

THE BRITISH SOCIETY OF RHEOLOGY

BULLETIN



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THE BRITISH SOCIETY OF RHEOLOGY

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EDITORIAL

In this issue of our Bulletin we have reports on two meetings; the Second Symposium on Settling in Non-Newtonian Fluids held in Wales and the Young Rheologists day held at the National Motorcycle Museum. It is good to hear that these meetings were both well appreciated. It is always interesting to read such reports and, for those who did not manage to attend, to have a summary of how the science is advancing and, at a more social level, to hear how our fellow members are getting on. Anytime that you have attended an interesting meeting, please feel free to send me a report, whether technical, personal or even (mildly) scandalous!

It is also a pleasure to report the presentation of Society awards and to reprint here the citations for our Gold Medal award to Professor Marcel Crochet and the Special Award to Jack Roberts. The latter award was presented at our recent AGM, whilst the Gold Medal award will be presented at the Rossett Workshop in Wales in April 1995.

In our last issue I reported how there had been sweeping changes to your Society's Council. Two new members (or returnee in Howard's case), so far, have been persuaded to write personal profiles, by way of introduction to those members who do not know them (sometimes difficult to believe). I hope that we may have a few more of these profiles in our next issue.

I also reported in our last issue that we hope to include more European coverage in the Bulletin. To this end, at our most recent Council meeting, I found myself given the grandiose title of European Liaison Officer. My task, wearing this hat, will be to establish a corresponding relationship with as many appropriate officers of the rheology societies in Europe as possible and to elicit from them, news of their current activities and reports of their meetings. I would be very glad to hear from any of our European members who feel they could provide me with such reports or could send me copies of their own Bulletins if they have one.

As you know, the previous issue was my first as Editor, and I must report that I have been notified of a number of errors, for which my sincere apologies. In particular, my apologies to Clegg & Collyer for getting the price of the new book "The Structure and Properties Polymeric Materials", wrong. This should not have been £83 (the price of the previous entry), but £35 in hardback or £10 for a student edition. In the conference diary, the date of the XIIth International Congress in Quebec, should of course be August, 1996, not 1995! In the membership news section, my apologies to

Dr Chohan for omitting the name of a new member approved at the previous Council meeting. This has been rectified in the current list. I have also been told that I got the Society's logo on the front cover of the Bulletin, upside down! Did anybody else notice, or even know that it was not symmetrical? In my defence, or that of our printers, who actually mounted it, I must say that it is the same way up on all previous recent copies of the Bulletin. Perhaps it is upside down on our stationery instead!

I hope I have done better in my second attempt!
The copy date for the next issue is March 30th, 1995

LETTER TO THE EDITOR

191 Icknield Way,
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Dear Sir,

Thank you for the September issue of the Bulletin which makes interesting reading. I have always found the Bulletin so and would like to take the opportunity to thank the previous Honorary Editors for their effort in putting the issues together. I know we did not thank them often enough when they were on the job, but their work was much appreciated nonetheless. So, much belated thanks to them all; and keep up the good work yourself.

I am writing to make a small contribution to the current discussion on the role of the BSR and the needs of the Membership. I refer specifically to that of the increasing number of Members who have taken early retirement, but who continue to be active in the field of rheology. We are not really unemployed so much as not engaged in gainful employment. As you yourself identified, one of the back-up resources that we sorely miss is the ready access to a good technical library. The British Library is good, but it is costly.

Now, BSR does have the Scott-Blair Collection in Aberystwyth. I hope it is being developed into a comprehensive and up-to-date rheological library and that, with the help from Mrs Scott-Blair's legacy, Council has a definite policy to that end. Key rheological books should be purchased and maybe even periodicals subscribed to. When the catalogue of the Scott-Blair Collection is updated each year, it would be useful to remind members of the contact in Aberystwyth for access and loans from the Collection, and of any formality that should be followed.

On a more personal note, I wonder where all the rheological books and periodicals go when they become surplus to requirements when institutes

and individuals curtail their rheological activities. I would be interested to take them off their hands if I know about it. Are there duplicate copies in the Scott-Blair Collection that can be made available on extended loan?

I think there is a specialist second-hand scientific book-seller somewhere in the middle of the Wales/England border, but I have not been able to locate it. If any member knows about it, I would be grateful for the address.

Yours etc.,
D.C-H. Cheng

Editor's note in reply to a query in the above letter.

The Scott-Blair collection is housed in the Library at the University of Wales, Aberystwyth under the terms of the bequest which founded it. It is administered on behalf of the Society by a working party of BSR Council or ex-council members. The members of the Scott-Blair Working Group are: Roy Carter (Secretary), Tony Evans, John Benbow (Archivist) and Merwyn Jones. The librarian, Mrs Ghosal is responsible for the housing, safe keeping and administering of the collection. She is the contact for access to, and loans from the collection. The Society has arranged that loans may be made to BSR members via Inter-Library loans.

COMMENTARY: 279th COUNCIL MEETING

Eight members of a newly elected Council met at the Moat House International Hotel in Chester on the 9th December, 1994. It was a most civilised affair.

The new ordinary members had been invited to dine, the previous evening, with those more experienced members, in order to learn a thing or two about the ways of the BSR Council. Among other things, one learnt that the Bulletin Editor possessed a most useful knowledge of the wines of the Haut Medoc, no doubt acquired from years of rheometrical study. One also learnt that he same editor could be "leant on" when it came to choosing the lighter grape. One new member, unnaturally predisposed to Chardonnays of the Southern Hemisphere, was bold enough to take full advantage of this weakness.

But the greatest lesson of all for new members was: never leave the table before your elders and betters. Alas, I was not to know, and foolishly did so. The following morning I was informed that, by unanimous decree, I must write an account of the meeting for Bulletin readers...

It was announced that the Society's Gold Medal would be awarded to Professor Marcel Crochet (Louvain-la-Neuve) during the Ninth International Workshop on Numerical Methods for Non-Newtonian Flows, to be held at Llyndir Hall, Rossett. The actual presentation would take place at a banquet at Ruthin Castle on Thursday, April 20th, 1995, one of the social events of the meeting. Professor Crochet's lecture would follow on the morning of April 21st, at Llyndir Hall. The Society's Annual Award would also be presented to Professor Gareth McKinley (Harvard) at this meeting.

Professor Tom McLeish announced preliminary details of the Isaac Newton Institute's plans for six months' activities on the Dynamics of Complex Fluids, to be held in Cambridge during the first half of 1996. It is to be hoped that one of the many events will be a NATO Advanced Study Institute on Theoretical Techniques in the Dynamics of Complex Fluids, and the BSR was invited to co-sponsor this event. On the understanding that a large number of students and young researchers would be invited to this meeting, the Society agreed to offer financial support.

It was reported that the Young Rheologists' Day, organised by the Society in September 1994, was much enjoyed by all concerned. There was considerable enthusiasm for this to become a regular event. Another Young Rheologists' Day is planned for September 1996.

Much time was spent discussing the proposed European Society of Rheology. The President read the latest version of the proposed constitution, noting, in particular the following benefits:

- (1) Closer collaboration with other European Societies.
- (2) Increased interchange of information concerning events and scientific developments.
- (3) The adoption of *Rheologica Acta* as the European Journal of Rheology, with possible reductions in purchase costs due to increased circulation. It was noted, however, that membership of the ESR would necessitate a significant increase in the BSR's subscription rates. It was argued that the major benefits could be achieved within the current system of individual societies by nominating European Liaison Officers to promote cooperation. Rather than forming a European Society at once, the BSR Council preferred the more cautious route of first making a better effort at cooperation, and to review the situation as soon as advantages of this cooperation became apparent. Eurosceptics will no doubt dance with glee at this response. Others will react more soberly.

PROFILES OF NEW COUNCIL MEMBERS

Howard Anthony Barnes, President

It's now more than 30 years since I applied for vacation employment in the Physics Department at the (now defunct) National Institute for Research in Dairying at Shinfield near Reading. I was then doing a degree in Physics at the University College of Wales, Aberystwyth, and had seen an advertisement on the noticeboard for someone to help Dr Hywel Thomas - an old boy of the physics department - develop a blood viscometer. At that time I knew nothing about viscosity or blood, but it looked interesting. I got the job, and found myself in Dr George Scott-Blair's group. For the sake of those who are new to the field of rheology, I should explain that George Scott-Blair was the grand old man of British Rheology, who before, during and after the second world war, with a few other dedicated people, put rheology firmly on the map of British science. By the end of that summer I had met quite a number of rheologists of his generation who came to visit, among them Marcus Reiner. Scott-Blair's parting words to me were "I hope you catch the bug". I think I have suffered from a severe dose!

On returning to "Aber", I found that Ken Walters, a lecturer in Applied Mathematics - whom I had previously got to know through church connections - was also doing rheology, mostly of the theoretical kind, but he had started experiments. He suggested I did research with him after I finished my physics degree. I eventually did this, having first - at the insistence of the physics professor - done a postgraduate diploma in electronics. When I got to Maths, I found that they were then the only maths group in the country with a laboratory. My research was an experimental study of the steady and unsteady flow of viscoelastic fluids through straight and curved pipes, funded by NEL at East Kilbride. My results were to be compared with the theory worked out by Ken Walters and coworkers.

The work went well, and I had the opportunity to further my interest in blood flow. Ken had accepted an invitation to a conference on blood flow in Heidelberg in Germany. As this was to be my first-ever trip abroad, I really went to town with these experiments. First get your blood I thought - well that was a problem. It was finally solved by a trip to an abattoir in Carmarthen with a stainless steel bucket and a sample of anticoagulant from a friendly GP. The men at the abattoir wanted to know if I was a

black pudding maker! The experiments eventually proved that under the conditions used, unsteady flow was no different to steady flow - for the same pressure. On reflection the result was obvious, the flow rate was so high, the blood was effectively Newtonian.

During that time such worthies as Nev Walters, Peter Townsend, Eirion (TER) Jones, etc. were also doing research at Aber. with Ken Walters. Prince Charles also came to the university to learn Welsh for the Investiture. A lot was to happen for both of us in the next 25 years!

The time came to leave Aberystwyth, after 8 years, and by then I was married with a baby boy (who is now himself doing research in fluid flow in a Maths Dept.). I was invited to Unilever Research by the late Brian Yates, who had recently been seconded to do a Ph.D. with Anthony Pearson at Cambridge (later a BSR President). Two of the research group at Aber. had already been invited to Port Sunlight, but they had decided that all that was needed was a rheogoniometer driver. Well armed with this prejudice I went along, but was impressed enough to accept a job offer, albeit for 10% more than they were originally offering!

Those early days were very interesting and informative, with the group made up of a chemical engineer (Brian Yates), a colloid scientist (Ed Willis) and a mechanical engineer (Dave Steen) and even a young mathematician (Andrew Eastwood). This experience gave me a very good picture of what rheology and fluid mechanics could do for a company like Unilever. First of all Brian Yates' Rheology and Fluid Mechanics Section was in the Basic Science Division, and the work I did was a straight continuation of what I had done at Aberystwyth. It was true what they said in those days; it was the University of Port Sunlight! Soon however we moved into the engineering group, and I found that there was a detergents business out there with factories that had problems in rheology that I could help solve.

My first business trip was to our Newcastle factory to help design an on-line viscometer for Domestos. Then, after a few years, I got involved with the processing of fabric conditioners and liquid abrasive cleaners around Europe. This was the first processing work done on liquid detergent formulations. Then it appeared that a similar approach could be used for soft solid materials such as soap, so I set up a programme in this area also. Both these areas are now served by whole sections. This interest in what is essentially chemical engineering, brought me into contact with new groups of people.

Among them was the Process Technology Group of the Royal Society of Chemistry. In 1980 they made me their first industrial fellow, and I carried out a survey throughout the UK on Dispersion Rheology, and the industrial problems and academic progress in that area. Whereas my previous interest, like most rheologists then, was in polymer solutions, I became (and still am) very interested in the flow of dispersions. This took me into the colloid chemistry area. The RSC seemed to like my report, for a few years later they awarded me one of their annual awards (1984).

This interest also took me into the Science and Engineering Research Council, where I joined the Coal and Particle subcommittee of the Process Engineering Group. I have been active in this area ever since, and am currently helping with the Processing of Soft Solids initiative for EPSRC, the successor of the SERC.

Over the years Unilever Research has been good enough to allow me to continue to publish, giving me enough time to be involved in areas that are allowed to see the light of day in scientific journals. My collected works were recently accepted by the University of Wales for a D.Sc. But for this I must thank Professor Ken Walters, now an FRS, for his stimuli over the years for keeping up my interest in the area. Anyone who works in industry these days knows that satisfying the growing demands of business and still maintaining an interest in a basic area of science is like walking a tight-rope in a high wind.

Fortunately I have been able to keep my finger on the pulse of academic work in rheology and process engineering by holding visiting professorships at Aberystwyth (Mathematics) and Liverpool (Mechanical Engineering), as well as sitting on various government funding bodies in research, and education and training.

I was delighted to be asked to be President of the BSR, particularly remembering that I've worked with so many past presidents, starting with Scott-Blair, then John Hutton and Ken Walters with whom I wrote "An Introduction to Rheology", as well as previously serving as a committee member with many more. What do I want to do as President? Simply to try to keep the BSR at the highest level of usefulness that it has been in the past to both industrial and academic members alike. This will be done by organising events ourselves and in conjunction with other groups, as well as progressing various educational initiatives.

Arthur Russell Davies, Council Member
(B.Sc. Lond., M.S.c., D.Phil. Oxon)

Russell Davies graduated from King's College, London in 1969, where he read Mathematics and Physics. He pursued further study and research at the Universities of Cambridge and Oxford, specializing in computational mathematics and inverse problems. His first appointment was as Atlas Research Fellow at Pembroke College, Oxford, working on the inverse problem of phase determination in X-ray crystallography.

He moved to the University of Wales, Aberystwyth, in 1976, as Lecturer in Applied Mathematics. He helped to create the Computational Rheology Group at Aberystwyth, as well as maintaining his interests in inverse and ill-posed problems. He has published over forty papers and one book on theoretical and computational rheology, and was awarded a Personal Chair by the University of Wales in 1990.

British Society of Rheology Awards, Call for Nominations

The Secretary would be pleased to receive nominations for the BSR's Annual Award, 1995 as soon as possible, and in any event, not later than June 1st, 1995. The Annual Award is either designed to reflect contributions made over a prolonged period or to be used in appreciation of a particular contribution to the field including the publication of a single meritorious paper. Council would particularly welcome nominations of younger members whose contributions are judged to be of especial merit or promise.

Professor Marcel J. Crochet
Gold Medal Award Citation

Marcel Crochet was born in Uccle, Belgium in November, 1938. He read Electrical and Mechanical Engineering at the University of Louvain, before continuing his (postgraduate) studies at the University of Berkeley, California, where he worked under the able supervision of the late Paul Naghdi. An MSc in 1964 was quickly followed by a PhD in 1966.

Since 1966, Professor Crochet has been associated with the Université Catholique de Louvain, first as Assistant Professor, then as Associate Professor, before being promoted to a Full Professorship in 1975. He has become one of its most illustrious sons and he has helped to put the relatively new campus at Louvain on the international map. Currently he is Dean of Engineering.

During his tenure at Louvain la Neuve, Professor Crochet has also held temporary visiting positions at various Universities in Belgium, France and the USA.

Professor Crochet would list his main scientific interests as Continuum Mechanics, Rheology, Viscoelastic Flow and Computational Rheology. His work on Computational Rheology in particular, has been immensely influential and he is without doubt the leading international expert in the field at the present time. Although he commenced his research work in this area using the *finite-difference* method, he now specializes in the *finite-element* technique. This is the basis for the popular Polyflow program, which is now associated with a commercial venture under the same name, based at Louvain la Neuve.

Professor Crochet's reputation has attracted to his research group a number of excellent research students and postdoctoral workers and the Louvain la Neuve team is an impressive collection of Applied Mathematicians, Numerical Analysts and Engineers. The resulting research work is of the highest possible class and is always topical and relevant.

Some of us have had the privilege of interacting and collaborating with Professor Crochet through books, reviews and research articles. This has always been stimulating and highly enjoyable. He and his charming wife, Brigitte, are delightful hosts and a visit to Louvain la Neuve is always something to be savoured. Professor Crochet's organizational skills are well known and many of us will recall the excellent IUTAM meeting at Louvain la Neuve in 1978 and the 11th International Congress of Rheology in Brussels in 1992. He and Professor Jan Mewis of Leuven were superb as chairmen at the latter event.

Professor Crochet has been a long-time friend and supporter of the B.S.R. and it is clear that he has achieved a level of eminence in the field of Rheology which makes him a very suitable recipient of our Gold Medal. His many friends and colleagues will greet the news with much pleasure and acclaim.

Ken Walters

Gareth H. McKinley

BSR Annual Award Citation

Assistant Professor of Engineering Sciences, Harvard University

Gareth McKinley's interest in rheology was aroused by Malcolm Mackley, who was his undergraduate supervisor at Downing College, Cambridge during the period 1982-1986. He obtained the equivalent of an M.Sc. in Malcolm's laboratory, working on Laser Doppler velocimetry and birefringence studies on polypropylene melts. After graduating with a First at Cambridge, Gareth headed for the U.S.A. and initiated a brand new programme in Polymer Science and Technology at M.I.T., where for five years he had a most productive period working with Professor Robert A. Brown and Robert C. Armstrong. Publications following this period covered LDV measurements of viscoelastic flow instabilities in the wake of circular cylinders, observations of elastic instability in cone/plate and parallel plate flows of Boger-type fluids and the grandly titled "Flow stimulates endothelial cells to release a nitrovascodilator that is potentiated by reduced thiol". I'm afraid I've never heard the American verb "to potentiate" before!



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More research interests include extensional rheology of non-Newtonian liquids, spiral instabilities in torsional flows of elastic liquids, settling phenomena in elastic liquids, viscous fingering in oil recovery and numerical methods in general. It is clear that Gareth's research interests span the theoretical and practical aspects of rheology and the quality of his work is such that he hopes to be promoted from Assistant to Associate Professor at Harvard in the near future.

In 1986/87 he was awarded the Kennedy Memorial Scholarship for study at M.I.T., presented the "best paper" in the fluid mechanics section of the A.I.Ch.E. Annual Meeting in 1989 and also won the National Young Investigator Award (National Science Foundation) in 1993. He has obtained research funding from a variety of sources and has presented nine invited talks at important meetings.

On the personal side, Gareth is married to an American girl, Julie, and they have a son, Andrew, who is one year old. Gareth was born in Hertford (UK) and went to the Richard Hale School in Hertford. His nationality is British, but he is a U.S. Permanent Resident. Interestingly he holds a Private Pilots licence, permitting him to fly light, single engined aircraft, but one has the feeling that he has little time for this expensive pursuit! Gareth will be a welcome addition to our list of fine young BSR Annual Awardees.

Dr DR.Oliver

Jack Roberts Special Award Citation

In June 1993, the Society celebrated the centenary of Karl Weissenberg with an invited lecture by Professor Arthur Lodge. This event was reported on in our Bulletin (Vol 36 No.2, p 45). This lecture prompted the proposal that Jack Roberts should be given an award to mark his work on the development of the Weissenberg Rheogoniometer. Jack himself described some of the background to this development in a recent article in this Bulletin (Vol 36 No.4, pp 85-89). Your Council agreed that a Special Award should be made and this was presented by President Ralph Oliver to Jack Roberts at the Society's 1994 AGM held during the Young Rheologists' day in September.

Brief mention was made of this presentation in the reports on the AGM and in the Officers' reports published in last quarter's Bulletin (Vol 37 No.3, pp54-55, 59-60) and in the report on the Young Rheologists' day on page 89 of this Volume. By way of a Citation accompanying this Special Award presentation, our President's remarks were based on the following text received from Alan Jobling in support of the award.

Jack Roberts is best known for his key paper¹ on the measurement of the normal stress distribution in laminar shear of a viscoelastic liquid. This paper in itself was a condensation of several years of work published in full only in a Ministry of Supply report² and it established at once the pre-eminence of Weissenberg's ideas on viscoelastic flow and the concept of rheogoniometry.

Roberts worked closely with Weissenberg from the early 1940's until about 1960 and each had a very high regard for the other. Roberts is both a very good all-round physicist and a skilled engineer and the particular strength of the collaboration was that he was able to take Weissenberg's theoretical ideas of what he wanted to measure and to convert these into practical instruments and experimental techniques of considerable elegance and precision. Roberts himself designed (and in some cases, partly made) all of the early rheogoniometers, including the first commercial ones, as well as doing the key experiments. Weissenberg was no abstract theoretician and was keenly interested in practical experiments and demonstrations but in my experience, his practical skills were limited.

The construction of the rheogoniometer involves a great deal of precision engineering, which is difficult enough with today's materials and techniques, let alone those available in the early stages of this development. Moreover Roberts did all this in addition to his other work in armaments research and development.

As well as wanting to be able to measure the complete angular distribution of stresses and strains in a flowing liquid, Weissenberg then conceived the idea that it would be possible to make an independent measurement of the viscous and elastic moduli of a flowing liquid by superimposing a sinusoidal oscillatory strain and measuring the response. Again Roberts solved the difficult engineering problem and this has become a standard technique.

Next, Weissenberg pointed out that nearly all of the test methods of conventional rheology at that time were limited to testing either laminar shear or pure shear. He wanted to be able to utilise a much wider range of strain geometries so Roberts produced a number of precision-engineered machines which were able to apply controlled strains to a deformable substrate, usually a rubber sheet on which the test sample was spread in a thin layer. These enabled some interesting observations to be made on the properties of dilatant materials and on how the ways in which various materials break up can be related to the strain geometry. (See for example refs. 3 & 4).

In summary, I maintain that Weissenberg's undisputed theoretical brilliance was complemented by Roberts' experimental and engineering skills and their pioneering work on viscoelastic flows was very much a joint effort. Partly because of the constraints of his job, particularly in the earlier years, Roberts has not published widely and I fear that his contribution has tended to be neglected by those who have not worked with him. I commend Jack Roberts' work to the Society.

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Commentary on the Young Rheologists' Day and 27th AGM

Paul Doody
National Starch & Chemical Ltd.

On what turned out to be a beautiful bright September's day, the National Motorcycle Museum in Solihull was the venue for large numbers of enthusiastic young rheologists gathering to talk to an equally enthusiastic audience. By the way does anyone have any suggestions on the correct collective noun for a gathering such as this? One suggestion (a flock of rheologists) caused sufficient groans that there has to be mileage for a decent competition here somewhere! (Suggestions to the Editor please). Fortunately the standard of presentations once the meeting got started was on a higher plane.

The Scott Blair Biorheology scholar, Stefaan de Smedt (University of Gent), started the proceedings with an interesting talk on the use of rheology to determine the permeability of hydrogels used for pharmaceutical research, which was only challenged for technical mastery by the adept timekeeping skills of the President (who ruled the first session with a stopwatch of iron!). The interest of the audience well and truly captured, the first half of the morning session proceeded with a great deal of fervour encompassing such topics as pipe flow prediction (T. Au - Bradford), Taylor vortices in suspensions (Supinder Aneja - Bradford), and electro-rheological fluids (Tsung-Yu Chen - Imperial College).

After a short break for coffee, an interesting presentation on the use of rheology in the confectionary industry (James Greener - Mars Confectionary) grabbed everyone's attention (and reminded them that lunch was still a good hour or so away!). Chocolate turned out to be a recurring theme with another chocolate-related paper given later in the afternoon by Anne McGinnes of Birmingham University. Alas, there were no free samples!

The remaining three papers in the morning session were all concerned (to a greater or lesser extent) with polymer melts. Janet Johnson (Sheffield) spoke very well on the linear rheological behaviour of poly(styrene)/poly(isoprene) star copolymers. Maria Odriozola (Strathclyde) spoke of the rheological behaviour of polymers from solution to melt. She introduced a new standard fluid proposed by the University of Strathclyde (S1) and presented rheological data on both its shear and extensional flow characteristics. The next paper was presented with great enthusiasm by Ruifeng Liang on the studies he has been pursuing with numerical simulation of poly(ethylene) melts flowing through slit dies.

Lunchtime arrived and, following a very pleasant meal, the council disappeared back into the lecture room in order to have a meeting. This gave the rest of the attendees time to glance around the Motorcycle collection held in the museum, before our presence was required for the AGM. In a meeting remarkable for its brevity, the AGM proceeded before the afternoon session commenced. The Treasurer's report told of a shining example of the efficiency of our banking system. In an amusing recount of the tribulations involved in communication with the bank's branch in Leatherhead, the author was reminded of the Vagon bureaucracy described by Douglas Adams in "The Hitch-hiker's Guide to the Galaxy" in which documents are filled out in triplicate, lost, found, lost again, found, buried and eventually recycled as firefighters! It is to be hoped that the gentleman whose bank account was debited in our favour did not suffer as much stress or strain as our Treasurer! Our outgoing President thanked everybody for attending and formally handed over to our new President, Prof. Howard Barnes, who proceeded to chair the remainder of the day's activities.

After the meeting there was, in my mind, one of the highlights of the day with the presentation of a delicately engraved glass award to Jack Roberts in recognition of his lifetime of involvement in rheometry. His early involvement with Weisenberg and his critical involvement in the development of the first rheogoniometers represent some of his finest achievements and it was excellent to see and hear of his experiences and career as one of the elder statesman of our science. Jack's career should be an inspiration to all members (young and old) as he combined the practical and theoretical aspects of our science to a degree that we can all learn from.

The author (as Scott Blair scholar) then had the (nerve-wracking) privilege of kicking-off the afternoon session describing the uses of rheological techniques in the development of hot melt adhesives. I would like to take this opportunity to again thank the BSR for their support. Bas Smeulders from Cambridge University described a development in capillary rheometry using servo-controlled dual pistons and went on to relate some of the results he is beginning to obtain from his machine. The last presentations were given by Mark Whiskens and Anne McGinness from Birmingham University. Anne, as already mentioned, spoke about chocolate whilst Mark described his work with injection-moulding resins and his attempts to describe the behaviour of the mix using models of varying complexity.

There were prizes awarded for the best presentations of the day and these went to James, Janet and Supinder. The judges must have had a difficult job choosing three prizewinners as all of the presentations were well presented, informative and clear. On summing up the day as a whole I thought it was a very enjoyable, relaxed (at least after you had finished your bit!) and entertaining day. The atmosphere was informal and the support given by more experienced rheologists to us newcomers was encouraging and welcome. Thanks must go to the Council, and particularly Carole, for organising the whole day. Lets hope it becomes a tradition!

Travel Grants for Students.

The Society makes grants to students engaged in research in rheology to attend and present their work at meetings on rheology, both its own and those of other societies. Members of the Society, who are full-time students, may apply in writing to the Secretary to be considered for an award and that application should be supported by the student's supervisor. The application should give details of the proposed expenditure, the title and date of the meeting and the title of the paper to be presented. They should be submitted in time for consideration at a Council meeting before the money is needed, i.e. by the beginning of March, June, September or December. The amount and number of such awards will be at the discretion of Council.

Report on the 2nd Symposium on Settling in Non-Newtonian Fluids

B.H.A.A.van den Brule and G.Gheissary
Shell Research B.V., P.O.Box 60
2280AB-Rijswijk, The Netherlands

November 1, 1994

The 2nd Symposium on Settling in Non-Newtonian Fluids was held in Lake Vyrnwy (Wales) from Oct. 17-19, 1994. This symposium was one in a successful series of mini-symposia organised by the University of Wales Institute of Non-Newtonian Fluid Mechanics (INNFM). No formal proceedings will be published but it was considered useful to have a brief report on the main conclusions and discussions of the symposium. This report is not intended to give an abstract of all the presentations but is a personal account of what we feel were the main items discussed at the symposium.

The meeting was attended by forty-two participants from Europe, Australia and North-America. Fifteen of the participants came from industry which is an indication of the practical relevance of the problems addressed at this symposium. The opening lecture was given by Barnes who presented an industrial perspective of settling problems. A total of seventeen talks were presented which roughly fell into three categories; (1) settling of a single particle, (2) particle-particle interactions, and (3) flow of dense suspensions of particles.

1 Settling of a Single Particle

1.1 Quiescent fluid

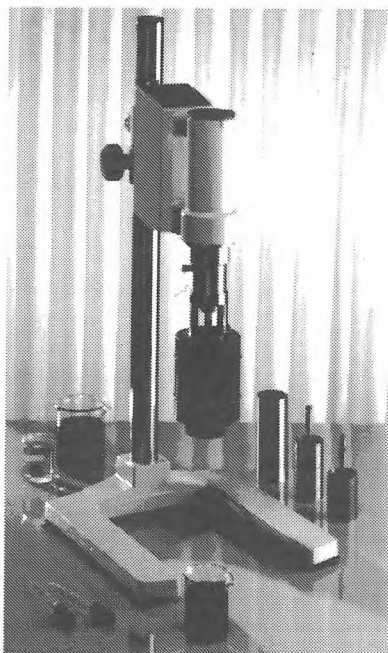
In the previous symposium on this subject, also organised by the INNFM at Miskin Manor (Wales) from 31 March to 2 April 1993, considerable attention was paid to the settling of a particle in a Boger fluid. Experimental results as well as numerical simulations, using Oldroyd-B and upper Convected Maxwell models, were presented. At that time the picture was far from complete. Now, there is excellent agreement between the numerical calculations of the drag correction factor performed by the different groups using different methods for the bench mark problem where the particle radius is half the radius of the container (Baaijens, Phillips). However, this does not imply that the simulations always agree with the experimental findings!

The experimental situation is complex. The correction of the drag coefficient as a function of the Weissenberg number depends on the type of Boger fluid used in the experiment. There might be a measurable decrease of the drag coefficient with increasing Weissenberg number which is sometimes followed by an increase, whereas in other fluids the decrease is virtually absent and only an increase is observed. A compilation of experimental results can be found in a recent review by Chhabra [1]. The generic behaviour of the drag correction as a function of Weissenberg number has been postulated by Walters and Tanner [2] and is now corroborated combining experiments on freely settling particles with drag force measurements on fixed spheres (Walters). The observed discrepancies between experiments using different fluids are believed to be caused by the different elongational properties of the fluids used. A key element in this context is the molecular extensibility L , defined as the ratio between the length of a fully extended molecule and the size of the polymer coil in the equilibrium state. Unfortunately, it is very difficult to obtain reliable elongational material functions.

To investigate the effect of finite extensibility of the molecules on the drag correction, numerical simulations have been performed using the Chilcott-Rallison model. This model is a variant of the FENE-P model with the modification that it is not shear thinning. For this reason it seems to be a good model to describe a Boger fluid including a bounded elongational viscosity. The results indeed show that the change of the drag coefficient with Weissenberg number depends on the value of L . A worrying aspect is that the value of L suggested by analysing the experimental data appears to be quite low, $L < 10$. The role of elongational effects was further investigated using a Rivlin-Sawyers constitutive equation with the Papanastasiou-Scriven-Macosko damping function (Hassager). This model has the useful property that the extensional properties can be changed without affecting the behaviour in shear flow. The results of this approach confirm the importance of the elongational flow field in the wake of the sphere. Other numerical simulations explored the negative wake phenomenon using the Chilcott-Rallison model (Harlen) and the drag force in a power-law fluid at finite Reynolds number (Graham).

To check the predictions based upon the Chilcott-Rallison model, settling experiments were performed in three different Boger fluids, based on a solution of high and very low molecular weight polystyrene in dioctylphthalate, where the molecular extensibility, L , was varied by changing the molecular weight and solvent quality (Muller). A large

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augmentation of the drag coefficient was observed but the drag enhancement did not correlate with the value of L . Currently it is attempted to measure the elongational viscosity of these fluids in a device similar to the one used by Tirtadmadja and Sridhar [3].

An alternative numerical approach to the problem is based upon the Dissipative Particle Dynamics approach (ten Bosch). In essence, this method simulates the micro structure of a flowing polymeric liquid. The bulk behaviour of the simulated system can be tuned to represent a viscoelastic fluid. The advantage of this approach is that it is easy to change the fluid properties and to extend the simulation to concentrated systems. The drawback is that at present the length scale of the simulated molecules is comparable to the size of the particles.

1.2 Wake-effect

Another issue which was addressed at this symposium is the so-called time-effect or wake-effect. It is often observed that the sedimentation velocity of a sphere depends on the time interval between sphere drops. In other words: It appears as if the first sphere carves out a path through the fluid structure which offers less resistance to the settling of subsequent spheres. Normally, the sedimentation velocity increases with a decrease in the time interval between two spheres, suggesting that the wake structure needs time to relax. This relaxation time is found to be surprisingly longer than the time required for the stress to relax. Experiments in Carbopol showed provocative behaviour: The sedimentation velocity initially increased with an increase of the waiting period between two experiments and actually it takes rest periods of up to 72 hours before the settling velocity becomes independent of the waiting time (Gheissary)!

1.3 Sheared fluid

It is well known that in an elastic fluid an extra reduction of the settling velocity can be obtained when a flow is generated in a plane orthogonal to the direction of settling. Further work on settling in sheared fluids showed that this effect can reach dramatic proportions in highly elastic fluids like reversibly cross-linked polymer gels (Fokker).

Similar experiments have been performed on a number of inelastic, shear thinning fluids (Gheissary). It was shown that for some of the fluids the settling velocity could be predicted from the shear viscosity curve of the suspending fluid, but for others, however, the settling velocity was significantly over predicted. It was conjectured that the differences might be attributed to the way fluids shear thin: By an isotropic break down of some kind of structure or by an orientation due to flow.

2 Particle-particle interactions

It has been observed that in some fluids the settling particles tend to aggregate, forming large clusters of particles which settle more rapidly, whereas in other fluids the particles disperse and settle slowly. A video tape with experiments on interacting particles was shown (Gheissary). The results suggest that particles are dispersed due to elastic effects whereas shear thinning leads to clustering. Again, experiments in Carbopol produced anomalous results: despite the fact Carbopol is virtually inelastic and highly shear thinning, spheres released side by side aggregated, but later dispersed as they turned and settled behind one another. There is no consensus on these phenomena and clearly this problem needs to be investigated in more detail, see also Joseph et al. [4]. A complicating factor is that the wake effect obviously plays an important role in experiments where spheres settle behind each other. Also numerical simulations with a FENE model were performed on the interaction between two spheres falling behind each other (Bodart). It was found that both separation and attraction can occur depending on the Weissenberg number, the ratio between the particle diameter and the diameter of the container and the initial separation of the spheres.

3 Flow of dense suspensions

So far we discussed fairly simple situations of the settling of one or two particles in quiescent or sheared fluids. In the industrial practice one often has to solve the flow of a dense suspension of particles. A particular example from the oil and gas industry was considered at the symposium. It dealt with the problem of hydraulic fracturing where a concentrated suspension has to displace a fluid with lower density. At the symposium an approach starting from phase averaged balance equations was presented. Combined with experimental studies regarding e.g. the distribution of particles across the flow domain, this resulted in a computer code which

simulated the placement of proppant particles in a fracture (Pearson, Hammond, Tehrani, Unwin). The experiments, performed in a tube, showed that in an elastic liquid there is a remarkably rapid migration of the particles towards the centre of the tube.

4. Conclusion

Considerable progress has been reported on the problem of settling of a single sphere in a quiescent liquid. Different numerical methods now give identical results for the Upper Convected Maxwell and Oldroyd-B models. To date, it is still difficult to predict the settling behaviour of a single particle and certainly of a group of particles using simple rheological input. Using models with bound behaviour in elongational flow the role of finite molecular extensibility in particle settling is now understood. It is believed that this at least qualitatively explains the discrepancies between experiments with different fluids. Regarding the wake effect it is probably impossible to explain these phenomena without taking chemical and thermodynamical details of the fluid into account. Two challenging areas for further research which would be of direct practical use were identified: Settling of a single particle in a sheared fluid and particle-particle interactions. Better insight in these phenomena would almost certainly lead to improved formulations of suspending liquids. Another promising area for further research is to study the relation between molecular extensibility and settling behaviour.

References

- [1] R.P.Chhabra, *Bubbles, Drops and Particles in Non-Newtonian Flow*, CRC Press, Boca Raton, 1993.
- [2] K.Walters and R.I.Tanner, in R.P.Chhabra and D.de Kee (Eds.), *Transport Processes in Bubbles, Drops and Particles*, Hemisphere, New York, 1991, p73.
- [3] V.Tirtaadmadja and T.Sridhar, A filament stretching device for measurement of extensional viscosity, *J.Rheol.*, 37(6), 1993, pp1081-1102.
- [4] D.D.Joseph, Y.J.Liu, M.Poletto, J.Feng, Aggregation and dispersion of spheres falling in viscoelastic liquids, *J.Non-Newtonian Fluid Mech.*, 54 (1994), pp45-86.

AWARENESS FORUM - BRISTOL COLLOID CENTRE

The Bristol Colloid Centre at the University of Bristol is a specialist centre in the field of colloid science able to provide advice, research facilities, training and general support to industry .

One part of this remit is to provide an opportunity for industrial companies to improve their awareness in a particular area. This is of course not only applicable to the larger companies, but would be particularly useful for the small and medium sized establishments (SME's).

One of the means by which we hope to promote increased awareness is to provide a facility for an open forum, where the latest product developments and formulation principles can be discussed. To this effect, we intend to run annual "Awareness Forums" in a specific area of colloid science. The first event will be:

THICKENERS AND THICKENING BY ASSOCIATION WEDNESDAY 3rd MAY COVENTRY - FORTE POSTHOUSE HOTEL

By thickeners we refer to any additive used to thicken and provide rheological control, be it polymeric or particulate. In particular, several of the newer thickener types can be classed as associative thickeners and so we feel these should be highlighted.

The event will be informal and brief presentations on the background theory to thickening, types of thickeners, applications of thickeners, formulation with thickeners and means of measurement and evaluation - along with what we hope will be a lively discussion of the limitations, principals and advantages from the floor.

If you would like to attend, or you or another representative of your company would like to make a presentation or provide a display, please contact:

Dr. Cheryl Flynn, Tel/Fax 0117 929 8388
Bristol Colloid Centre, University of Bristol, School of Chemistry,
Cantocks' Close, Bristol, BS8 1TS.

Bristol Colloid Centre

RHEOLOGY FOR TECHNOLOGISTS

21st-24th March 1995

School of Chemistry, University of Bristol

This course is for a small group of participants and will be an introduction to rheological measurements. It is aimed at technologists who are relatively new to the field.

The small numbers will allow the course to be interactive. There will be a mix of talks/lectures and practical exercises, designed to provide a good understanding of the fundamentals of rheological measurements.

Topics included will be:

- Definitions and terminology
- Rheometers: types, methods and use
- Viscometric measurements: types, curve fitting, model behaviour
- Dynamic measurements: oscillation, relaxation, types of response
- Creep and Recovery
- Yield and Related Phenomena
- Thixotropy, time dependent flows
- Other flow examples, elongation, turbulence, surface rheology.
- Example Case Studies: i. Polymers ii. Sedimentation iii. Emulsions and Polymer Colloids

At least half of the course time will be devoted to the "hands-on practicals", demonstrating a range of techniques and principles and using a variety of rheometers.

For further information on this (or our other courses) please contact:

Dr. Cheryl Flynn, Tel/Fax 0117 929 8388
 Bristol Colloid Centre, University of Bristol, School of Chemistry,
 Cantocks' Close, Bristol, BS8 1TS.

Future courses: Spring School in Colloid Science : April 1995

Emulsion Polymerisation : June 1995

also: Surface Characterisation and Porous Media - Dispersion
 Stability - Emulsions and Foams - Surfactants and Wetting

CONFERENCE DIARY

DATE	PLACE	DETAILS
27-29/3/95	Guildford, U.K.	'Deformation and Fracture of Composites', 3rd Int. Conf. Contact: Institute of Materials, Conf. Dept., 1 Carlton House Terrace, London, SW1Y 5DB, UK Fax: (+44) 171 823 1638
28-29/3/95	Nottingham, UK	'Workshop on Biopolymer Extrusion' Contact: Dr M.A.Hill, Nottingham University Tel: 0160 251 6150 Fax: 0160 251 6142
29-31/3/95	Bristol, UK	'Concentrated Dispersions', Contact: Dr A.Lips, Unilever Research, Colworth Laboratory, Sharnbrook, Bedford, MK44 1LQ
30/3/95	Belgrave Sq., London	'Transport in Porous Media' Colloid & Surface Science Group, SCI Contact: SCI Conf. Dept., 14/15 Belgrave Square, London, SW1X 8PS Tel: 0171 235 3681 Fax: 0171 823 1698
4-7/4/95	Lancaster, UK	'Multi-phase Materials Prepared by Emulsion Polymerisation', Macro Group, RSC and BSR. Contact: Ms L.Edwards, Conference Officer, Bailrigg, Lancaster, LA1 4YT. Tel: 01524-65201 Ext 2177
19-22/4/95	Rossett, Wales	'Ninth International Workshop on Numerical Methods in Non-Newtonian Flows', Contact: Dr T.N.Phillips, Dept. of Mathematics, University of Wales, Aberystwyth, SY23 3BZ
3/5/95	Coventry, UK	'Thickeners and Thickening by Association', Awareness Forum Contact: Dr Cheryl Flynn, Bristol Colloid Centre, University of Bristol, Bristol, BS8 1TS Tel/Fax: 0117 929 8388
15-17/5/95	Lyon, France	Euromech 334, 'Textile Composites & Textile Structures' Contact: Prof. P. Hamelin, Laboratoire Mécanique et Matériaux, Université Lyon I, IUT A - Génie civil 43, Boulevard du 11 Novembre 1918, F-69622 Villeurbanne Cedex, France Tel: (33) 78.94.88.97 Fax: (33) 78.94.69.06

- | | | |
|------------|--------------------|--|
| 10-20/7/95 | Durham, UK | The Durham Mathematical Symposium on Liquid Crystals.
Contact: Dr Iain Stewart/Prof Frank Leslie, University of Strathclyde.
Tel: 0141 552 4400 Ext 8128 |
| 10-14/7/95 | Sheffield, UK | 5th International Conference on Electro-Rheological Fluids, Magneto-Rheological Suspensions and Associated Technology. Contact: Norma Parkes, Dept of Mech. & Process Eng., University of Sheffield, P.O.Box 600, Mappin St., Sheffield, S1 4DU.
Tel: 0114 282 5434 Fax: 0114 275 3671
Email: N.Parkes@Sheffield.ac.uk |
| 4-7/9/95 | Aberystwyth, Wales | 'Polymer Melt Rheology',
Contact: Prof K.Thomas,
Dept.of Mathematics, University of Wales, Aberystwyth, SY23 3BZ
Tel: 0970-622768 |
| 6-8/9/95 | Leeds, UK | Physical Aspects of Polymer Science - Biennial Meeting of the Polymer Physics Group of the Institute of Physics
Contact: Prof G.R.Davies,
IRC in Polymer Science & Technology, University of Leeds. Tel: 0113 233 3815
Fax: 0113 233 3846 |
| 6-8/9/95 | Paris, France | 'Gels', Contact: Dr J.W.Goodwin,
School of Chemistry, University of Bristol, Cantocks Close, Bristol, BS8 1TS |
| 19-22/9/95 | Leeds, UK | 'First European Coating Symposium',
Contact: Dept of Chemical Engineering, University of Leeds, LS2 9JT |
| 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. |

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

8/1-22/6/96	Cambridge, UK	6 month Workshop on 'Dynamics in Complex Fluids'. For further details, see below
18-23/8/96	Quebec City, Canada	'XIIth 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

Workshop on Dynamics of Complex Fluids

A six month workshop on Dynamics of Complex Fluids is to be held at the Isaac Newton Institute, University of Cambridge from the 8th of January to the 22nd of June 1996. Meetings planned within the workshop so far are as follows:

8-1/1/96	Experimental Problems in Complex Fluid Flows.
26-28/3/96	CISG/INIMS Joint meeting on Colloidal Aspects of Complex Fluids.
25/3-4/4/96	Advanced Study Institute on Theoretical Methods for the Dynamics of Complex Fluids.
15-19/4/96	Constitutive Equations for Complex Fluids and their Applications.
24-28/6/96	Computational Aspects of Complex Fluid Modelling.

In addition to these meetings, many other one or three day workshops are planned and members may wish to take advantage of a number of high profile international visitors who will be resident at the Isaac Newton Institute in Cambridge during the period of the workshop.

For further details of this six month workshop, please contact:

Prof T.C.B.McLeish,
IRC in Polymer Science and Technology,
University of Leeds,
Leeds, LS2 9JT
Tel: +44 (0)113 233 3845
Fax: +44 (0)113 233 3846
E-mail: phy6tcbm@uk.ac.leeds.novell.phys-irc

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

COURSE DIARY

DATE	PLACE	DETAILS
21-24/3/95	AEA, Harwell, UK	'Applied Rheology Course' Contact: Dr Neil Alderman, AEA Technology, 404 Harwell, Didcot, Oxfordshire, OX11 0RA Tel: 0123 543 5677 Fax: 0123 543 2548
21-24/3/95	Bristol, UK	'Rheology for Technologists' Contact: Bristol Colloid Centre, University of Bristol, Bristol, BS8 1TS Tel: 0117 929 8388
24-28/4/95	Bristol, UK	'Spring School in Colloid Science' Contact: Dept for Continuing Education, University of Bristol, Bristol, BS8 1HH Tel: 0117 928 7122
April 1995	Cirencester, UK	International Bohlin Users Meeting on Rheology. Contact: Caroline Waters, Bohlin Instruments Ltd, 5 Love Lane, Cirencester, Glos., GL7 1YG Tel: 0128 564 4407, Fax: 0128 564 4314
30/5-2/6/95	Ross Priory, Scotland	Short Course: 'Theoretical, Experimental and Industrial Aspects of Rheology', Contact: Dr N.E. Hudson, Dept of Pure & Applied Chemistry, University of Strathclyde, 295 Cathedral St., Glasgow, G1 1XL. Tel: 0141 552 4400 X 2162 Fax: 0141 552 5664 Course sponsored by TA Instruments, Leatherhead, Surrey
26-30/6/95	Bristol, UK	'Emulsion Polymerisation' Contact: Bristol Colloid Centre, University of Bristol, Bristol, BS8 1TS Tel: 0117 929 8388
16-20/10/95	Strasbourg, France	'European School in Colloid Science' Contact: Dept for Continuing Education, University of Bristol, Bristol, BS8 1HH Tel: 0117 928 7122

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. The summaries are based on those of the publishers. The editor takes no responsibility for their accuracy. However I do apologise for getting the price of the book below wrong in the last issue.

The Structure and Properties of Polymeric Materials, 1993, D.W.Clegg & A.A.Collyer, The Institute of Materials, London, pp292, ISBN 0-904357-98-8, £35, Hardback; Student Edition, £10. Presents the basic principles underlying the properties of polymeric materials. Contents: the nature of polymeric materials; polymer blends and composites; the viscoelastic nature of polymers; the rheology of polymer melts; the effects of process variables and molecular architecture on the rheological properties; extruder and extruder-based processes; injection moulding processes; joining with polymers; designing with plastics; index.

Membership Details

Our Honorary Membership Secretary, Dr Nick Hudson, intends to publish a new edition of the Membership List later this year. The last edition appeared in 1992. He would appreciate it if all members whose details, as they appeared in that previous edition, contain errors, or whose details have changed in the meantime, could please contact him and give him the correct details. This should include any changes in the classification of the member's interests as indicated by the abbreviations given. It is appreciated that such changes are very likely since the member first joined the Society. An explanation of the abbreviations is given on the Membership news page. Dr Hudson's address is given inside the front cover.

MEMBERSHIP NEWS

The following applications for membership were approved at the Council meeting, December 9th, 1994

Prof P. Attané,
Laboratoire de Rheologie,
BP 53,
38041 Grenoble Cedex 9,
France
(fetsa DK)

Ms H. Chisholm,
Dept of Pure & App Chemistry
University of Strathclyde,
295 Cathedral Street,
Glasgow, G1 1XL
(fetsa DEO)

Dr R.K.Chohan,
Pharmaceutics Dept.,
School of Pharmacy,
29 Brunswick Square,
London, WC1N 1AX
(petsa DEFGHJLMNO)

Mr B.Gustavsson,
Nynäs AB,
14982 Nynäshamn,
Sweden
(fesa JO)

Dr A.M.Wilton,
Royal Ordnance plc,
Station Road,
Bishopston,
Renfrewshire, PA7 5NJ
(feta EGO)

Mr A.Worrall,
Printflo Ltd.,
Adelaide Street,
Burslem,
Stoke-on-Trent
(fetsa CDFGJO)

Mr G.Worrall,
Printflo Ltd.,
Adelaide Street,
Burslem,
Stoke-on-Trent
(fetsa CDGIO)

The following resignations have been received:

Mr L. Coucoulas, Mr K.E. Middleton

The following cease to be members under rule 4(d):

Mr J.Bilney, Mr N.S.Hearne, Mr N.G.Henderson, Mr A.R.McLelland, Mr J.A.Roberts, Mr W.A.Short,
Mr N.C.Thomson, Mme N.van Uffel, Mr J.H.C.Young.

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
B composites
C solid polymers
D molten or dissolved polymers
E natural fibres
F liquid-liquid systems
G liquid-solid systems
H particulate systems
I glasses, ceramics
J oils, greases
K building and road materials
L foodstuffs
M biological materials
N theoretical models
O other systems

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