

THE BRITISH SOCIETY OF RHEOLOGY

BULLETIN

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Hon. Editor
 Mr P.C.Anderson,
 32 Queensway,
 Feltham,
 Middlesex,
 TW13 7NS

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**Department of Pure and Applied Chemistry
University of Strathclyde**



PROCESS RHEOLOGY
3rd to 7th November 1997

This short intensive course on Process Rheology, held each year, is aimed specifically at the application of rheological techniques to the processing of non-Newtonian fluids such as polymer melts and solutions, suspensions and emulsions, biological fluids and foods, oils, etc. The participants will include rheologists from industry as well as postgraduate research students and university lecturers. The basics of rheology will be introduced to those who have no experience in this area, and a computer assisted learning package has been specifically developed for this purpose. Course contents will include the principles of rheology, both in general and for specific fluids, and the molecular and structural parameters governing non Newtonian flow. In addition to measurement techniques both in the laboratory and in line, the application of the concepts to process plant design and to process fluids will be emphasised. Practical methods in using rheological characterisation to model stages in processing will be demonstrated. The latest methods for describing the rheology of these materials will also be discussed. The use of constitutive equations in quality control and process control applications will be addressed. Representatives of several instrument manufacturers will be present with a range of equipment. Details about the course can be obtained from

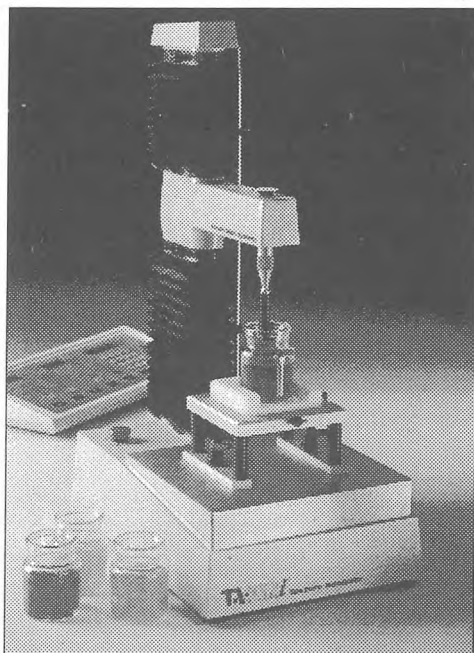
**Dr N E Hudson, at Thomas Graham Building,
295 Cathedral Street, Glasgow G1 1XL
Tel: +44(0)141-548 2162 Fax: +44(0)141-552-5664
e-mail: n.e.hudson@strath.ac.uk**

A note from the Publications Manager

The photograph on the cover of this Bulletin is entitled "hanging by a thread", and shows a pendant drop of a solution of Polyox in water supported by a filament of the same solution. The cover photograph of Bulletin 40/1 was entitled "hands on rheology". The Editor and I welcome submission of suitable photographs for this spot.

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CONFERENCE REPORTS

SOCIETY OF RHEOLOGY, 68th ANNUAL MEETING,
Galveston, Texas, 16-20th February 1997.

by Robert de Roeck

Dept. of Chemical Engineering, University of Cambridge.

On arrival at the conference venue, my first impression of the welcoming reception, and indeed of the venue itself, was of the promise of a relaxed atmosphere, conducive to academic debate. The conference hotel was situated right on the sea front overlooking the Gulf of Mexico, ensuring that time could be spent relaxing to the sound of rolling surf in the course of the busy programme. An inspiring setting in which to mull over the finer points of rheology.

The first evening saw the arrival of large numbers of delegates from a diverse range of backgrounds. This diversity was reflected in the conference programme that listed over 200 talks divided into 18 categories. The great wealth of material to be presented meant that all four conference arenas would be used continuously for the four day duration of the event.

The opening plenary talk was given by Dr. Hans Christian Öttinger, setting a great precedent for the other delegates. It was a well delivered overture, addressing some of the central issues in the mathematical formulation of non-equilibrium systems. As well as proposing his own model for such systems, he also proudly contributed a brand new acronym to science by naming it, 'G.E.N.E.R.I.C.' Judging by the plethora of questions that ensued his talk, this model will no doubt be a point of discussion in the future.

My personal interests, as a haemorheologist, were centred around talks on suspensions, aggregation mechanisms, experimental methods, flow visualisation, and an element of computational modelling. Of course, polymer systems, drilling fluids and food systems also featured centrally in the themes of the conference. The large number of talks served to ensure that the majority of delegates were entertained for most of the day.

Although there were no talks specifically dealing with haemorheology, it was enlightening to see just how much overlap exists between the different experimental systems. For example, clay suspensions exhibit similar rheological profiles observed in the blood system. Certain food-stuffs also fall into the 'soft colloids' categories, again resulting in a useful dialogue between myself and other researchers.

A notable quality, revealed in many talks, was the increasing tendency for research groups to collaborate with international partners. This was exemplified by a talk on 'flow instabilities observed in the cold extrusion of chocolate,' presented by Prof. Gareth McKinley of Harvard University. This work is part of an Anglo-American project on a system that has been investigated for several years, by Dr Malcolm Mackley and members of his research group at Cambridge University (of which I am one). It seems that this trend of global research efforts was favoured by the delegates and, more-over, was deemed necessary for the advancement of science.

In the course of the proceedings I presented a poster and a talk, which, although slightly nerve racking, turned out to be an immensely enjoyable experience. The issues that my talk raised, resulted in some friendly discussion, and introductions to people of similar interests. This opportunity enabled me to think of my work from new perspectives, sometimes shedding light on previous 'dead end problems'.

Another aspect of the conference that I particularly enjoyed, and greatly benefited from, was the opportunity to meet some of the most respected authors in my field. Notably, Prof. George Thurston, who has been working in haemorheology since the late 1950's. He has contributed a great amount to haemorheology, not least of which is his capillary rheometer known as the Vilastic. He was one of the pioneers in his field, publishing some of the first visco-elastic data on human blood. Since then, his work has covered a wide range of aspects centred on the blood system, of both a pure and applied nature. Having read a number of his 300+ papers, I was able to converse with him, and sometimes even debate some of his work, which greatly increased my understanding of the field.

Aside from the numerous social events sponsored by the high profile rheometer manufacturers, the climax of the event was the awards banquet, at which Prof. Henning Winter was honoured as this year's Bingham Medal recipient. His numerous achievements were recounted by the awards committee, which was then followed by a very eloquent acceptance speech. A pleasantly humorous address, high-lighting a great modesty for his work. Accompanied by an enjoyable banquet, the whole evening was regarded as a great success.

The only disappointing element to the conference was the absence of certain entertainments that were promised for the welcoming reception. Suggestions of a pool filled with a visco-plastic material, through which previous Bingham award medalists would swim, turned out to be a little hopeful.

As a Ph.D. student attending my first international conference, the benefits I have received from the experience have been numerous. By far the most striking in my mind was the time I spent with Prof. Thurston and Prof. Meiselman, whose expertise I would not otherwise have access to. Also talking with other Ph.D. students gave me a good insight into the trials and tribulations common to just about all research students, as well as the pros and cons of the different education systems of the world.

By no means least in my mind are the thanks that I owe to the award granting bodies that have made this experience possible: The British Society of Rheology Student Travel Grant scheme, Downing College, Cambridge and the Oppenheimer fund are gratefully acknowledged for helping me to attend this conference.

"RECENT DEVELOPMENTS IN SHEAR AND EXTENSIONAL RHEOLOGY"

La Clusaz, France, January 19 - 25, 1997

This European meeting is part of a long and successful series held during the winter in the French Alps. Much credit must go to Professor Jean-Michel Piau, who chose most of the venues and checked out the suitability of the hotels beforehand. Skiing plays an important part of the morning programme (chuckles from people back home!), but a point often missed is that this form of meeting appeals to the younger type of rheologist and greatly helps in their physical and mental development. La Clusaz is a lovely town with a French flavour which is unspoiled by foreign tourists; the hotel Corlina provided excellent food and facilities (swimming pool, jacuzzi, sauna and steam room) but was located above the town and ski lifts, giving further tough exercise before the afternoon lectures began.

The programme covered a blend of theoretical and experimental topics, plus an 'optional extra' when Jim Ferguson presented a new version of his talk on the life of James Clerk Maxwell. Equally absorbing were the statement that Boltzmann had called the model of viscoelastic liquids "too simple to understand" and the thought of Mrs Maxwell running up and down stairs with buckets of coal in an attempt to keep the loft warm for Maxwell's experiments! In another paper, Jim described his 3-dimensional plotting technique for viscoelastic liquids. Ken Walters presented a novel paper on the narrow spike of liquid which shoots upwards when a sphere falls into liquid. The spike often rises much higher than the distance the ball has fallen and when the liquid is viscoelastic the phenomenon is largely suppressed. This affords a possible means of measuring the extensional flow properties of the liquids.

Several flow processes were studied by means of mathematical models, Peter Townsend describing two slightly different methods of wire coating and Mike Webster covering his work on the new finite volume method. He also dealt with a model for the coating of glass rovings. Jeff Goshawk moved into the topic of soft solids, unintentionally provoking a lively argument about what a soft solid really is. What about drilling mud which has just set? (author) There must be some materials on the borderline between liquids and solids! Ken Thomas described collaborative work with the National Physical Laboratory on the die-swell phenomenon using an integral model (KBKZ), whilst Russell Davies gave an interesting discourse on relaxation time spectra with particular reference to the frequency ranges for which appropriate constants could be found.

Our French colleagues gave talks on varied topics - extensional flow of polymer solutions into orifices (Jean-Michel Piau), squeezing and mixing flows of flour doughs (his wife Monique), the cohesion of jets of printing ink and their impact on surfaces (Paul Attané) and the chemistry of sticky, adhesive polymers (Claude Verdier). Jon Maia, of Portugal, described preliminary work in which a rheogoniometer was modified to measure stretching flow of a hot polymer rod, attached to the rim of the rheo at one end and being gradually extended from the other end. This related to similar work by Ralph Oliver in which a jet of highly-elastic ("supergoo") was pulled from a nozzle on to the surface of a rotating cylinder driven by a Haake system. These tests showed an abrupt transition from liquid-like to solid-like behaviour; additionally, comment was made on the fact that the density of glycerol/water mixtures was reduced by more than one per cent as a result of the addition 500 parts per million (0.05 per cent) of polyacrylamide. Were chemical bonds being grossly modified? David Binding described a high-pressure capillary rheometer which should be capable of development (the oil industry would be interested) and finally Prof. Covas (of Portugal) gave an excellent talk, initially describing his own University (Minho) and progressing to a complete discussion of extrusion and injection moulding techniques.

The scientific programme was followed by meaningful discussions in the Jacuzzi, which sometimes strayed to the topic of skiing. "Blue" Walters acquired the nickname as a result of having, more than once, negotiated a difficult run near the top of the Beauregarde peak and is now a committed "downhill". Russell Davies demonstrated his own version of ski aerobatics by rolling over backwards off his chair and Ralph Oliver regretted going to Jim Ferguson's aid just off the edge of the piste. He pitched forward, bottom up, in soft snow, leaving a clear "scarecrow" imprint and with snow packed behind both lenses of his glasses! The younger members of the group demonstrated the challenge of Les Hautes de Manigot to the more sedate skiers and Jim was enticed to great heights by Claude Wolff. Following a desperate descent, Claude said "Jim is a very good skier - he is almost as good as I am"!

Mary Walters made good progress, under a variety of quality instructors and social proceedings were concluded with a get-together in Mike Webster's room, with entertainment provided by "Les trois crèmes brûlées". The meeting matched the quality of its best predecessors and it is hoped to continue the sequence next winter, Claude Wolff having offered to find a venue.

1997 BRITISH APPLIED MATHEMATICS COLLOQUIUM

Edinburgh, 1st-4th April, 1997

by Gillian Clissold, University of Wales, Aberystwyth

I took the appearance of the comet, Hale-Bopp in the sky as I left to catch my early train to Edinburgh as a good omen of things to come at the 1997 British Applied Mathematics Colloquium, which took place from 1st - 4th April this year.

Over 350 participants attended the meeting, a large number of whom were students. One of the exciting things about this colloquium is the opportunity it gives postgraduate students to give a presentation of their work, and to encourage them, the Watson prizes are awarded for the best presentations and posters.

There were five parallel sessions of oral presentations, as well as five invited lecturers who spoke to plenary sessions. These ranged over many aspects of applied mathematics, but there were several of particular interest to rheologists this year.

John Hinch from Cambridge gave one of the plenary sessions, and received a glowing introduction, when we were informed that 'when he gets it right he epitomises all that is best in British applied mathematics!' His talk was entitled 'Explaining the behaviour of elastic liquids', which he went on to do with great clarity for the benefit of the many delegates whose knowledge of non-Newtonian fluids was scanty, as well as providing food for thought for those in that field. He referred to various types of constitutive equations and their varying degrees of success in explaining the behaviour of such problems as flow past a sphere, and contraction flow vortices.

We were privileged to have a visit from Prof. Milton van Dyke from Stanford University, whose work in the field of perturbation methods in fluid dynamics is a classic text for many rheologists. He spoke about how he is revisiting work carried out twelve years ago using long series solutions to various rheological problems. With the advent of the modern computer we may extend a regular perturbation series to dozens or even hundreds of terms, and analysis of the structure of these solutions in the complex plane of the perturbation quantity can be used to improve the results. He posed the question 'When is a mathematical singularity a physical singularity?' in his closing comments, and left us all to ponder on this. Prof. van Dyke also gave a lecture entitled 'Snapshots from an Album of Fluid Motion' as part of the Edinburgh Science Festival after the end of the colloquium.

Of the contributed talks, one of the most interesting for me was given by A. Clarke from Kodak, who spoke about 'Flow Visualisation of Curtain Coating Phenomena'. The fluid is shear thinning, and the high shear rate where the curtain meets the film gives rise to a recirculation region, and often an instability downstream. Three eddies were identified in the recirculating area using flow visualisation techniques.

Sarah Burgess from Manchester gave a talk concerning yield stress effects in the unsteady shear flow of a viscoplastic material between two infinite parallel plates, modelling the behaviour of a light duty clutch, and other control devices. Oliver Harlen from Leeds spoke about 'The drift in orientation of fibres suspended in a dilute polymer solution during oscillatory shear flow', where over many cycles the fibres drift towards alignment with the flow direction, which minimises the fibres' effect on the rheology.

Helen Wilson from Cambridge gave a talk about her research into the coextrusion instability of viscoelastic fluids, which included the clearest explanation I have ever heard of the nature of a viscoelastic fluid and the derivation of the Oldroyd B model, for which she deservedly won a Watson prize.

Another of the invited speakers who aroused great interest was K. Hutter from Darmstadt who spoke about his work modelling the flow of avalanches and glaciers. He explained that the ice sheet dynamics is essentially non-Newtonian Stokesian free surface flow, and modelled this as a power law fluid, where the varying presence of dust particles in the ice alters its properties.

The social programme of the colloquium was most enjoyable, with various receptions, including one in the beautiful library of the Old College, with a seemingly unlimited supply of malt whisky for us to taste and compare. Wednesday evening included a light hearted talk on the acoustics of brass instruments, liberally illustrated by musical demonstrations given by Dr. Murray Campbell of the Physics Department. The Banquet was held at the Dalmahoy Hotel and Country Club where we were greeted by a piper in full regalia, and then treated to a sumptuous meal.

The colloquium ended all too soon, but I hope that I may be able to attend many more and look forward to more contributions from rheologists in the future.

FOOD PROCESSING, EXPERIMENTATION & SIMULATION

Lake Vyrnwy, Mid-Wales, 24-26 March, 1997

Food for Thought

This was a very successful conference - a lovely location, occasional sunshine, good food to eat as well as for thought, a sensible balance between academic and industry in both the backgrounds of the attendees and the topics of their talks. The organisers (Dr. Gareth Roberts, ably assisted by members of the Institute of Non-Newtonian Fluid Mechanics of the University of Wales) are congratulated on and thanked for the success of their efforts.

In many ways, this conference represented a *meeting between the molecule and the continuum*, since, as the presentations and discussion unfolded, it became clear that many aspects of the R&D of Food Processing and Science could not be treated in isolation as either molecular kinetics or continuum mechanics. In addition, the talks clarified, on numerous occasions, how each acted to lubricate (cross-fertilize) the other.

Professor Howard Barnes (Unilever) set the scene for the conference with his opening address on "*Foods that Flow*". In a quite masterful way, it set the scene for and even anticipated the flavour of the subsequent presentations and deliberations. In particular, Professor Barnes stressed

- the key role that the food industry plays in the national economy;
- the importance of choosing the rheometry to truly reflect the nature of the application;
- the process of "experimentation → simple models for intuition and insight → simulations" in order to achieve the goal of correctly modelling the flow of foods in complex geometries;
- though food technology is diverse, the focus must always be and remain the needs and wishes of the customer;
- there was a crucial need to understand, model and explain the current rules-of-thumb used for decision making in the food industry, such as Brabender/Farinograph measurements; and
- the rheological issues which are central to modelling "foods that flow" are compressibility, viscoelasticity, temperature/shear sensitivity and multi(two)-phase flow (wall effects and inter-surface behaviour within a food).

As the challenges for the future, Professor Barnes suggested

- the fluid dynamics of cleaning;
- the modelling of chewing and swallowing; and
- understanding the (possibly unmet) needs of the customer.

The other invited talks were by Professor Gordon Williams, FRS, (Imperial College, London) on the *"Fracture Mechanics of Foods"*, and Dr. Sumana Chakrabati (Pillsbury Co.) on the *"The Applications of Rheology to Food Characterisation and Processing"*. Professor Williams started his talk with the proposition that the industrial characterisation of the texture of a food should be based on the following four physical properties

- elasticity, Young's modulus, E ,
- yield stress, σ_Y ,
- coefficient of friction, μ , and
- fracture toughness, G_C .

A careful discussion then followed of the various way in which one can perform simple experiments to determine μ , and G_C for cheese. The focus of these deliberations was the role of wire cutting. Professor Williams made one of the quotes of the conference: "People believe that, for foods, rheological data will be all over the place, but they are not. Though, however, if one goes to another block of cheese, then one tends to get a different set of answers." It is a little like the old saying "A place for everything, but everything all over the place." The point in the talk which caught everyones' attention was Professor Williams' comment that the elastic modulus of cheese was clearly different in compression and tension. Unfortunately, Dr. Chakrabati was unable to attend the conference because of a back injury, but, fortunately, her colleague Dr. Peter Pescheck was also an attendee who agreed to give the talk at short notice. Some of the key points of Dr. Chakrabati's talk were

- the different roles played by starch in food technology such as the stabilization of air bubbles in ice cream and dough, and the source for slip planes in puff pastry;
- the food industry needs rheology in order to interpret the feedback from customers in the assessment of product quality;

- rheology gives one the opportunity to obtain molecular information;
- slip and wall effects are the real world in the food industry, so there is an acute need to measure, model and interpret them; and
- for microscopy, "A picture is WORTH a thousand words", but, because rheology does not have that luxury, the presentation of rheological information to the "customer" is a major challenge.

Dr. Chakabрати's talk included two impressive videos. One showing the slip in mayonnaise, and the other showing fracture in fat free mayonnaise.

All the other 20 talks deserve a detailed summary, but this is, unfortunately, not possible. Dr. Sue Riley (BBSRC) and Dr. Mike Fredrickson (EPSRC) discussed technical matters related to the funding of food technology research. Together, the remaining 18 talks cover a very broad spectrum of the science and technology of food processing, including:

The Rheology of Specific Foods. Dr. Jeff Goshawk (INNFM) discussed the challenges of modelling the multi-phase response of mayonnaise to rheometric testing, conjectured that the phase-separation was due to particle migration, and used chemometric techniques to test this hypothesis. The effect on shear thickening of a hydrated polymer layer on the surface of fractionated starch granules was the topic examined by Dr. Bill Frith (Unilever). Interesting results were presented for the swelling of the starch particles in two different media (water and ethane diol). Cultured buttermilk was the topic examined by Dr. Francis Butler (University College Dublin), who showed how the structural parameter equation of Tiu and Boger (Chew and Bodger) could be modified in the light of experimental results. The rheology of wheat flour dough was the focus for three talks. Dr. Monique Piau (University of Grenoble) reported on the use of ultrasound techniques to analyse the consistency of dough, mixed to peak dough development, as a function of its water content and rest time. Dr. Bob Anderssen (CSIRO, Canberra) described current work on modelling the mixing of dough on a MixographTM. The role of enzymes in bread making was the topic of Mr. Brian Brooker's (IFR, Reading) talk. The goal is better breads from weaker flours, but first one must understand how the different commercial enzymes work. The multi-phase solidification characteristics of chocolate, which is controlled by its cocoa butter fat content, was examined by Professor Kevin Roberts (Heriot-Watt University).

The analogy between the tempering of steel and the crystallisation of chocolate was explored, as well as the related nucleation processes. The purity of olive oil was examined by Professor Douglas Kell (University of Wales, Aberystwyth). However, the goal and purpose of his talk was not directly rheological, but to explain to those present the potential of modern multivariate spectroscopic chemometrics for the identification of the presence or otherwise of particular molecules in the conjunction with rheological considerations. The advantages of having a suitably chosen control with respect to which to do the identification was carefully explained. Dr. Geoff Brownsey (IFR, Norwich) considered food polysaccharide functionality. The gel behaviour of naturally occurring and synthetic polysacchrides was examined as well as the effect of molecular modification on associated rheological properties.

The Modelling of Gellation. The rheology of foods, while they are being manufactured, was the focus for Dr. Sidi Chouikhi's (Unilever) talk, who went on to examine the breakup of gel structure under shear to make smaller units with desired properties. Modelling and simulation of gel systems for foods like yoghurt and margarine was discussed by Dr. Martin Whittle (University of Leeds), who indicated that the challenge is to model situations where a small change in additives can produce a large change in structure. Good visual agreement was obtained between simulated and real structure patterns.

Old, New and Novel Instrumentation. Dr. Mike Corfield gave Professor Brian Briscoe's (Imperial College, London) talk on the conical indentation testing of cheese. The role of load-loading tests was explained, and the classical Box-Cox statistical analysis of such data was mentioned. Understanding the rheological processes occurring at the gel-point has been a major motivation behind the development of the pulse-resonance rheometer. In his lively talk, Dr. Rhodri Williams (University of Wales, Swansea) described with clarity the wave theoretic basis for the instruments design and application. Mr. Ingham (Sensor Technology) described his company's new torque meter, which exploits the linear dependence of the frequency of Rayleigh surface waves on the applied stress. One has a situation where mechanical complexity has been replaced by electrical so that the measurement of torque can be more carefully and accurately controlled.

Modelling and Simulation. Dr. Mike Corfield (Imperial College, London) examined the mechanics of constrained food flows with particular emphasis on pastes, and showed that the lubrication theory assumptions, which implied flow around a stagnant central region, were invalid. The computer simulation of container filling with foods was the subject of Professor Sean McKee's (University of Strathclyde) talk, which included results about the buckling of a falling column of Newtonian fluid as validation. Dr. Ralph Oliver (University of Birmingham) spoke about the heat transfer to liquid foods in laminar flow in horizontal tubes. The associated dimensional analysis was built around the Nusselt number and the Graetz-L  v  que equation, and resulted in the conclusions that most liquid foods containing edible starch have a pseudo-plastic behaviour and tube heating transfer can be enhanced through the application of static mixers. Beans in sauce and peas in water were the motivation for the solid-liquid numerical simulations examined by Dr. Alan Clarke (Silsoe Research Centre). The goal was the characterisation of the normal stresses and the effective solids viscosity of such mixtures. Such work leads to the counter intuitive result that the concentration of a solid-liquid mixture in a pipe is different to that in the container feeding it (because of the relative velocities of the liquids and solids).

Extensional Viscosity. The focus for the last two talks at the conference was extensional viscosity. Dr. John Meadows (NEWI) compared the extensional and shear viscosities for a variety of aqueous polymer solutions in order to compare the relative effects of molecular weight, concentration and molecular configuration. Some quite interesting comparisons were presented. Professor Jim Ferguson (University of Strathclyde) examined the extensional viscosity of a variety of cheeses and compared them with previously derived results for synthetic polymers melts.

At the end of the conference, Dr. Ralph Oliver summarized the deliberations and, in his usual style, ended with an appropriate limerick.

There was a young fellow called *Bodger*,
Who was an Australian codger,
He also did yoga,
While dressed in a toga,
But, truly, his real name was *Boger*.

Bob Anderssen (visiting INNF, University of Wales, Aberystwyth)
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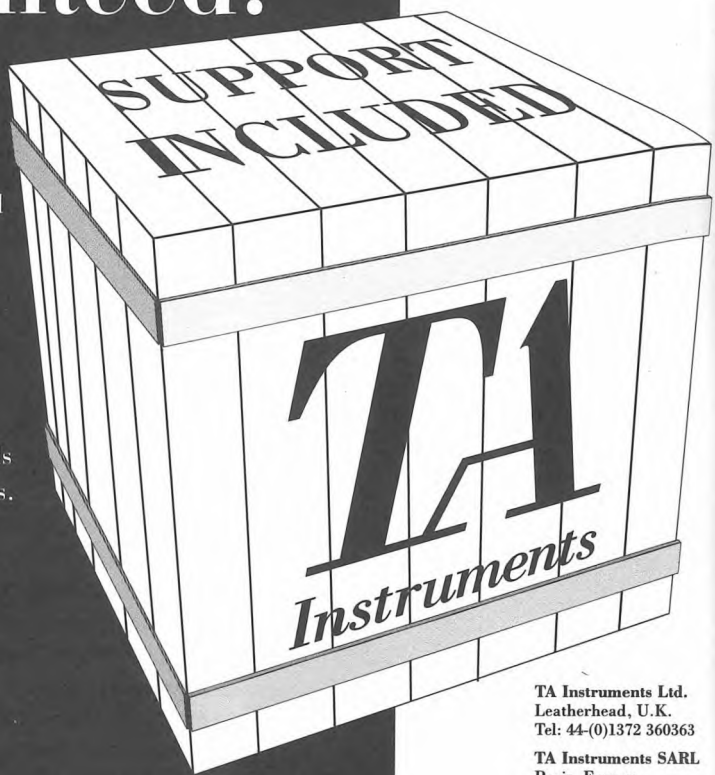
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THE BRITISH SOCIETY OF RHEOLOGY

Main Roles for the BSR in the New Millennium Some Suggestions for Discussion

Russell Davies, Paul Doody, Carole Moules

The BSR Council recently set up a working party of the above three of its members to consider the future role of the Society. The following is their report to the Council meeting in March 1997 of their initial views. It is reprinted here so that the Society membership as a whole has a chance to add their views to those of Council and to influence any changes that may result. If you do have any views or points you wish to raise, please communicate them to one of the above members.

The main aim of the BSR has always been to serve the rheological community as best it can. Traditionally this has been done (i) via the Bulletin, which disseminates information and reports current events in rheology at an informal level; (ii) via Rheology Abstracts, which provides an invaluable survey of current publications of relevance to rheology; and (iii) by organizing conferences. As we approach the new millennium the BSR must respond to the changing needs of the rheological community. This letter is meant to generate discussion on how best the Society can continue to serve its members.

In writing this letter we have borne in mind two major changes which are likely to affect the Society in the long term. First, the Society now has an increased revenue resulting from the decision to publish Rheology Abstracts privately (currently £9000 per annum). Secondly, the BSR has been instrumental in founding the European Society of Rheology (June 1996). It is incumbent on the BSR to play a leading role within the ESR.

We address the following topics:

1. Serving Industry.
2. Serving the Academic Community.
3. Conferences.
4. Publications.
5. Marketing and Publicity.

1. Serving Industry.

The BSR should create more direct links with industry by offering Company Membership. In return for an annual subscription the BSR should offer:

- (i) advice on general or specific training needs;
- (ii) advice on instrumentation;
- (iii) the organization of Problem Oriented Workshops to help solve current problems or to identify specialist research avenues.

The BSR membership collectively covers an enormous range of expertise, much wider than can be offered by any individual consultant, training agency or instrument manufacturer. The BSR should attempt to exploit this knowledge base to the advantage of its company members.

2. Serving the Academic Community.

The BSR has always offered travel grants to students, and should continue to do so. The scheme should be extended to enable international scholars to visit British Universities for short periods, either to plan collaborative research projects or to give public lectures on rheological topics.

BSR Studentships The possible alternatives (in order of costs) are:

- (i) Extra funding for studentships already funded by research councils (£1000 per annum).
- (ii) Case studentships (£1000 per annum for 3 years).
- (iii) MSc (fees only). (£2000 per annum for one or two years).
- (iv) PhD shared studentships with industry, possibly as part of a company membership scheme. (£4000 per annum for 3 years).

3. Conferences

There are two points to make here. The conference scene internationally is now highly active. Secondly, academic and industrial members of the BSR have very little time to take on organizing roles. Often they must organize meetings for their own institutions for fund-raising purposes.

Instead of competing *against* the system we believe the BSR should help in other ways. We Propose:

- (i) Annual meetings of the BSR should be discontinued, but
- (ii) The Young Rheologists' Day should become a regular event (every 2 or 3 years).
- (iii) The BSR should sponsor other meetings (either no, or minor financial contributions).
- (iv) Major financial contribution in return for a part of the profits (e.g. Rheology 2000).
- (v) The AGM should be held at a YRD or a sponsored meeting.

4. Publications

Rheology Abstracts should continue in its present form. There is still a role, despite easy access to electronic abstracting.

We suggest a new format for the Bulletin, comprising:

- a wider listing of events and conferences
- an ESR page
- an Industry page - individuals from industry to write on issues of importance to those companies
- a University page - individuals from the academic community to write on issues of importance to their institutions
- a Student page
- a Day in the Life of an academic or industrialist
- life elsewhere - comments and articles from outside Britain.

5. Marketing and Publicity.

The BSR needs to establish the correct profile/image for projecting itself. We should consider commissioning a marketing expert to help us. Particular issues on which we need advice are; how best to approach industry, and how best to increase public awareness of rheology.

Other aspects for consideration are: a World Wide Web page; schools liaison; press releases on important rheological issues and events; list of rheological expertise of BSR members.

HOWARD AT THE PALACE

Friday March the 21st's entry in Howard's diary said - the Palace! That morning the Barnes family collected together at Buckingham Palace from Bromborough, Bristol and Ealing to see Howard receive his OBE. That day the Queen was away and the Prince of Wales was responsible for the Investiture - quite appropriate as Howard is Welsh. On entering, the recipients were arranged into groups and given precise instructions:

- * When your name is read out, walk to the centre of the room,
- * turn to your left and bow, and walk towards the Prince.
- * He will pin your award onto the clip previously provided.
- * He's happy to be addressed as Sir, rather than HRH,
- * he will say something appropriate, you answer his questions,
- * he shakes your hand, you walk backwards and bow again,
- * turn to your right and walk out"

When Howard's turn came, he found that the Prince was well briefed by his aide who whispered in his ear between each recipient, so he knew about Howard's connections with Unilever Research, Rheology, etc. Howard was able to add that he had been at university in Aberystwyth when the Prince arrived for a crash course in Welsh, so that he could reply to the Queen in Welsh at his own investiture as Prince of Wales at Caernarfon. The Prince remarked what a small world it was. The hand was offered, Howard walked backwards, bowed, etc.

Also that day as recipients were Martin Offiah (MBE) the well known rugby player, and Steve Redgrave (CBE) the rower who won the gold medals at the Olympics. After the usual photograph session, the family walked across Green Park for a celebratory lunch at the Ritz. There they were delighted to find that two tables away from them, the Queen Mother was celebrating with another recipient from that day's Investiture - a nice end to a very happy day!



Howard with his wife and two of his sons at the Palace

SCOTT BLAIR COLLECTION WORKING PARTY

From time to time we are asked to make up collections of the Bulletin and Rheology Abstracts. To do this we rely on gifts from members. At present our stocks are rather low and we would be pleased to receive copies which are no longer needed. This applies particularly to earlier issues.

The address to which they should be sent is :-

Mrs C. Ghosal,
Hugh Owen Library,
University of Wales,
Aberystwyth
SY23 3DZ

Most of the BSR collection of business papers which are stored at Aberystwyth are made up from past literature from Council Officers, but we have also received some books and papers from Society members. The papers refer to people, meetings, and events which we think will be of special interest to BSR members. Any offers will be considered and, if they are appropriate, will be added to the collection.

My address is :-

Dr J.J. Benbow,
Fairways,
3 Dunvegan Close,
Kenilworth,
Warwickshire
CV8 2PH

John Benbow

Dear QA Managers and Process Engineers:

1. Are you tired of filling up a hot barrel every few minutes on your capillary rheometer? Wouldn't it be nicer (& safer & more efficient) if this could be done automatically for you, so you just had to load it every 10 barrels full with cold material into a cold hopper? You can still run it at many speeds and with 2 dies for each barrel full! **Ask for a P5.**

2. Do Gardener glass tubes give you a headache with their imprecise lettering system for measuring viscosity after you waited 7 minutes for your resin to cool? You do not wish to go to the expense of a £30k On-Line rheometer (although this could pay for itself in under 2 years*), but wouldn't it be more convenient and faster to be able to measure an accurate viscosity digitally at 80°C (or other T a few °C below the process T)? Then repeat a measurement twice more and have a print-out of the data - all for £5k - £6k? 1% accuracy and reproducibility is achievable & after each test you throw away (or recycle) the glass (or Pyrex**) test tubes which cost 12p each! **Ask for Visco-Noury 150°C! (to BS188)**

3. Are you still using a paper-clip to test reactivity and gel-time of your thermo-set resin or food gel on a hot plate or beaker? For £8k (+ your PC) you can automate this and have both measured for you automatically using a range of cleanable or disposable end fittings which measure right into the solid state! **Demandez Trombomat!**

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* P1 OLR has often paid back in <1 year.

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NEWS OF EUROPEAN RHEOLOGY SOCIETIES

6th Nordic Rheology Conference, 6 - 9 August 1997, Reykjavik, Iceland

The sixth Nordic Rheology Conference will take place in Reykjavik, Iceland from the afternoon of August 6 to August 9, at the Grand Hotel Reykjavik. The 6th annual business meeting of the Nordic Rheology Society will also take place during the conference.

The conference will include a general session, covering both the theoretical and experimental aspects of rheology, with special sessions on rheology of food, polymers and particle suspensions such as cement based materials. Also included are invited lectures by:

H.A.Barnes (UK) Rheology of particle suspensions

J.Giacomin(USA) Suspension in general

P.F.G.Banfill (UK) Cement based materials

Among the topics of the special sessions is Rheology of Particle Suspensions, covering both the technical and experimental aspects, as well as the fundamental aspects of dispersing polymers. Rheology of particle suspensions is a rapidly developing area of interest for industry and academics and the special session will provide a forum for exchange of information and ideas between Nordic industrial companies and universities. In special, a new area has expanded rapidly during the last decade, where the Nordic countries have been pioneers in many ways; rheology of cement based materials such as paste, mortar and concrete.

Exhibits of products and demonstrations of processes will also be arranged within the framework of the conference. The deadline for final registration and submission of manuscripts for the Annual Transactions of the Nordic Rheology Society is 1st May 1997.

For further details contact: Olafur Wallevik, IBRI, 112 Keldnaholt, Iceland. Tel: +354 567 6000 Fax: +354 567 8811



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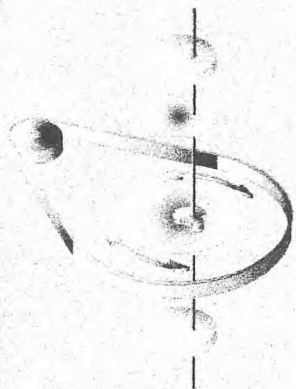
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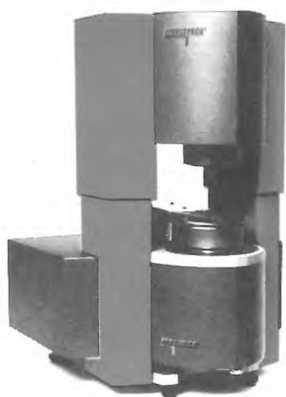
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RHEOLOGENTAGUNG 1997**A Joint Meeting of the German Society of Rheology (DRG) and
the Section Rheology of the Czech Chemical Society****Chemnitz, March 11-13, 1997**

The biannual meeting of the DRG was organized in conjunction with the Czech Rheologists at the University of Chemnitz-Zwickau, Chemnitz, which was known as Karl-Marx-Stadt in the not so distant past and has a peculiar charm of a city where recent history has left its marks, is located between Prague (150 km) and Berlin (200 km), and was an ideal location for the purpose. The scientific programme featured 3 plenary lectures by H. Buggisch (U Karlsruhe) on "Rheology of Pastes", by J. Sestak (U Prague) on "Pressure Drops in Pipes and Ducts", and by M. Fleissner (Hoechst AG, Frankfurt) on "Structure and Processing of Metallocene Polyolefines" as well as 83 contributed papers from all branches of rheology.

A public evening lecture on "Rheology of Avalanches and Glaciers" by K. Hutter (U Darmstadt) attracted a wide audience and was followed by a champagne reception of the DRG, Augustusburg Castle, a splendid manor built in 1568-72 by August, Elector of Saxonia, was the venue of the conference dinner. The dinner speech by Mrs Aksel on "Rheology, Theory and Application in Daily Life", detailing the rheology of honey coating her husband, the right honourable local conference organizer, Prof. N. Aksel (U Chemnitz-Zwickau), was greeted by the 150 delegates with great applause.

The next biannual meeting of the DRG is scheduled for March 1999 in Leipzig, and will be organized jointly by the DRG and the polymer physics group of the German Society of Physics (DPG).

M.H. Wagner, President, DRG.

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Note: A similar course is also organised, for the 22nd time, in the USA,
at the University of Minnesota, August 11-15 (1997)

STANDARD NOMENCLATURE, SYMBOLS AND GRAPHS FOR RHEOLOGICAL DATA - A BEGINNER'S GUIDE

Prof Howard A. Barnes, Unilever Research, Port Sunlight, England

1. Introduction

In reporting rheological results, there is often confusion as to the nomenclature and symbols used in describing material properties etc. This is true in academic and industrial circles, due in part to the different origins of the subject. The (American) Society of Rheology has for many years been concerned with this problem, and has sought to introduce standards. These have been reported at various stages for nearly 40 years. The latest, written by Prof. John Dealy is thought to be definitive [1]. It coincides almost exactly with the names and symbols used by Barnes, Hutton and Walters in their text-book called "An Introduction to Rheology" [2]. IUPAC is also producing a standard nomenclature for material properties based on a similar approach.

In this note, those parameters most often measured and reported in rheological work are put into the standardised form. Also, they have been plotted in a conventional way, following the Institute of Physics suggestions for axis labels and units. It is hoped this will remove any confusion, and make life easier for newcomers to the subject.

2. Plotting Graphs

Graphs of rheological quantities are often plotted on logarithmic axes so that the wide range of shear rates used and viscosities found are best represented. In this case the axis divisions are in decades. The best way of representing this is to use decade exponents, i.e. 10^4 ; other ways to represent this can be clumsy and confusing, e.g. $E+4$, and are best avoided. The axis labels can also be confusing. To overcome this, the standard format should first give the name of the quantity being plotted, e.g. viscosity, then its symbol, in this case η , and then the units should be given, e.g. Pa.s, but shown as a division, so that the quantities plotted on the graph are pure numbers. Thus the complete axis label should look like:

Viscosity, η / Pa.s or Shear stress, σ / Pa

If the units being plotted are large, then the units should be increased, for instance,

Tensile stress, σ_E / MPa,

then the numbers plotted are in mega-Pascals, and the numbers are arrived at by dividing the original quantity by 10^6 . Reference 2 gives a large number of examples of the use of this method, where it should be noted that the names of the quantities plotted begin with a capital letter. If graphs are plotted to show qualitative relationships, then the units should be omitted or equally if the quantities are dimensionless.

3. Rheometry

Virtually all rheometric measurements have to do with imposing either a force or a movement at a surface in contact with a contained liquid. The response of this liquid to either the force or the movement is measured at that surface or at some other surface in contact with the liquid. The surfaces so described also make up simple containing geometries for the liquids. Examples of the geometries include tubes, parallel plates, cone and plate, and concentric cylinders. Sometimes artifacts arise whereby the presence of these surfaces interferes with the liquid microstructure, giving apparent slip effects. This has been recently reviewed, and ways of coping with the situation were given [3].

The aim of rheometry is to reduce the applied force to a stress, and the movement to a measure of shear or shear rate (in simple shear flow) imposed on a small element of fluid, either at a standard reference point such as the immediate vicinity of the tube wall; the inner cylinder or the outer edge of the cone and plate etc. Then for instance the stress and the shear rate can be plotted as a function of one another, or else the stress can be divided by the shear rate to give the viscosity.

Other kinds of experiments are performed and these will be described as necessary. All the quantities used here are given in SI units, where for instance the units of viscosity are Pa.s, which are 10 times bigger than the older cgs unit of viscosity, the Poise, but numerically, $1 \text{ mPa.s} \equiv 1 \text{ cP}$, which is the viscosity of water at 20.2°C .

3.1 Stress

Stress is force per unit area, and would thus have the units of Newtons per square metre, Nm^{-2} , but stress like pressure is now given the single symbol of Pascal, Pa, in the SI system. For reference, standard atmospheric pressure, 14.7 PSI is 10^5 Pa. Stress is symbolised using the Greek letter sigma, σ . For simple shear flows (like those found in rotating flow geometries and inside long pipes) the symbol is simply σ , and for extensional flow, it is σ_E .

3.2 Shear and Shear Rate

Shear and shear rate are the proper measures of deformation and deformation rate in simple shear flow, see reference 2, chapter 1. Shear itself is dimensionless, but the rate of shear in steady continuous flows has the dimensions of s^{-1} . The symbols for shear and shear rate are γ and $\dot{\gamma}$ respectively: the latter dot convention follows Newton's original way of expressing differentiation with respect to time.

3.3 Viscosity

Viscosity is the ratio of stress to shear rate, thus $\eta = \sigma / \dot{\gamma}$, and has the dimensions of $\text{Pa}\cdot\text{s}$ or Pa s , with the stop being optional, but a space should be left if the full stop is omitted, so $\text{Pa}s$ is unacceptable. As this unit is only about 0.001 for water, the prefix m is useful, so $1 \text{ mPa}\cdot\text{s}$. Usually the asymptotic values of viscosity at very low and very high shear rate respectively, the so-called zero-shear and infinite-shear viscosities are symbolised as η_0 and η_∞ .

It is also worth noting that the following quantities are often quoted, with the appropriate symbols and units: viscosity of the solvent or continuous phase, η_s , $\text{Pa}\cdot\text{s}$; dimensionless relative viscosity, η_r , the ratio of the viscosity and the continuous phase viscosity, η / η_s ; the dimensionless specific viscosity, η_{sp} , given by $\eta_r - 1$ and the intrinsic viscosity, $[\eta]$ (with dimensions $\text{m}^3 \text{ kg}^{-1}$) which is the specific viscosity divided by the concentration of a dispersed phase.

Strictly speaking, if shear rate is used as the variable as in laboratory viscometers, viscosity/shear rate should be plotted. Conversely, if stress-controlled instruments are used, for instance the Carrimed or Bohlin etc, then viscosity/shear-stress should be plotted. In fact the latter are far more revealing for very shear-thinning non-Newtonian liquids.

The quantities we have discussed so far and their equivalent for uniaxial extensional flow are summarised in table 1.

QUANTITY	SIMPLE SHEAR FLOW	UNIAXIAL EXTENSION	SI UNITS
Stress	Shear stress, σ	Tensile stress, σ_E	Pa
Strain	Shear strain, γ	Tensile strain, ϵ	-
Strain Rate	Shear rate, $\dot{\gamma}$	Strain rate $\dot{\epsilon}$	s ⁻¹
Viscosity	Shear viscosity, η	Ext. viscosity, η_E	Pa.s or Pa S

Table 1: Nomenclature, symbols and units for shear and extensional flows.

3.4 Simple Constitutive Equations

Sometimes the results of viscosity measurements can be described by simple equations, for instance the Sisko equation, here the standard nomenclature is, $\eta = k \dot{\gamma}^{n-1} + \eta_\infty$ where k is called the consistency, and has the strange units of Pa.sⁿ and n is the dimensionless power law which usually lies between 1 (for Newtonian liquids) and 0 (for most non-Newtonian liquids). For very shear-thinning liquids, it is easy to show that the Sisko equation reduces to $\sigma = \sigma_y + \eta_\infty \dot{\gamma}$, the Bingham equation, where σ_y is an apparent - but not real - yield stress. For a number of applications, the Sisko model can be simplified to the Power-law model, $\sigma = k \dot{\gamma}^n$ if $k \dot{\gamma}^{n-1} \gg \eta_\infty$ which is often the case at low shear rates.

3.5 Elasticity

Elasticity in liquids manifests itself in a number of ways, but usually we only measure the linear elasticity in oscillatory flow and the normal forces generated in steady-state flow. Oscillatory shear can be performed in almost any geometry if it is limited to testing in the region of linear response, usually at a single frequency, ω , where although usually referred to in its familiar terminology of hertz (Hz), i.e. cycles per second, *all calculations are done on the basis of the angular frequency in radians per second, which is 2π times the value in Hz.* The method requires that either a stress or a strain wave is applied and the corresponding response is monitored. This response is then resolved into the in-phase elastic response and the out-of-phase viscous response. The simple division of peak values of stress and strain in the input and output waves gives the complex shear modulus, $G^*(\omega)$. The in-phase component of response yields the storage modulus, $G'(\omega)$ and the corresponding out-of-phase component gives the loss modulus, $G''(\omega)$. The units of all moduli are Pa. Sometimes the dynamic viscosity, $\eta'(\omega)$, is plotted, which is the loss modulus divided by the applied frequency, hence: $\eta'(\omega) = G''(\omega)/\omega$, with the normal viscosity units of Pa.s - remembering that ω is the angular frequency in radians per second. The plot of dynamic viscosity against frequency is then analogous to viscosity against shear rate and at very low values of ω and $\dot{\gamma}$ the viscosities necessarily converge.

In steady-state flow, elasticity manifests itself in normal-stress differences, and in its most well-known form, as a force pushing rotating plates apart, either parallel plates, or cone and plate. When this is reduced to stresses, we have the so-called first and second normal stress differences, N_1 and (the infrequently measured and much smaller) N_2 . Being stresses, these again have the units of Pascals, Pa. Sometimes coefficients are obtained from these normal stress differences by dividing by the shear rate squared, hence $\psi_1 = N_1 / \dot{\gamma}^2$ and similarly for ψ_2 : these coefficients have the units Pa.s². When plotted against shear rate they have the same general shape as the viscosity curve, with an asymptotic limit at very low frequency which should be the same value as $2G''/\omega^2$.

3.6 Creep Testing

Creep testing is the application of a stress and monitoring the strain response of the liquid. Creep testing is quite revealing in that it first detects the immediate elastic response of a material, and eventually settles down into a steady-state viscous response. The parameter plotted is the compliance obtained by dividing the strain γ obtained at any time t by the applied stress σ but because it is a function of both applied stress and time, it is written $J(t, \sigma)$. Very often at long times, the strain response is linear with time, then we can write $J(t, \sigma) = J_s(\sigma) + t/\eta$ where J_s is the steady-state compliance. It is from this expression that we usually evaluate the viscosity η at very low stresses and hence shear rates, typically $<10^{-4} \text{ s}^{-1}$: in fact η is then η_0 , the zero shear viscosity. The value of J_s is constant at low values of applied stress but usually decreases rapidly when the material is in the nonlinear region of response.

If the creep test is carried out in uniaxial extension, then for a properly defined strain, the tensile creep modulus is given by: $D(t, \sigma_E) = \epsilon/\sigma_E$. At long times, the strain becomes a linear function of time and then, $D(t, \sigma_E) = D_s^0 + t/\eta_E$. The properly defined strain is given by the increase in length of a thread or rod of material divided by the original length if the increase in length is small, or given by the natural logarithm of the ratio of the current length at time t to the original length, i.e. $\epsilon = \ln(l/l_0)$.

4. Other Rheological Quantities

Various non-steady-state quantities may be defined, such as growth and decay in stress or strain, but they are rarely used in internal reports. The suggested nomenclature for these may be found in the quoted references [1,2].

5. References

1. J.M.Dealy, J.Rheol., 39(1) (1995) 253 - 265.
2. H.A.Barnes, J.F.Hutton and K.Walters, "*An Introduction to Rheology*", Elsevier, Amsterdam, 1989.
3. H.A.Barnes, J.Non-Newt. Fluid., 56 (1995) 221 - 251.

CONFERENCE DIARY

DATE	PLACE	DETAILS
7-10/5/1997	Capri, Italy	The Second International Conference on 'The Dynamics of Polymeric Liquids' Hotel Residenza, Capri. Contact: Prof. K. Walters, Dept of Mathematics, University of Wales, Aberystwyth, Ceredigion, SY23 3BZ, UK Tel: +44(0) 1970 622750 Fax: +44(0) 1970 622777
29/6-2/7/1997	Univ of Delaware USA	'The 71st Summer Symposium on Colloid and Surface Science' . Sponsor: American Society's Division of Colloid and Surface Chemistry. http://www.che.udel.edu/colloid/
27-31/7/1997	Melbourne, Australia	'Second Pacific Rim Conference on Rheology' Conference Organiser: David V. Boger, Univ of Melbourne. Conference Secretary: Leong Yeow, Univ of Melbourne. Technical Programme: Carlos Tiu, Monash University. Local Arrangements: Sati Bhattacharya, RMIT. Contact: Christine Collis, Dept of Chemical Engineering, The University of Melbourne, Parkville, Victoria 3052, Australia. Tel: 61 3 9344 7440 Fax: 61 3 9344 4153 E-mail: prcr2@unimelb.edu.au
6-9/8/1997	Reykjavik Iceland	'Nordic Rheology Conference 97' with special sessions on Rheology of Particle Suspensions & Cement Based Materials Contact: Olafur Wallevik, IBRI, 112 Keldnaholt, Iceland Tel: +354 567 6000 Fax: +354 567 8811 Web site: http://www.sik.se/nrs/
19-21/8/1997	Gothenburg Sweden	'The Polymer Processing Society' Europe/Africa Region Meeting, Conference of Polymer Processing. Organized by: Chalmers University of Technology, Conference Secretary: Dr Johan Becker, Department of Polymeric Materials, Chalmers University of Technology, S-412 96 Gothenburg, Sweden Tel: +46 31-772 1316 Fax: +46 31-772 1313 E-mail: jbecker@polymmm.chalmers.se

DATE	PLACE	DETAILS
8-10/9/1997	Wrexham, UK.	'Polymers and Surfactants: Association, Segregation, Competition at Interfaces' , Royal Society of Chemistry, Faraday Division, Colloid and Interface Science Group. & Society of Chemical Industry, Colloid & Surface Chem. Group. Contact: Prof. P.A. Williams, Centre for Water Soluble Polymers, The North East Wales Institute, Plas Coch, Mold Road, Wrexham, LL11 2AW, UK Tel: +44 (1978) 290666 Fax: +44 (1978) 290008
8-12/9/1997	Bordeaux France	'1st World Tribology Congress' Contact: J. Brown, World Tribology Congress (C491), Inst. of Mechanical Engineers, 1 Birdcage Walk, London, SW1H 9JJ, UK. Fax: +44 171 222 9881
23-26/9/1997	Bordeaux France	'2nd World Congress "Emulsion"' Contact: Comité Mondial de l' Emulsion, 50 place Marcel Pagnol, 92100 Boulogne-Billancourt, France Tel: +33 1 4761 7689 Fax: +33 1 4761 7465
19-23/10/1997	Columbus, OH, USA	'69th Annual Meeting of the Society of Rheology.'
24-25/11/1997	Malmö Sweden	'The Rheology of Industrial Coatings Systems' Contact: Calmia AB, Box 2161, S-220 02 Lund, Sweden Fax: +46 46 211 0020
1-4/3/1998	Pasadena California, USA	'2nd International Conference on Mechanics of Time Dependent Materials' The Society for Experimental Mechanics Contact: Kathy Ramsay, Conference Manager, SEM, 7 School Street, Bethel, CT 06801, USA Tel: (+1-203) 790-6373 Fax: (+1-203) 790-4472 E-mail: sem@sem1.com or Mateja Bourke, Secretary, SEM - European office Cesta na Brdo 49, SI-1000 Ljubljana, Slovenia Tel: (+386) 61 123 2247 Fax: (+386) 61 123 2471 E-mail: mateja.bourke@ki.si

DATE	PLACE	DETAILS
7-9/7/1998	Brighton UK	'World Congress on Particle Technology 3' Contact: Miss Jennie Black, Conference Section, IChemE, 165-189 Railway Terrace, Rugby, CV21 3HQ, UK Tel: +44 (0) 1788 578214 Fax: +44 (0) 1788 577182 E-mail: jblack@icheme.org.uk
6-11/9/1998	Ljubljana Slovenia	'5th European Rheology Conference' Contact for Scientific Information: Prof. Igor Emri, Center for Experimental Mechanics, University of Ljubljana, Cesta na Brdo 49, SI-1000 Ljubljana, Slovenia Tel: (+386) 61 123 2247 FAX: (+386) 61 123 2471 E-mail: Rheo.98@ki.si Contact for General Information: Teja Alic, Cankarjev dom Presemova 10, SI-1000 Ljubljana, Slovenia Tel: (+386) 61 210956 FAX: (+386) 61 217 431 E-mail: cankarjev.dom@k2.net
4-8/10/1998	Monterey, California, USA	'70th Annual Meeting of the Society of Rheology.'
March 1999	Leipzig Germany	'Rheologentagung 1999' Joint meeting of the German Society of Rheology and the Polymer Physics Group of the German Society of Physics
17-21/10/1999	Madison, Wisconsin, USA	'71st Annual Meeting of the Society of Rheology.'
21-26/8/ 2000	Cambridge, UK	'Rheology 2000 - XIIIth International Congress on Rheology' To be organised by the British Society of Rheology with the assistance of the European Society of Rheology. Contact: Chairman of the Executive Committee, Prof. K. Walters FRS., University of Wales, Dept of Mathematics, Penglais, Aberystwyth, Dyfed, SY23 3BZ, Wales, UK. Tel: (+44) 1970 622750 Fax: (+44) 1970 622777

Travel grants are available to help students attend any of these meetings.
Applications to the BSR Secretary supported by a letter from supervisor.

COURSE DIARY

DATE	PLACE	DETAILS
27-30/5/1997	Ross Priory Loch Lomond Scotland	'Theoretical, Experimental and Industrial Aspects of Rheology' Dept of Pure and Applied Chemistry, University of Strathclyde. Contact: Prof J. Ferguson or Dr N.E.Hudson Tel: +44 (0) 141-548-2161 or 2162 Fax: +44 (0) 141-552-5664 E-mail: n.e.hudson@strath.ac.uk
11-15/8/1997	Minneapolis Minnesota, USA	'Rheological Measurements Short Course' Sponsored by Center for Interfacial Engineering and University of Minnesota. Contact: Kathy Walsh, Professional Development and Conference Services, University of Minnesota, 204 Nolte Center, 315 Pillsbury Drive S.E. Minneapolis, MN 55455-0139. USA Tel: (612) 625-5512 Fax: (612) 626-1632 E-mail: kwash@mail.cee.umn.sdu Web site: http://www.cems.umn.edu/conferences/rheocourse.html
8-12/9/1997	Leuven Belgium	'European School of Rheology' 'Short Course on Rheological Measurements' Applications to Polymers, Suspensions and Processing. in cooperation with the Belgian Group of Rheology and the European Society of Rheology. Contact: Dr.Ir. Jan Vermant, Dept of Chemical Engineering, de Croylaan 46, B-3001 Heverlee, Belgium. Tel: +32 / 16 / 32 23 55 Fax: +32 / 16 / 32 29 91 E-mail: jan.vermant@cit.kuleuven.ac.be Web site: http://www.cit.kuleuven.ac.be/cit/ltrk/course.html
13-17/10/1997	Hinckley Leicestershire	'School of Industrial Rheology '97 & Back to Basics' Contact: Camtel Ltd., FREEPOST, 5 Carrington House, 37 Upper King Street, Royston, Herts, SG8 9BR Tel: +44 (0) 1763 244280 Fax: +44 (0) 1763 244298 E-mail: camtel_ltd@compuserve.com
3-7/11/1997	Glasgow Scotland	'Process Rheology' Dept of Pure and Applied Chemistry, University of Strathclyde. Contact: Prof J. Ferguson or Dr N.E.Hudson Tel: +44 (0) 141-548-2161 or 2162 Fax: +44 (0) 141-552-5664 E-mail: n.e.hudson@strath.ac.uk

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MEMBERSHIP NEWS

The following applications for membership were approved at the Council meeting on March 26th, 1997.

Dr O.G. Harlen,
Dept of Applied Maths Studies,
University of Leeds, Leeds,
LS2 9JT
(fts BDGN)

Ir I. Heessels,
GE Plastics BV, Plasticlaan 1,
4612 PX Bergen op Zoom,
The Netherlands
(feta BCDFG)

Dr L.J. Kecskes,
US Army Research Laboratory,
AMSRL-WM-WD,
B120, Aberdeen Proving Ground,
MD 21005, USA
(petsa AGHI)

Dr D.T. Leighton,
Dept. of Chemical Engineering,
University of Notre Dame,
Notre Dame
IN 46544, USA
(fetsa FGHM)

Mr P.J. Moran,
Dept of Chemistry,
University of Huddersfield,
Queensgate, Huddersfield,
West Yorkshire
(fetsa GO)

Ms F. Power,
Linkam Scientific Instruments,
8 Epsom Downs Metro Centre,
Waterfield, Tadworth,
Surrey, KT20 5HT
(petsa ABCDEFGHIJKLM)

Mr M.R. Smithson,
CBDE Porton Down,
P & D1 Building 383,
Salisbury, Wiltshire,
SP4 0JQ
(fesa BCD)

Mr A. Totosaus,
Av. Michoacan y la Purisma,
Colonia Vicentina 09340,
Distrito Federal,
Apdo Postal 55-535, Mexico
(pes L)

Mrs C. Tiver,
Dept of Mathematics,
University of Wales,
Aberystwyth, Dyfed, SY23 3 BZ
(ftsa N)

It is with regret that we have been informed of the death of the following member: Mr G.R. Sothorn, a member since 1955 and Hon. member since 1993.

The following member has resigned:
Dr A.J. Rosenthal.

With these changes, the membership stands at 624, including 54 honorary members.

Classification of abbreviations for Members' Rheological Interests

f	Member's main interest is rheology (ie. full-time)		
p	rheology is secondary interest (ie. part-time)		
e	approach is experimental	t	approach is theoretical
s	area of work is pure science	a	area of work is technology
A	metals	I	glasses, ceramics
B	composites	J	oils, greases
C	solid polymers	K	building and road materials
D	molten or dissolved polymers	L	foodstuffs
E	natural fibres	M	biological materials
F	liquid-liquid systems	N	theoretical models
G	liquid-solid systems	O	other systems
H	particulate systems		

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