technician working with a very old lathe on a small gallery overlooking the main undergraduate teaching lab.

After four years of frustration, it all came together and we were able to show by direct measurement^{1,2} that, for simple liquids composed of small molecules, the variation of viscosity with temperature at constant volume is quite small. Most of the viscosity change with temperature at atmospheric pressure is due to the thermal expansion of the liquid and not, as had been generally believed until then, to the increased thermal energy of the molecules.

For those who think that current times are hard, I can only say "Brother you ain't seen nuthin'".

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Alan Jobling

THEORETICAL AND GENERAL RHEOLOGY

For the second year in a row, the Society's Autumn Meeting was held in Cambridge, being magnificently managed by Malcolm Mackley, and ably administered by Robert Marshall. Recent conferences had emphasised the experimental aspects of our science, so the more theoretical theme of this meeting was very welcome. As with last year, it had been decided to make it a joint venture with another organisation, in this case the Dutch Society of Rheology, reviving memories of the last such liaison with the Dutch in Amsterdam, 1979. In the beautiful setting of Robinson College — the newest one in Cambridge — over ninety delegates and accompanying persons gathered for the start of the conference. Though the majority was from the UK, nearly twenty came from the Netherlands, and a further ten from the USA and the rest of Europe.

The organisers had prepared a very full programme, not just presented papers and posters, but visits to Research Laboratories and historical sites, a wine-tasting event, and a musical evening before the Conference Dinner. It was very apposite that the first paper was on miscible blends, considering the varied backgrounds of the delegates, from both industry and academia, and from science and engineering. This blending continued throughout the meeting with many discussions taking place outside the lecture theatre as well as inside. It is not my intention to go into detail about the thirty four papers and twelve posters. A list of these appeared in the Conference Announcement in the last Bulletin. They were generally well presented, and stimulated some good debate.

At the conclusion of the first day's proceedings, we were invited to a wine-tasting event organised by John Hinch, and kindly sponsored by Schlumberger Cambridge Research. It was held in the Needham Institute, a centre for the translation and preservation of ancient Chinese scientific texts and artefacts. The building itself is very reminiscent of a Chinese mountain lodge, and it was said that the original benefactor, now in his nineties, was still a regular visitor.

The programme for the second day divided the lectures into two parallel sessions; unusual for our normal meetings, but exemplifying the

success Malcolm had achieved in attracting presentations. The afternoon period was quite short, and most of the delegates set off by coach to visit Ely Cathedral, Wimpole Hall, or Schlumberger Research. Late afternoon saw the council members of the BSR gathering for their meeting, which was followed by the Annual General Meeting, reports from which are included elsewhere in this Bulletin.

That same evening, we had a musical "sandwich" before the Conference Dinner. This delicacy consisted of several slices of amateur "fillings" surrounded by pieces of professional "bread". The professionals were the singer Elizabeth Wood, who gave us two delightful love songs from Purcell, and the two Organ Scholars of Robinson, Andrew Reid and Sarah MacDonald. The former played a Bach harpsichord concerto and a carillon (a ring of bells) on the organ, whilst the latter accompanied the "star" turns. In the first of these, Russell (Fozzy Bear) Davies gave an enthusiastic rendition of a Haydn harpsichord concerto. Though obviously thoroughly at home on a keyboard (computer), this processor seemed to have more "wait-states" than would be expected with this piece. This was followed by Phil (Footlights) Banfill giving a powerful rendition of the old Flanders and Swann number, *'Mud, mud, glorious mud'*. Trust a building scientist to sing about brick making components. Very few of our overseas visitors or the younger set would have heard this number before (it was from the late '50s), but they soon picked up the theme and everyone joined in the last verse. The final slot was taken by Tom (Horatio) McLeish, who played two movements of Mozart's Horn Concerto. The 2nd movement was fairly restrained, but in the 3rd all "constraint" was "released", and one could almost see the notes "reptating" out of the French Horn.

This delightful event, kindly sponsored by Rheometrics, was followed by a Reception and the Conference Dinner. The meal, like all the others that we had in the College, was of the highest quality and was well presented and served.

The final day's presentations continued with their high quality, and it was soon lunch time. This was followed by "pudding", a lecture without mathematics but in which chocolate was passed round. The final lecture was again suitably chosen, since it concerned weakly aggregating dispersions. Those delegates who had aggregated two days earlier, were now dispersing to their respective homes. Overall, it was a highly successful conference, and the Society must thank Malcolm and Robert for all their efforts.

Nick Hudson

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REPORTS OF OFFICERS

The following Officers' reports were presented at the 53rd A. G. M.

PRESIDENT

This has been another successful year for the Society. Two successful meetings should be highlighted: last year's Autumn meeting in Cambridge when we welcomed our French friends and the Summer meeting in Newbury for the Weissenberg Centenary lecture given by Professor Arthur Lodge. We are grateful to Malcolm Mackley and Carole Moules for organising these events. Unfortunately the attendance at our Spring meeting in Manchester was rather disappointing.

Other successes have been the award of the Scott Blair Scholarship and the Scott Blair Biorheology Scholarship to Paul Doody and Stefaan de Smedt respectively and allocation of three other smaller grants to students. In addition, we have elected six Honorary Members.

An ex-President of the Society, John Benbow, has taken on the difficult task of Archivist, which involves the well-known problem of deciding which old papers to keep and which to throw away, and also where to keep the useful material.

Having awarded two Gold Medals in 1990, we are now having preliminary discussions about the award of the next one, and it has not been awarded this year.

Looking to the future, the Groupe Française de Rhéologie is hoping to invite members of our Society to a joint meeting, possibly in Bordeaux, in September 1995, and next year there are meetings in Seville in September and Tobago in January, which I hope will be well supported. The Council has decided to review the future role of the Society and intends to consult interested parties, including ex-Presidents, and would welcome any suggestions which the members can make.

Finally, I would like to thank all the Officers, Council Members and organisers of meetings without whom the British Society of Rheology would cease to function.

SECRETARY

This year started with the appointment of a new President, Dr Ralph Oliver, and a new Council Member, Dr Gerry Meeten. Ralph is well known to members, having been on Council for several years. Ralph made it clear from the start what his approach would be, emphasising the informal club atmosphere.

Since last September's meeting on Gels here in Cambridge, which we shared with the French Society, the Council have organised a one day meeting at Manchester on Experimental Rheology which followed immediately after a one day joint meeting with the Non-Newtonian Club on the subject of Particulate Systems. In June we held an evening meeting to celebrate the centenary of the birth of Karl Weissenberg. Now we are back in Cambridge with another joint meeting, this time with the Dutch Society.

Further meetings are already planned, a joint one with the Water Soluble Polymers Group of the British Association of Chemical Specialities and a return meeting with the French Society in 1995. Preliminary communications about a joint meeting with the Japanese Society have been made. I feel that joint meetings which bring more people together from a wider range of disciplines are the way to go for the foreseeable future. On the wider international scene, this year has seen the acceptance of the Russian and Korean Societies into the International Council of Rheology and the Nordic Society held their first annual meeting in August. The 1996 International Congress will be held in Quebec and we intend to make a bid to host the 2000 Congress in the year of our Diamond Jubilee.

At the moment we have three working groups dealing with a proposed handbook on rheology, a project on transparency in rheometry and computer software, and the Scott Blair Collection and a sub-committee on scholarships and awards. Under the chairmanship of Dr David Cheng, the first has completed an initial feasibility study and identified a publisher who is keen to take the proposal up. The second group has now been wound up following an unsuccessful attempt to extract information from manufacturers. Eventually a round robin test using fluid S1 was reported at our meeting in April, which showed that there was reasonable agreement but that academic groups produced data with a smaller spread than manufacturers' own laboratories, probably as a result of the time they had available to complete the measurements. The third group, by appointing a dedicated local chairman and a library assistant at Aberystwyth, ensures that the Collection is well cared for, but meetings of the group involving two Council Members are difficult to arrange and it is impossible to ignore the fact that visiting the Collection is difficult and time consuming. There is a certain amount of muttering within the membership that the venue is not conducive to visitors.

Finally, as a result of repeated pleas in the Bulletin, we have received various applications and nominations for scholarships and

awards and have agreed the following. The Scott Blair Scholarship has been awarded to Paul Doody, a part time student from National Starch, investigating mechanical, thermal and rheological properties of non-pressure sensitive, hot melt adhesives at Coventry University. The Scott Blair Biorheology Scholarship has been awarded to Stefaan de Smedt who is carrying out physico-pharmaceutical studies on hyaluronic acid at the Biochemistry and Pharmaceutical Laboratory of the University of Gent. A travel grant has been made to D. R. Liang of the Department of Chemical Engineering, University of Cambridge, to present a paper at the Fourth International Conference on Electrorheology in Austria in July. A grant for the purchase of books has been made to Janet Johnson of the Department of Physics, University of Sheffield, in support of her research into the rheology of hetero-star polymer melts. A travel grant has been made to Mark Whiskens of the Ceramics Forming Group of the University of Birmingham, working on flow analysis and its relationship to fibre alignment, to present a paper at the World Ceramics Conference in Florence.

In addition to these groups the Society has been lucky to appoint Dr John Benbow as archivist. John has been working with me to sort out unused material and will be working with other Officers in due course. He is also liaising with Dr Geoff Tattersall, who has kindly donated his collection of papers and reprints to the Society. After indexing, the collection will be housed in the Institution of Civil Engineers in London.

The Society celebrated the centenary year of Karl Weissenberg with a lecture and dinner, jointly sponsored by T. A. Instruments who are the new owners of Carri-Med and thus market the rheogoniometer. Professor Arthur Lodge gave a most enjoyable speech to a family audience which was followed by some personal tales by Jack Roberts, a splendid dinner, a few drinks and some more personal memories.

Following the article in the Bulletin by Neil Cogswell we have received a trickle of views on the future role of the Society, which will be discussed at forthcoming Council meetings. We would welcome more views on this important matter.

In conclusion, this has been an interesting year for me as secretary and I send my regards to all members, many of whom I have not met, and especially to Tony Evans, who retires from Council after 24 years of continuous service.

MEMBERSHIP SECRETARY

This year my principal targets were to complete and distribute a new Membership List and to ensure that members' payment records

were up to date. The former was achieved before Christmas and the latter is a continuing process.

During the year 43 UK and 16 overseas members were admitted and 17 people resigned. The total membership stands at 595, of whom 375 are from the UK and 179 from overseas.

DR N. D. WATERS

Neville Waters graduated from the University of Wales, Aberystwyth in 1962 with a first class honours degree in Mathematics. He became one of Ken Walters' first research students and gained his Ph. D. in 1966 after being appointed tutor and assistant lecturer in Applied Mathematics in 1963 and 1964 respectively. After spending a year as an assistant professor at Oregon State University he joined Professor J. G. Oldroyd and Professor L. Rosenhead in the Department of Applied Mathematics at Liverpool as a lecturer in 1967.

Having been stimulated by the enthusiasm of Ken Walters in the early years of the fast-developing 'hot bed' of Rheology at Aberystwyth, Neville has maintained his interest in the subject with an emphasis on theoretical problems with physical applications. Earlier work includes the flow in rheogoniometers and the start-up and decay of various steady flows. Subsequently he analysed the flow in the continuous-flow squeeze film and the instabilities that arise at the interface of materials flowing together. In recent years he has successfully collaborated with Unilever on the drainage of liquid films.

Neville met his wife Janet while they were students at Aberystwyth and they have two grown-up children. He still tries to play squash and a little tennis after a fashion, rugby having given him up some time ago! However, he maintains his interest in rugby as Chairman of Selectors at New Brighton Rugby Club.

BRITISH SOCIETY OF RHEOLOGY

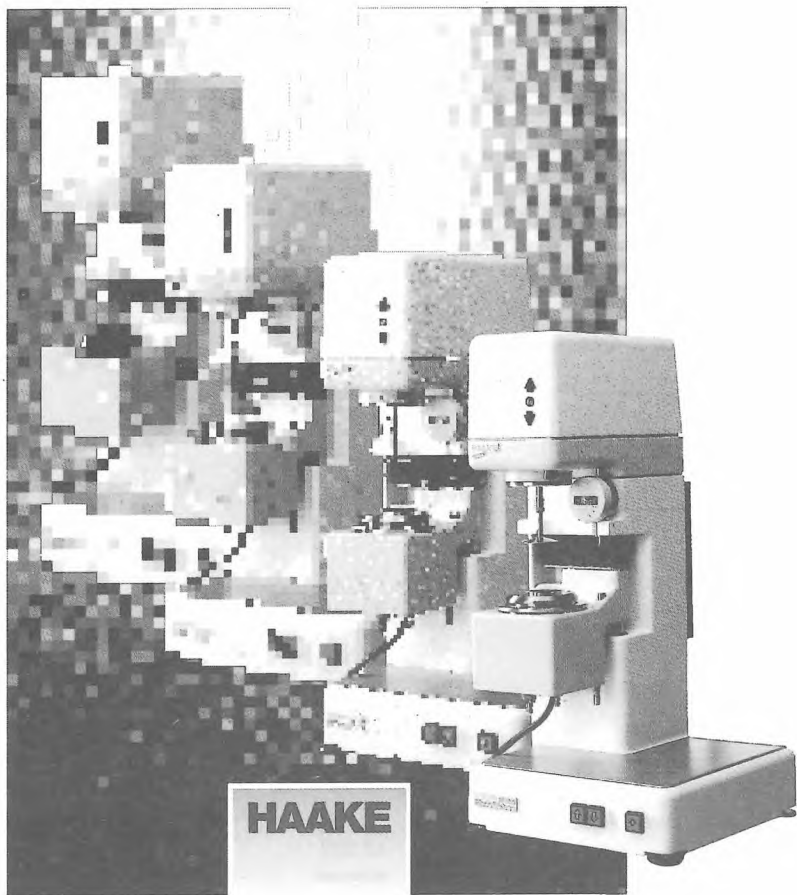
Revenue Account for the Year Ended 30th June 1993

	£	1993 £	£	1992 £
EXPENDITURE				
Council Expenses		3,558		4,834
Bulletin production costs		5,047		7,152
Expenditure by officers:				
Secretary	906		90	
Treasurer	38		—	
Membership Secretary and circulation	<u>1,514</u>		<u>1,172</u>	
		2,458		1,262
Professional Fees		250		228
Insurance		120		109
Awards		397		332
Weissenberg Lecture		969		—
Miscellaneous		694		213
Student Grants		200		1,150
Cardnet Charges		154		—
Bad and Doubtful debts		—		1,100
Depreciation:				
Word Processors		<u>1,297</u>		<u>1,451</u>
		15,144		17,831
EXCESS OF INCOME OVER EXPENDITURE		<u>3,930</u>		<u>561</u>
		<u>19,074</u>		<u>18,392</u>
INCOME				
Annual Subscriptions & Entrance Fees		4,753		6,230
Publisher — Rheology Abstracts		6,746		4,882
Advertising		2,622		3,060
Bulletin Subscriptions		317		134
Sale of Ties		56		67
Bank Interest		2,038		2,591
Conferences (see below)		<u>2,542</u>		<u>1,428</u>
		<u>19,074</u>		<u>18,392</u>
CONFERENCES ACCOUNT				
Surplus or (deficit) after expenses:				
Liverpool, 1990		88		219
Manchester, 1993		354		—
London, 1991		569		—
Edinburgh, 1990		—		(405)
Bristol, 1991		—		1,614
Cambridge, 1992		931		—
Donations		<u>600</u>		<u>—</u>
		<u>2,542</u>		<u>1,428</u>

Balance Sheet as at 30th June 1993

	1993		1992
	£	£	£
FIXED ASSETS			
Word Processors			
At cost at 1st July 1992	<u>5,805</u>	<u>5,805</u>	
	5,805	5,805	
Depreciation to date	<u>(5,413)</u>	<u>(4,116)</u>	
	392		1,689
CURRENT ASSETS			
Cash at Bank:			
Premier Interest Account	34,212	32,928	
Current Account	<u>2,142</u>	<u>1,425</u>	
	36,354		34,353
Sundry debtors and prepaid expenses	<u>2,804</u>		<u>1,110</u>
	39,550		37,152
CURRENT LIABILITIES			
Sundry creditors	<u>1,576</u>	<u>3,108</u>	
	<u>1,576</u>		<u>3,108</u>
	37,974		34,044
SCOTT BLAIR LEGACY FUND ASSETS			
Premier Interest Account	<u>11,254</u>		<u>11,287</u>
	49,228		45,331
	<u><u> </u></u>		<u><u> </u></u>
GENERAL FUND			
At 1st July 1992	34,044	33,483	
Excess of income over expenditure in the year	<u>3,930</u>	<u>561</u>	
	37,974		34,044
SCOTT BLAIR LEGACY FUND			
Balance at 1st July 1992	11,287	10,526	
Bank Interest	<u>669</u>	<u>941</u>	
	11,956	11,467	
Expenses	<u>(702)</u>	<u>(180)</u>	
	<u>11,254</u>		<u>11,287</u>
	49,228		45,331
	<u><u> </u></u>		<u><u> </u></u>

P. C. Anderson, Hon. Treasurer
 Alfred Simmons and Co., Auditors



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MEMBERSHIP NEWS

The following applications for membership were approved at the Council Meeting, September 23rd, 1993.

Miss D. C. Andrei,
Particle Technology Group,
Dept. of Chemical Engineering,
Imperial College,
London
SW7 2BY

Mr M Appello,
Raychem Ltd.,
Faraday Road,
Dorcan,
Swindon
Wilts
(peta BCD)

Dr N. Botu,
Universitatea Technica,
GHE. Asachi Facultateade
Constructii si Arhitectura,
Splai Bahlui, Nr 43 stg.,
6600 Iasi, Romania
(fetsa JO)

Mr R. I. Clift,
DRA, Fort Halstead,
Sevenoaks,
Kent,
TN14 7BP,

Mr K. Davey,
Dept. of Colour Chemistry
University of Leeds,
Leeds,
LS2 9JT,

Prof. E. El-Rafey,
Material Science Department,
Institute of Graduate Studies
& Research, Alexandria
University, Shatby,
Alexandria, Egypt.

(fetsa DGN)

(fetsa DFGJN)

Mr J. M. Harris,
ZENECA
Agrochemicals
Yalding,
Kent,
(fet GH)

Mrs R. Hodges,
Unilever Research,
Colworth House,
Sharnbrook,
Beds MK44 1QL,
(fet DEFGLH)

Miss J. Johnson,
Department of Physics,
Hicks Building,
Sheffield University,
Sheffield,
(fets D)

Dr L. B. Knudsen,
MD Foods amba,
Roeddrumvej 2,
DK-8220 Brabrand,
Denmark.
(fetsa FTHL)

Dr J. S. Malhi,
Department of Pharmacy,
University of Brighton,
Brighton,
BN2 4GJ
(etsa FGHMO)

Mr M. Pearson,
Physiology & Biophysics Dept.,
St Mary's Hospital Medical,
School, Norfolk Place,
London W2 7PG

Dr A. Senouci,
BP Chemicals Ltd.,
R & D Centre
P. O. Box 21.
Bo'ness Road
Grangemouth
(fetsa FGH)

Prof. M. T. Shaw,
Institute of Materials Science
University of Connecticut
Storrs CT 06269-3136,
U. S.A.
(fetsa CDG)

Professor W. Zuna
Graduate School, China
University of Mining and
Technology, 13 Xueyuan Rd.,
Beijing 100083, PR
China
(fetsa FGH)

The following have resigned: G. Downs, D. Dowson, P. E. Halstead, J. F. Ingenhousz, J. R. Nebrensky, A. J. Shah and R. H. Thomas.
Professor T. G. Rogers has died.

DR TONY COLLYER

Dr A. A. Collyer has taken early retirement from his lecturing post at Sheffield Hallam University, formerly Sheffield City Polytechnic. I met him and David Clegg, his co-editor of several rheology books, at the University College of Wales, Aberystwyth in 1980. He is a graduate of UCW, and it was here that he was dubbed "Jim" by Dr G. Hooper to distinguish him from other Tonys. Many undergraduates and postgraduates fondly remember not only his amusing style of lecturing, but also his selfless and, some might say, obsessive dedication to the production of home-brewed wines, which he aims to continue, along with writing novels, in his retirement in Weston-Super-Mare. The pinnacle of these herculean efforts in practical bulk rheology must surely be his renowned and widely feared curry wine, for the handling of which his research students thoughtfully provided protective gloves and facemask. The memory of the demi-johns happily bubbling away on every windowsill, on each edge of every tread of the stairs, and in the airing cupboard (where Tony had considerably removed one segment of the insulating jacket around the hot water cylinder in order to optimise the fermentation temperature) is strong.

On July 14th I was privileged to attend the retirement celebrations in Sheffield, where, after the traditional curry and a few pints of Ward's best, the following poem by John Moffatt was presented.

In sixty-eight 'e cum up 'ere
 We gev 'im a job, an' showed 'im beer
 We tried to show 'im proper ways
 Even in t'earliest days
 But by 'eck it wor a job
 They're an awkward lot this Southern mob
 Of proper things e' a'n't a clue
 Like speykin' reight 'n' suppin' brew
 "Dry Martini with ice and slice -
 That would be awfully nice"
 Die of shame, did we 'ear true?
 'E's not wi' me, 'e must be wi' you!
 Tomato juice wi' Worcester Sauce!
 That's just as bad o' course.
 In pubs throughout our verdant land
 Such puffy suppin's gen'rally banned!
 Yet underneath, this young lad
 For a South'ner weren't s' bad

A glimmer of 'ope did one day appear
 'E 'ad a glass o' proper beer!
 Two days later when 'e cum round
 A new perspective we reckoned 'e'd found
 Burr 'is delicate Southern constitution
 Couldn't cope wi' the confusion
 Enlightenment wor beaten back
 To familiar ways 'e'd beat a track.
 So, we gev 'im support 'n' 'elped 'im out
 For twenty five years or theer about
 This poor demented tortured soul
 'Ad but one unbelievable goal
 To go back South, soon as 'e could
 To live in Weston-Super-Mud!

Roy Carter

SCIENCE AND TECHNOLOGY NOW

Science and Technology Now is a new quarterly magazine from the Arab-British Chamber of Commerce promoting the transfer of British and European technology to the Arab world. Bilingual, it provides a useful opportunity for reaching potential customers in this large export market and for introducing research findings to the Arab academic world. For more information contact Emmeline Rogers, Arab-British Chamber of Commerce, 6, Belgrave Square, London, SW1X 8PH, telephone 071 235 4363 ext 268.

SOLID LIQUID

An article appeared in a recent issue of Chemistry in Britain with this title describing work on dilatant colloids done by Dr François Lafuma in Paris. It contained the following recipe for a do-it-yourself dilatant colloid to be made in the kitchen. "Mix in a bowl, cup or glass three measures of cornflour - finely ground maize (not wheat) - with two measures of water. Then slowly add more and more water up to about one more measure, until the mixture becomes rich and creamy. At about this point, you will find that the mixture will only allow gentle stirring; if you stir vigorously, it turns solid. But as soon as you stop stirring, it instantly turns liquid again. Try pulling your finger quickly out of a wine glass containing the mixture - it's weird!" Of course, such behaviour is well known to rheologists, but your editor would be pleased to receive recipes for samples showing other types of rheological phenomena, and which can be prepared from easily available materials. Please send him your suggestions for future publication.

RECENTLY PUBLISHED BOOKS

Information on recent books is given here for the benefit of members, but the Society cannot answer queries about the availability of particular titles. Place orders for books with publishers through booksellers and agents.

Benbow, John, and Bridgwater, John, *Paste flow and extrusion*, Oxford University Press 1993, ISBN 0-19-856338-8 160pp illus £35.00.

This book is aimed at those with an engineering or science background who have to deal with paste flow and extrusion in industry, but will also be useful to those involved in research. It deals with fundamentals of paste flow, types of extruder, processes, laboratory evaluation methods, die design, paste formulation, screw extruders and flow defects.

Druyanov, B, *Technological mechanics of porous bodies*, Oxford University Press 1993, ISBN 0-19-856364-7 208pp illus £37.50.

This is a full mathematical account of the mechanics of porous bodies, including sintering. It deals with the foundations of the theory of plasticity of such materials and gives the mathematical background to processes of practical importance.

Fung, Y.C., Biomechanics, *The mechanical properties of living tissues* 2nd ed., Springer-Verlag 1993, ISBN 3-540-97947-6, 568pp, illus DM89.00.

The second edition of this classic book gives an outline of the discipline, with applications to bioengineering, physiology, medicine and surgery. It reflects the broad advances made in recent years and adds new topics. After a historical introduction, the definitions and vocabulary of applied mechanics are related to biological tissues. These tools are then used to treat the mechanical properties of blood, biological fluids, muscle, bone and connective tissue.

LETTERS TO THE EDITOR

Harpenden, Herts.

Dear Sir,

Without wanting to be unduly critical of a report of what was essentially a social occasion, the Weissenberg Centenary Lecture, (Bulletin, 1993, 36 (2), 45) I cannot let pass without comment the statement that "In about 1953, Weissenberg advised Arthur (Lodge) to try to measure these normal stress differences . . .".

The first measurements of the normal stress distribution using a rheogoniometer were made by Jack Roberts working at the Armaments Development Establishment, Horsham. The results of several years work were published in a Ministry of Supply internal report¹ in 1952 and then in his classic paper² presented at the Second International Congress of Rheology at Oxford in July, 1953. In the autumn of 1952, I started a research project in the then Department of Colloid Science at Cambridge to continue the development of rheogoniometer techniques and was supplied by Roberts with an instrument described as the R7, designed by him and built by Farol Engineering of Bognor Regis. In other words, by 1952-3, the Weissenberg rheogoniometer was already into its seventh version.

In no way do I wish to detract from Arthur Lodge's achievements in this field but it is important to get the story right while those of us who were there are still around. Because he thought doing was more important than writing, Jack Roberts' essential part as an equal partner of Karl Weissenberg in the development of the rheogoniometer has, in my view, been greatly underestimated.

Yours faithfully
Alan Jobling (Dr)

References

1. Roberts, J., Pressure distribution in liquids in laminar shearing motion and comparison with predictions from various theories, Ministry of Supply, Report A.D.E. 13/52, August 1952.
2. Roberts, J., Pressure distribution in liquids in laminar shearing motion and comparison with predictions from various theories, Proc. 2nd International Congress on Rheology (V.G.W. Harrison, editor), London, Butterworth, 1954, 51-57.

Azur , Israel.

Dear Sir,

I found "Delphi Revisited" (Bulletin 36 (2)) extremely interesting. Certainly the emphasis on different aspects of rheology changes with time! *παντα ρει!*

It may be of interest to you that, at the Technion-I. I. T., Haifa, we have a Reiner Chair of Mechanics and Rheology. The present incumbent is Prof. S. I. Bodner who has occupied the chair since its establishment about eight years ago.

Yours faithfully,
Z. Rigbi.

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CONFERENCE ANNOUNCEMENTS

FIRST ANNOUNCEMENT

Joint meeting between British Society of Rheology and British Association for Chemical Specialities (Water Soluble Polymers Group)

April 28th 1994

at Newcastle under Lyme

This joint meeting will deal with rheological problems in the Water Soluble Polymers Industry. The outline programme is as follows:

MORNING: RHEOLOGY BASICS.

Introduction to rheology, dealing with stress, strain, strain rate, viscosity, elasticity, flow curves, structure, creep and elongation. Principles of rheological measurements, dealing with rotational, elongational, capillary, controlled speed, controlled stress and on line measurement. Rheological instruments, their features, computer control, what to look for, how to choose.

AFTERNOON: RHEOLOGY APPLICATIONS.

A series of talks by different speakers on the rheology of various systems of industrial importance, as affected by water soluble polymers. Cement and concrete, paints and surface coatings, food industry, cleaning products and toiletries.

For further information contact BACS, John Marshall House, 246-254 High Street, Sutton, Surrey, SM1 1PA.

SECOND INTERNATIONAL MEETING ON EXTENSIONAL AND
SHEAR FLOW OF POLYMER FLUIDS FROM THE SOLUTION TO
MELT

UNIVERSITY OF ST ANDREWS, SCOTLAND

JUNE 19TH-22ND 1994

Papers are invited for this meeting which forms a continuation of the conferences held under EC sponsorship over a number of years on the measurement of extensional flow and associated shear flow behaviour of polymer fluids.

The emphasis of the meeting will be on: industrial aspects of extensional flows; implications of shear and extension from a continuum and molecular standpoint; influence of physical and chemical effects in stretching flows.

Further details can be obtained from: Professor J. Ferguson, Dept. of Pure & Applied Chemistry, University of Strathclyde, Glasgow, U. K..
Tel.: 44-(0)41-552-4400 ext. 2161; Fax: 44-(0)41-552-5664

THEORETICAL, EXPERIMENTAL AND INDUSTRIAL ASPECTS OF RHEOLOGY

31st May to 3rd June 1994

This Rheology Course, sponsored by TA Instruments Ltd., of Dorking, Surrey, will take place at the University of Strathclyde's Educational and Recreational Centre, Ross Priory, on Loch Lomond, Scotland. The course, which is residential, is intended to cover the basics of rheology, modern experimental techniques (including constant stress rheometry, rheogoniometry, elongational flow and industrial aspects of rheology) and lead to state-of-the-art concepts in flow, data acquisition and interpretation. The lectures will be given by well known rheologists, namely: Professor H.A. Barnes, Unilever plc; Professor J. Ferguson, University of Strathclyde; Dr. N.E. Hudson, University of Strathclyde; Professor T.E.R. Jones, University of Plymouth; Mr. M. Power, TA Instruments Limited; Mr. S. Smith, TA Instruments Limited; Dr. A. Tanner, DEVRO Ltd; Professor K. Walters, U.C.W., Aberystwyth.

The cost of the course is £550.00. This includes the course fee, lecture notes, textbook, accommodation (full board) and transport to and from the centre of Glasgow. Accommodation at the Priory is limited and the overflow will be accommodated in a local hotel. All rooms have full facilities. If you wish to enrol, please complete the attached form and return it to the address below. It should be emphasised that the numbers on the course will be limited, so please book as soon as possible to avoid disappointment.

.....
To: Dr N.E. Hudson, Department of Pure and Applied Chemistry,
University of Strathclyde, 295 Cathedral Street, Glasgow G1 1XL,
Scotland.

I wish (a) more information* (b) to attend the Rheology Course*.

Please send details to:-

NAME (Mr, Mrs, Miss, Ms, Dr, etc)

.....
Address
.....
.....
.....
.....

Tel. No. Fax No.

* Delete whichever is inapplicable

TWO COURSES FROM CAMTEL SCIENCES

SCHOOL OF INDUSTRIAL RHEOLOGY

TORQUAY, OCTOBER 24-27TH 1994

The School of Industrial Rheology has been designed to provide participants with a practical working guide to rheology applications for problem solving. The principal lecturers, from industry and academia, are rheological experts in their own fields and include Professor H. Barnes (Unilever), Dr D. C.-H. Cheng (formerly Warren Spring Laboratory), F. N. Cogswell (formerly ICI Plastics) and Dr J. Goodwin (University of Bristol). Leading rheometer manufacturers are providing their latest models for your use.

The lecture programme will cover all the main product groups from polymer solutions to melts and dilute to concentrated suspensions. Instrumentation techniques will encompass constant stress, constant rate, extensional and capillary methods. Emphasis will be placed on providing 'hands-on' experience to collect sensible data using relevant test criteria with meaningful data interpretation. A range of industrial materials will be used to demonstrate correct techniques.

THE IMPORTANCE OF SURFACE MEASUREMENTS

WEETWOOD HALL, UNIVERSITY OF LEEDS

FEBRUARY 15-16TH 1994

To wet or not to wet? To stick or not to stick? Those are the questions.

The organisers believe that rheologists pay insufficient attention to the relationship between flow and surface properties. This two day course sets out to give delegates an understanding of the surface processes involving emulsification, washing, foaming, wetting and adhesion.

Whether in the R & D or Quality Control fields, surface measurements are vital in industries as diverse as paints, inks, petroleum, pharmaceuticals, cosmetics and food.

Dr R. Aveyard (University of Hull) and Dr J. Guthrie (University of Leeds) are key lecturers. Krüss instruments for both static and dynamic measurements of surface/interfacial tension and contact angles will be used in the demonstration and practical sessions.

The course fee including accommodation (on 15th) with full board is £275.00 + VAT.

For more information on both courses please contact the course organisers at : Camtel Sciences, 5 Carrington House, 37 Upper King Street, Rotston, Herts, SG8 9AZ. Tel.: 0763-244280 Fax: 0763-244298.

CONFERENCE DIARY

DATE	PLACE	DETAILS
29/11-3/12/93	Boston U. S. A.	'Symposium O: Complex Fluids', Materials Research Society Fall Meeting, contact: Eric Kaler, Dept. of Chemical Engineering, University of Delaware, Newark, DE 19716 U. S. A..
21/12/93	London, U. K.	'Rheological Problems in Suspension Concentrates' contact: Society for Chemical Industry, 14/15 Belgrave Square, London SW1X 8PS.
4-7/1/94	Tobago West Indies	'International Symposium on Viscoelastic Fluids', contact: Dr H. Ramkissoon, University of the West Indies, Dept. of Mathematics, St. Augustine, Republic of Trinidad and Tobago.
14-18/2/94	Adelaide Australia	'8th International Conference on Surface and Colloid Science', contact: J. Ralston, School of Chemical Technology, University of South Australia, SA 5095, Australia.
15-16/2/94	Leeds, U. K.	Short Course 'The Importance of Surface Measurements', Contact: Camtel Sciences, 5 Carrington House, 37 Upper King Street, Royston, Herts, SG8 9AZ, U. K..
23-25/3/94	Dijon, France	'Food Macromolecules and Colloids', contact: Prof. E. Dickinson, Proctor Dept. of Food Science, University of Leeds, Leeds LS2 9JT.
3-7/4/94	Akron, Ohio U. S. A.	'10th Annual Meeting' Polymer Processing Society, contact: PPS Secretariat, 13400 A. David, St. Janvier de Mirabel, Québec, CANADA JON 1L0. Fax: +1-514-433-9041.
11-14/4/94	Cambridge, U. K.	'Deformation, Yield and Fracture of Polymers' contact: Conference Dept. Institute of Materials, 1 Carlton House Terrace, London SW1Y 5YY.
28/4/94	Newcastle under Lyme U. K.	'Rheology and Water Soluble Polymers', contact: BACS, 246-254 High Street, Sutton, Surrey, SM1 1PA, U. K.
24-26/5/94	Moscow Russia	'International Conference on Superplasticity in Advanced Materials', contact: T. G. Langdon, Material Science and Engineering, University of Southern California, Los Angeles, CA 90089-0241, U. S. A..

Travel grants are available to help students attend any of these meetings.

31/5-3/6/94	Ross Priors Scotland	Short Course 'Theoretical, Experimental and Industrial aspects of Rheology', contact: Dr N. E. Hudson, Dept. of Pure & Applied Chemistry, University of Strathclyde, Glasgow G1 1XL.
1-3/6/94	Copenhagen, Denmark	'3rd Annual Meeting' Nordic Rheology Society contact: J. Becker, Dept. of Polymeric Materials, Chalmers University of Technology, S-41296, Gothenburg, Sweden.
19-22/6/94	St Andrews	'2nd International Meeting on Extensional and Shear Flow Scotland of Polymer Fluids from the Solution to the Melt', Prof. J. Ferguson, Dept. of Pure & Applied Chemistry, University of Strathclyde, Glasgow G1 1XL.
contact:		
4-9/9/94	Seville	'4th European Conference on Rheology', Spain. contact: Prof. C. Gallegos, Departamento de Ingenieria Quimica, Universidad de Sevilla, (Edificio de Quimica), 41071 Sevilla, Spain.
21-23/9/94	Cambridge, U. K.	'8th European Conference on Mixing' contact: Conference Section (MIX8) I Chem E, 165-171 Railway Terrace, Rugby, Warwickshire CV21 3HQ.
26-29/9/94	Kyoto, Japan	'First Asia-Oceanian Rheology Conference' Society of Rheology, Japan, contact: Professor Kunihiro Osaki, Institute for Chemical Research, Kyoto University, Uji, Kyoto 611, JAPAN Fax: +81-774-331247.
2-6/10/94	Philadelphia	'66th Annual Meeting, Society of Rheology', U. S. A. contact: N. Wagner, Dept. of Chemical Engineering, University of Delaware, Newark, DE 19716, U. S. A..
6-10/11/94	Yokohama, Japan	'International Adhesion Symposium' Contact: H. Mizumachi, University of Tokyo, Chemistry of Materials, Yayoi 1-1-1, Bunkyo-ko, Tokyo 113, Japan.
10-12/10/94	Sofia Bulgaria	'7th International Conference on Mechanics and Technology of Composite Materials', contact: Dr Y. Yanakiev, Central Lab. of Physico-Chemical Mechanics, Acad. G. Bonchev Str. Bl. 1, 1113, Sofia, Bulgaria.
24-27/10/94	Torquay U. K.	'School of Industrial Rheology', contact: Camtel Sciences, 5 Carrington House, 37 Upper King Street, Royston, Herts, SG8 9AZ, U. K..
1995	Caracas, Venezuela.	'3rd Caribbean Conference on Fluid Dynamics', contact: Dr H. Ramkissoon, University of the West Indies, Dept. of Mathematics, St. Augustine, Republic of Trinidad and Tobago.
18-23/8/96	Québec City, Canada.	'XIth International Congress on Rheology' Canadian Rheology Group/Groupe Canadien de Rhéologie contact: Prof. D. DeKee, Dept. of Chemical Engineering, University of Sherbrooke, Sherbrooke, Québec J1K 2R1. Canada.

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