

THE BRITISH SOCIETY OF RHEOLOGY

BULLETIN



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CONTENTS

Officers and members of Council	ii
Editorial	iii
Rheology in Oilfield Drilling and Pumping	
Operations: Geoffrey Maitland	78
The Early Years of the Society	89
Golden Jubilee Conference and Third	
Meeting of European Rheologists	91
Vinogradov Memorial Symposium	93
New Council Members	95
Awards 1991	96
Commentary: 263rd Council Meeting	98
Scott Blair Collection	99
Membership News	100
Obituary - E. W. J. Mardles	101
Competition No 2	103
News of Other Societies	104
Conference Announcements	105
Equipment for sale	115

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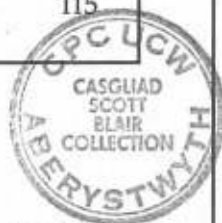
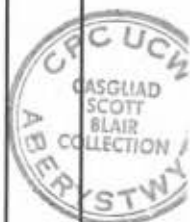
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1990/91

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EDITORIAL

I must apologise for omitting the name of my predecessor, Professor Peter Townsend, from the list of Council Members in the last issue. Sorry Peter.

Also on the subject of Council Members, this issue includes brief biographical details of Nick Hudson and Malcolm Mackley who joined the Council after the Annual General Meeting in September. They replace Steve Aldhouse and Harry Schimanski who have retired from Council after eight and three years respectively. Both have worked hard for the Society and we appreciate their efforts.

The response to our competition in the last issue was disappointing, but, not discouraged, we have prepared some more brain exercise for this issue.

There seem to be many meetings and conferences taking place and I would particularly like to draw members' attention to the Society's Annual Conference, the one day Conference at Strathclyde and the two short courses at Strathclyde, which share a common theme of industrial and engineering rheology. Please respond quickly to the announcements in this issue of the Bulletin. I am always glad to include notices of forthcoming meetings and reports of past meetings. I would appreciate it if members would pass any information to me, since I cannot possibly be a roving reporter.



RHEOLOGY IN OILFIELD DRILLING AND PUMPING OPERATIONS

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INTRODUCTION

Drilling, completion and treatment operations for oil and gas wells all use a range of specialised fluids, which are usually multicomponent dispersions and/or polymeric solutions. Each of these complex fluids is required to fulfil many roles, including pressure control in the wellbore, transport of material to or from specific downhole locations and protection of the formation against any harmful modification by the fluid itself. Because of this multifunctional nature, the design of the ideal fluid for any particular job becomes a complex optimisation exercise. The rheological behaviour of the fluid is naturally an important component of this process, controlling as it does the frictional pressure losses in the well, the pumpability of the fluid and its ability to transport solid material.

The complexity of understanding and controlling oilfield fluid properties is further magnified by the fact that once inside the well the fluid is circulated within what is essentially a massive high temperature, high pressure continuous chemical reactor. Hence its properties are being continually modified, not only because of the changing physical conditions it experiences but also because its composition is modified due to physical and chemical interaction with the porous formation to which it is exposed. The fluids themselves are usually highly shear-sensitive and thixotropic, since the state of aggregation and degree of interaction of the dispersed phase(s) of these heterogeneous fluids, and the adsorption of molecules onto the free surface they present, can all be sensitive to the nature of the flow to which the fluids are subjected. The rates of physical change within the fluid can also be relatively slow, so that its current state can reflect its previous history as well as the present conditions. Hence flow-history and time are important variables.

The rheological activity within the fluid chemical physics group at SCR in Cambridge seeks to answer such questions as:

What parameters characterise the rheological behaviour?

How do these parameters vary with changes in fluid history, well conditions, composition?

Why do the parameters vary in the way that they do?

This article describes how this three-tiered approach is being applied to fluids used in the drilling and cementing operations.

DRILLING - THE FLUIDS

Drilling muds are of two main types, distinguished by whether water or oil is used as the continuous phase. Water-based muds are typically suspensions of bentonite clay (largely sodium/calcium montmorillonite), to which further heavier minerals (usually barite), polymers and surfactants are added to optimise the rheology and other physical properties for a particular job. The primary clay platelets, present as a mixture of bound aggregates and dispersed individual particles, possess electrical charges on both their faces and edges which interact to form a loose network or gel.

Although polymeric additives are usually present to modify fluid properties, sometimes the clay component is partially or wholly replaced by a larger quantity of polymer e.g. KCl-polyacrylamide muds. Here the structure is provided by temporary crosslinks or 'entanglements' between the polymer chains, which give similar weak gel characteristics.

The most common oil-based drilling fluids are water-in-oil emulsions where micron-sized brine droplets, stabilised by emulsifier, are dispersed in a mineral oil, along with organophilic clays, weighting minerals, wetting agents and oil-soluble viscosifiers. The structure of these fluids appears to be quite different from the water-based muds. Electron microscopic examination of the frozen fluids reveals regions of close-packed water droplets dispersed in a relatively structureless matrix of oil and clay. While these fluids have been widely used for the past decade, increasingly tight environmental legislation is leading to a marked emphasis on developing and understanding better water-based fluids.

DRILLING - THE PROCESSES

Figure 1 is a schematic representation of mud flow in a section of the wellbore during drilling. The drilling mud is pumped down the drill pipe, usually in turbulent flow (Reynolds Number $Re \sim 10^3 - 10^4$), through the nozzles on the drillbit at even higher values of Re , before slowing down and flowing back up the annulus, usually in laminar flow. Here, it conveys the drilled cuttings back to the surface and, because of the positive pressure differential, Δp , between the mud and the formation pore fluid, also flows radially into the formation. At the rock surface the mud solids, especially the bentonite, rapidly form a filter cake whose permeability ($10^{-1} - 10 \mu D$) is usually very much less than that of the formation, so controlling the fluid loss rate. In fact a solids concentration profile is set up in the radial direction, increasing from a volume fraction of typically 0.05 in the bulk mud to a value of about 0.20 at the wellbore wall, over a distance of a few mm. As this occurs, the effective 'thickness' of the cake is limited by the mud cross-flow up

the annulus and a steady-state fluid loss rate is reached.

The rheology of the flowing mud is important, therefore, for frictional pressure drop calculations, for cuttings transport and for determining the hydraulic conditions at the outer boundary of the growing mudcake which eventually limit its growth. Its yield stress, and how this builds up with time, will determine whether drilled cuttings can be maintained in suspension when circulation is stopped. The rheology of the concentrated mud/filtercake zone also plays an important role in determining the final cake characteristics.

DRILLING FLUID RHEOLOGY

Much of our work on drilling muds has been aimed at characterising the precise form of the shear stress(τ)-shear rate($\dot{\gamma}$) rheogram for different fluids, and at understanding how the shape of this curve is modified by the changes of temperature, pressure and shear history the mud experiences during its downhole flow cycle. These measurements were mainly carried out using a Haake D1000/300 concentric cylinder viscometer capable of making measurements up to 1000 bar and 350 °C.

a) Oil-Based Muds

A range of oil-based muds (OBMs), have been studied up to 140 °C [1]. A typical rheogram obtained by ramping the shear rate up and down over a period of 35 min is shown in Figure 2. This shows a finite yield stress, shear thinning behaviour and essentially no hysteresis between the up and down rheograms. This low sensitivity to flow history appears typical of many well-mixed oil-based muds and makes them relatively easy to characterise. Temperature and pressure are the dominant influences in changing the rheology downhole.

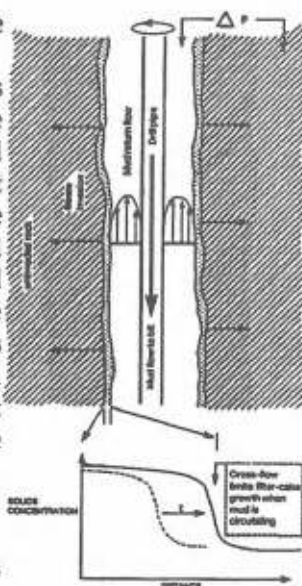


Figure 1. Schematic section of wellbore flow during drilling

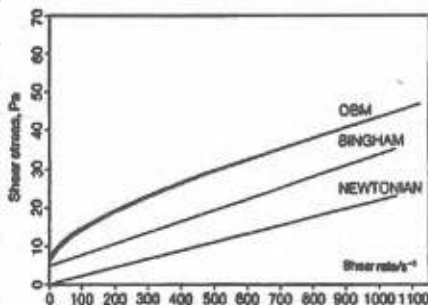


Figure 2. Up and down ramp rheograms for oil-based mud at 50°C, 400bar, ramp time 35min. Rheograms for Newtonian and Bingham-like fluids are shown for comparison.

The simplest model often used to describe the flow properties of drilling fluids, the Bingham model

$$\tau = \tau_B + \eta \dot{\gamma}$$

is clearly an unrealistic description of the OBM rheograms. More appropriate constitutive equations are:

$$\tau^{1/2} = K_0 + K_1 \dot{\gamma}^{1/2} \quad (\text{Casson})$$

$$\tau = \tau_y + K \dot{\gamma}^n \quad (\text{Herschel-Bulkley})$$

Both models fit the experimental data within their estimated uncertainty up to 1200 s^{-1} . We tend to favour the Herschel-Bulkley equation for general use, since it is also found to be applicable to other drilling fluids and cements, as well as polymeric spacer and fracturing fluids. Some of these fluids approximate to Bingham or power-law fluids under certain conditions, both of which are simple limiting cases of the H-B equation.

This effective high-shear Casson viscosity (k_1^2) decreases dramatically with temperature but also increases substantially with pressure, so that with descending depth downhole there is a partial compensation of the two effects. In fact these variations appear to follow the behaviour of the continuous oil phase and, following from the observation that for many hydrocarbons ($d \log \eta / dP$) increases linearly with $1/T$, the following equation was deduced to represent the entire pressure/temperature variations of the Casson parameters for an OBM:

$$k_i = A_i \exp[(E_i + C_i P) / T] \quad i = 0, 1$$

The parameters A_i and E_i can be determined for a given mud by making a few measurements as a function of temperature at ambient pressure; the parameter C_i requires a knowledge of the viscosity-pressure behaviour of the oil base fluid or the mud itself.

This equation for k_i is similar in form to that proposed by Eyring [2] for the viscosity of simple liquids; more modern theories of the liquid state appear to work equally well. The link between yield stress and the base oil viscosity implied by the above treatment has parallels with elastic floc models proposed for colloidal suspensions [3].

b) Water-Based Muds

Bentonite water-based muds (WBMs) show two major differences compared with OBMs. First, the mud rheology is much more sensitive to the method of mud preparation. The clay platelet aggregates need to be adequately dispersed in the suspension and this is achieved by a combination of mechanical energy in the mixing process and diffusion of water into the aggregates to swell and ultimately disperse them. This dispersal or ageing process causes irreversible changes in the fluid rheology

and a minimum of 48 hours mixing at 100 °C, and 5 s^{-1} is typically required to achieve a reproducible well-dispersed state. Higher shear rates, temperatures and times will all accelerate this process.

Secondly, even when the mud is in this well-dispersed condition its rheology is far more sensitive to the shear history of the fluid than OBMs. The thixotropy of a typical WBM is illustrated in Figure 3. If, after changing to a new shear rate, one waits only a short time before recording the shear stress then significant thixotropy loops and variations in rheograms with repeated cycling are observed. Waiting for increasingly longer times at each point reduces the hysteresis observed until eventually one reaches a single steady-state rheogram which can be reproduced in repeat experiments.

Some insight into the physical origins of this complex behaviour can be obtained by using techniques which probe the microstructure of the fluid. The loose interactive network within the fluid is being broken down on increasing shear rate and reformed as $\dot{\gamma}$ is reduced. This takes place on a timescale that reflects the local dynamics of the clay platelets. One way to investigate in a controlled manner how the balance between particle interactions and imposed shear changes the structure of the fluid, and hence modifies the rheology, is using particle dynamics computer simulations [4]. Figure 4 shows the results of one such simulation for a suspension of model charged clay platelets interacting with each other electrostatically and hydrodynamically through the continuous Newtonian viscous

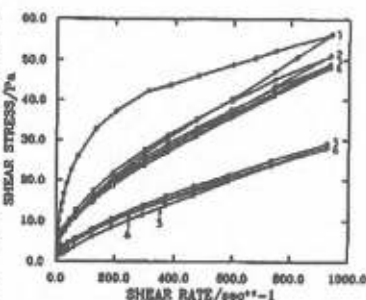


Figure 3. Shear stress-shear rate ramped cycles for a freshwater bentonite mud at 25°C, 1 bar. Stress equilibration times at each shear rate: curves 1-4 (successive cycles) 10 sec; curve 5, 15 min; curve 6, 30 min.

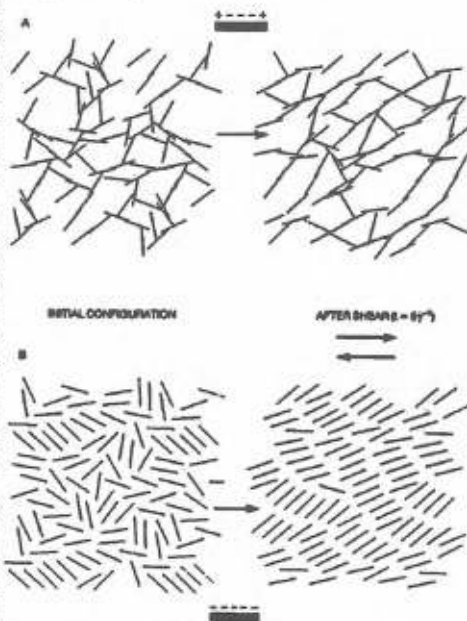


Figure 4. Structure of model clay suspensions obtained by particle dynamics computer simulation.
A: Mixed charges on platelets.
B: Uniform charge on platelets.
The structure within the dotted box is repeated periodically in space to simulate an infinite fluid.

phase. Note the contrast between the initial zero-shear structures when the platelets have both negative face charges and positive edge charges, as clay particles do in practice at low pH, and when all charges are negative, as at high pH. Dramatic changes to the structure are brought about on shearing the sample; in particular greater platelet alignment and lower connectivity of the network structure are apparent.

Evaluation of the stress-strain development of the sample in these computer simulations enables the links between structural changes and rheology to be studied. Similar information can be obtained experimentally by monitoring other properties in shear. For instance, Figure 5A shows the change in electrical conductivity of a WBM as a function of shear rate in a Couette flow cell. Perpendicular to the shear gradient, the conductivity increases whereas along the gradient it decreases, both changes increasing with shear rate to a limiting value. These data reflect the particle alignment observed directly in the simulations, and the changing tortuosity of the conductive pathways through the fluid as it is sheared. They can give information about the extent and anisotropy of structural changes accompanying shear, whereas the time dependence of conductivity as shear is imposed or removed (Figure 5B) gives information on the timescales of the local rearrangement processes involved.

The complexity of thixotropic behaviour is, of course, a reflection of the fact that for any step-change in shear rate, the stress takes many minutes, even hours, to come to a steady value. Studies of these kinetic processes are being carried out within SCR and are leading to a fuller understanding of the time-dependent behaviour of these fluids. Fortunately, however, it is not necessary to characterise this phenomenon completely in order to say something about the parallel effects of pressure and temperature. It is apparent from Figure 3 that with careful preparation and controlled pre-shearing of the fluid, it is

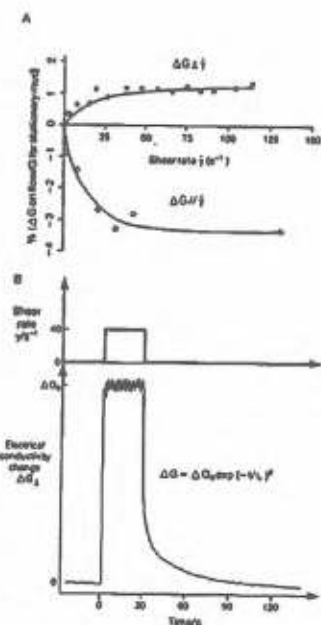


Figure 5. Changes in electrical conductivity, G , in sheared water-base mud.

A: Effect of shear rate on ΔG parallel and perpendicular to the shear gradient.

B: Time dependence of conductivity on imposition and cessation of shear flow; typical parameters for relaxation process are $\tau_r = 2s$, $\beta = 0.5$.

possible to study the fluid under reproducible iso-structural conditions e.g. curves 4,5 or 6. By studying fluids in this way, it is possible to eliminate the effects of thixotropy and examine the influence of varying external conditions.

Studies on WBM's over a range of 20 - 140 °C and 1 - 1000 bar [5] have revealed that the rheograms of fluids studied under these controlled conditions (corresponding essentially to a well-aged, highly circulated field mud) can again be approximated by the Casson model although for a more reliable representation for all conditions the Herschel-Bulkley equation should be used. For the latter model we can define a high shear rate viscosity, η , as the slope of the rheogram at $\dot{\gamma} = 1000 \text{ s}^{-1}$, viz $nK(1000)^{n-1}$.

Figure 6 shows how the Herschel-Bulkley parameters vary with temperature and pressure for a typical weighted WBM. The main features are:

- * η_{HB} increases with pressure to an extent which increases with mud density
- * η_{HB} decreases with temperature in a similar manner to the continuous water phase
- * The yield stress τ_y is essentially independent of pressure
- * τ_y remains essentially constant at low temperatures until a characteristic temperature T^* is reached, whereafter it increases essentially exponentially with $1/T$.

The temperature/pressure variation of the viscous characteristics of water-based fluids therefore appear, as in the case of OBMs, to be largely determined by the physical properties of the continuous phase. The pressure dependence arises from both the increase of water viscosity with pressure and an increase in solids volume fraction due to its small but significant compressibility. The pressure-temperature behaviour of the yield characteristics of WBM's is, by contrast, very different from that of OBMs. High temperature gelation of bentonite muds is a well-known phenomenon, but the precise physical origin of the sharp increase in τ_y near T^* is not clear. T^* itself is sensitive to the detailed surface chemistry of the bentonite platelets, generally decreasing as the strength of interactions increases.

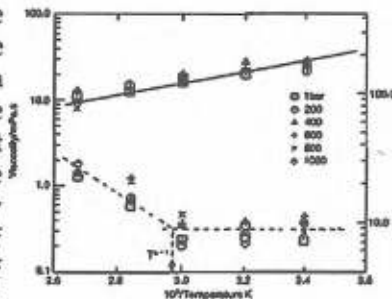


Figure 6. Variation of Herschel-Bulkley high shear viscosity (upper plot) and yield stress (lower plot) with temperature and pressure for a typical water-based mud. The solid line has the same slope as water viscosity. The characteristic temperature T^* depends on mud composition and the electrochemical characteristics of the bentonite used.

The implications of these findings for field measurements of fluid rheology for both OBMs and WBMs are that readings should be obtained over a wide shear-rate range, and that data at several temperatures, supplemented by laboratory measurements on pressure dependence, are required for accurate extrapolation to downhole conditions.

c) Low Stress Creep Behaviour

In the experiments described so far, the fluid is always flowing so that the yield stress is necessarily obtained by extrapolation from a finite shear rate. How does this value relate to the situation where one has an initially stationary mud and attempts to set it in motion as, for instance, in the mud circulation/displacement phase of a completion operation? Conventional wisdom is that the mud will not flow until its steady shear 'yield stress' is exceeded.

We have been investigating this in more detail by means of creep measurements carried out in a controlled stress rheometer, where a known stress is applied to the sample and the resulting strain measured as a function of time. The typical behaviour of a water-based mud in such experiments is illustrated in Figure 7. Contrary to conventional ideas, the mud does move below the yield stress deduced from steady flow measurements. In fact it exhibits classical viscoelastic behaviour: an instantaneous elastic response, γ_e , followed by time-dependent creep, leading finally to either a limiting strain (if $\tau < \tau_0$, the true yield stress) or a linear flow region ($\tau > \tau_0$) where the slope of the strain-time curve gives the strain rate $\dot{\gamma}$. The fluid shown does not flow significantly below an applied stress of about 1 Pa, which may be regarded as its true yield stress. Other fluids appear to flow at all stresses, exhibiting a

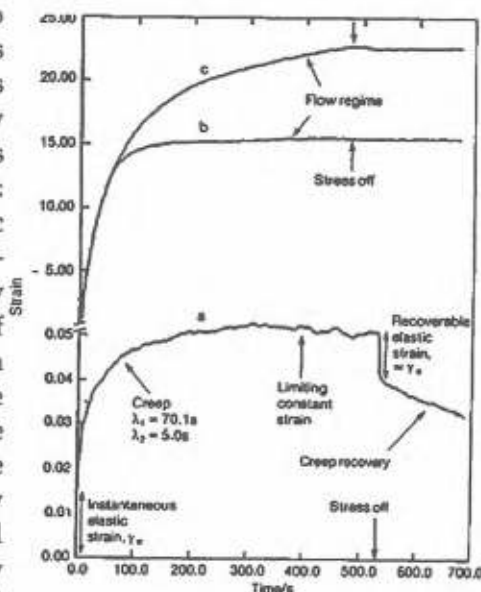


Figure 7. Creep curves at 25°C for an unweighted water-base mud having an apparent yield stress (from continuous shear experiments) of 5 Pa. Imposed stresses a: 0.6 Pa; 3.9 Pa; c: 4.4 Pa.

very large Newtonian viscosity at low stresses, followed by dramatic shear-thinning at shear rates far below 1 s^{-1} (see Figure 8). Variations on the Cross equation:

$$\eta/\eta_0 = 1/[1 + (K\dot{\gamma})^n]$$

may be used to describe this behaviour.

Hence drilling muds can show significant elasticity, which is important for keeping cuttings in suspension in

slow flow or stationary conditions, and will indeed flow when subjected to stresses below the nominal yield stress, given sufficient time. The idea of a yield point is an inadequate description of the yield behaviour of these fluids. It is more appropriate to talk of a yield space, which incorporates time as a variable and is characterised by parameters such as $\dot{\gamma}_e$ and τ_0 . Creep measurements, and complementary stress relaxation data [6], enable the stress-strain-time dependence of the onset of flow of drilling fluids to be mapped out in some detail.

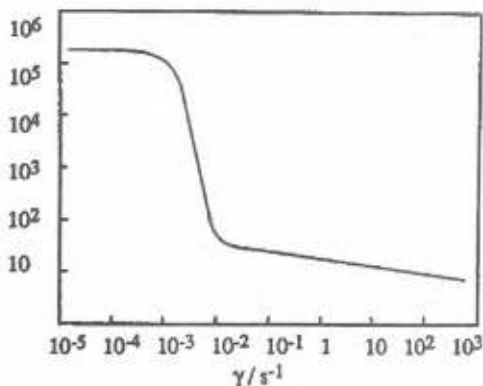


Figure 8. Flow curve over extended shear-rate range for drilling mud, exhibiting lower Newtonian viscosity region rather than a true yield stress.

RHEOLOGY OF HIGH-SOLIDS FLUIDS AND FILTERCAKES

The behaviour of low clay content drilling fluids described so far can be studied using conventional concentric cylinder rheometers. As the clay content is increased beyond a few per cent by weight, or significant quantities of heavy mineral particles are present as in higher density weighted muds or cement slurries, then two major problems appear: wall slip at the smooth moving surfaces of the rheometer, and particle migration due to gravity and centrifugal forces acting on the fluid within the rheometer gap.

The first factor can produce large underestimates of the effective yield stress of a fluid. We have used a variety of techniques to overcome this problem, including vane rheometry and squeeze film methods [7]. These have been applied to measuring changes in both yield stress and elastic modulus for concentrated clay suspensions as the clay volume fraction, ϕ ,

increases by several orders of magnitude, right up to those typical of a compacted filtercake. The data of Figure 9 show that τ_y for instance, varies with ϕ in a power-law manner with an exponent of about 3. This surprisingly uniform behaviour, from dilute suspensions to concentrated cakes, is in reasonable agreement with recent fractal aggregation models. As well as providing interesting fodder for theoreticians, such data are of direct practical value in understanding such wellbore phenomena as cross-flow filtration and the interaction of drill-pipe with the cake-coated wellbore wall.

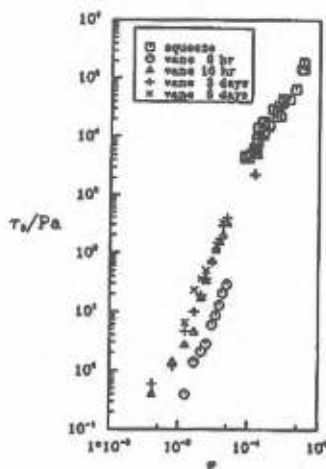


Figure 9. Vane and squeeze film applied to concentrated muds and filtercakes.

The second factor can cause large errors in the flow curve at all shear rates. This can be overcome using a pumped-cup rheometer recently developed in Cambridge[8], which has been applied successfully to many granular fluids, including weighted muds and cements — see Figure 10. Cements are also well represented by the Herschel-Bulkley equation, and are relatively inelastic prior to the onset of the setting process. In combination with the vane technique, this pumped-cup method can be used to characterise many solids-laden fluids for which more conventional techniques are inappropriate.

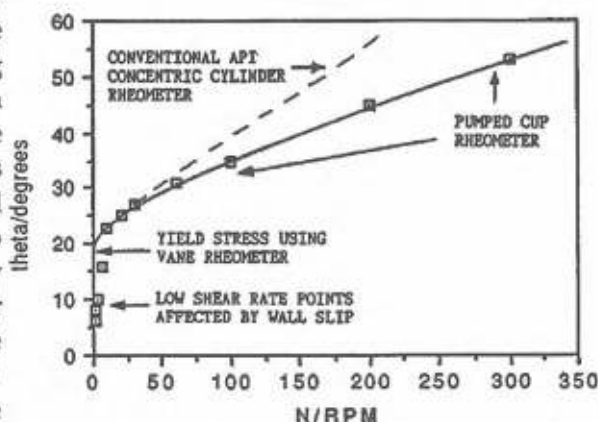


Figure 10. Torque/rotation speed rheogram for cement slurry illustrating problems of slip and particle migration encountered with granular fluids in conventional concentric cylinder geometry, and their solution by vane and pumped-cup techniques.

CONCLUSIONS

This article has given a brief review of some of the rheological behaviour of oilfield fluids. They range from inelastic viscoplastic fluids, typical of neat cement slurries, to highly viscoelastic power-law fluids, as exemplified by polymer-dominated fracturing fluids, with drilling muds sitting somewhere in the middle. One common feature which overlays the diversity of base fluid behaviour is the usual presence of high concentrations of suspended solids. Characterising this diverse range of materials brings both experimental challenges, to ensure that true material characteristics are being determined, and theoretical challenges to produce constitutive equations which can reconcile the contrasts in the small and large strain behaviour that are particularly marked for drilling fluids. In these respects they resemble many other complex fluids, such as those found in the food, pharmaceutical or coatings industries. Developing a unified approach to this wide range of complex fluids is one of the fascinating problems rheology faces in the 1990s.

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The work described in this article has been carried out by a considerable team of people in the Fluid Chemical Physics group at SCR, of whom Neil Alderman, Gerry Meeten and John Sherwood have made major contributions.

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THE EARLY YEARS OF THE SOCIETY (from the Archives)

Continuing the theme started in the last issue, in this Golden Jubilee year, I thought that members would be interested in the Editor's letter which was published in Bulletin No 26, March 1950. Written by Dr V. G. W. Harrison, the then Honorary Editor and one of the triumvirate who founded the club in 1940, it sets out clearly and wittily the case for a change of name from the British Rheologists' Club. As members will know, this change took place in 1950.

Your Committee is at present considering the advisability of changing the name of our Club to *The British Society of Rheology* or its equivalent. Several prominent members have recently expressed the opinion that we labour under a real disadvantage at present with our misleading name which gives scant indication of the true nature of our activities. Whether we like it or not, they say, we are in effect a minor scientific society with aims and methods of achieving them differing in no important respect from those of other learned societies, and so long as we retain the name "Club" we continue to put needless obstacles in the way of our foreign and junior members. There is much weight in this argument.

When the *British Rheologists' Club* was founded in the autumn of 1940, there was no intention of starting yet another scientific society and the name "Club" was chosen deliberately to emphasize the informal nature of our activities. We did not then know what the membership was likely to be, but we estimated (incorrectly as subsequent events proved) a total of about forty. We supposed that this little group would meet for an occasional meal to discuss rheological problems and to offer "mutual aid" of the type familiar to readers of the motorcycling press — save that in our case we should barter penetrometers and Newtonian liquids of high viscosity instead of magdynos and big-end assemblies. In fact, however, the membership has increased to well beyond the limits of what we had at one time considered possible; an Annual Conference with printed (if belated) Proceedings is now usual; we have an increasing number of distinguished overseas members; and many large firms have elected representatives solely in order to obtain this *Bulletin* for their libraries. All this is highly gratifying; but the inevitable corollary is that we can no longer run on a purely informal basis.

Some older members of the Club will deplore any change of name and the establishment of a constitution and rules, however simple. They tell us that the outstanding features of B. R. C. meetings have been their

informality, friendliness and vitality, which should be retained at all costs. A *Society* tends to become "stuffy" and a *Royal Society* "stuffer" still. The word "stuffy" in this context is not precisely defined, but one can guess roughly what is meant. They also fear that the subscription will be raised.

This point of view is acknowledged. Against it one must weigh the fact that the name "Club" puts difficulties in the way of overseas members who wish to remit subscriptions. To Customs and Treasury officials, *British Rheologists' Club* conjures up mental pictures of a large lounge in the West End furnished with hide armchairs in which are seated silent rheologists, asleep or reading *The Times*. It will make the payment of foreign subscriptions easier if we get ourselves recognized officially as a learned society — and in any case official recognition of our status has now become advisable for several reasons.

We are told further that employers who would not hesitate to let their junior rheologists attend a meeting of the *So-and-So Society*, may refuse them leave to attend a *Club* meeting; for to them *British Rheologists' Club* suggests not unnaturally a purely social organization, probably on a par with the *Hogsnorton Darts Club*.

Finally, the *British Rheologists' Club* will be representing British Rheology in the International Union, and for this purpose the name "Club" seems inappropriate.

Whether we like it or not, we are being forced to adopt certain simple rules. We have, for example, to deal with those rheologists whose researches are of so world-shaking a character that they have neither time to pay subscriptions nor to answer repeated letters from the Hon. Treasurer. Other rheologists have queer notions about what constitutes suitable "copy" for the press and some rules here are essential if those responsible for editing the yearly Conference Proceedings are to keep their sanity.

On balance, therefore, the Committee, though desiring to avoid "stuffiness", feels that the time for a change of name and the establishment of a simple constitution and code of rules is now overdue. Nothing can be done without the approval of a majority expressed at the General Meeting, and the whole matter will be discussed at the Reading Conference in the autumn. The purpose of this letter is to acquaint you with what is going on and to give you time to think over the proposed changes. If you have strong views, for or against, you are free to express them in this *Bulletin*. In any case, your Committee will be glad to hear from you.

V. G. W. Harrison, 1950

GOLDEN JUBILEE MEETING OF THE BRITISH SOCIETY OF RHEOLOGY AND THE THIRD EUROPEAN RHEOLOGY CONFERENCE

REPORT TO MEMBERS ON THE CONFERENCE ACCOUNTS

The final conference accounts have not yet been prepared, since there are one or two items outstanding, but the overall picture is of income of just under £90,000 and expenditure of over £94,000. The best estimate at present of the net cost to the Society is £5,299, of which £4,782 can be attributed to registration and accommodation costs for guests of the Society and travel costs of the two Gold Medallists (items 1, 2 and 3 below). The unplanned excess of income over expenditure is therefore in the region of £517 and this may be attributed either to overgenerous hospitality at receptions or overgenerous subsidizing of East European rheologists. Neither of these seems an unreasonable way of arriving at an error of about half of one percent in the budget, and the organizers hope that members of the Society considers its money (their money) well spent.

Details are as follows:

1. Representatives of fifteen societies of rheology (Australia, Austria, Belgium, Bulgaria, Czechoslovakia, France, Germany, Israel, Japan, Korea, Mexico, Poland, Sweden, U. S. A. and U. S. S. R.) came as guests of the British Society of Rheology. The total cost of this to the Society was £3,359.
2. The plenary lecturers were guests of the Society and as well as registration and accommodation, the travel expenses of the Gold Medallists were paid out of conference funds. The total cost for the two gold Medallists, Professor Edwards and Professor Gieseckus, was £1044.
3. Other guests of the Society (paid in part or full) were founding member Dr Harrison and his wife, Annual Award winner Dr Heyes and Scott Blair student Mr Nithiananthan. The costs for these totalled £379.
4. A number of East European delegates could not pay registration or accommodation in full (or at all in some cases). A Royal Society grant of £1000 was obtained specifically for this purpose and donations from other sources (acknowledged elsewhere) were also used for this purpose. The total amount of the subsidy for 12 delegates from Poland, Czechoslovakia and the U. S. S. R. is £2,529.

Items which could affect the final picture (or members' attitudes to it) include the stock of Golden Jubilee ties, pins and conference proceedings which the Society still has and can sell. There is also the possibility of making refunds of payments to those delegates who registered and paid, and then told the organizers before the conference that they would be unable to attend. A full set of accounts will be prepared and presented to Council, who will no doubt decide what to do with them.

CHRIS PETRIE

EDITOR'S NOTE

Copies of the proceedings, containing the text of the 180 contributed papers and the abstracts of the three plenary and the eight keynote papers presented at this meeting, are still available. The cost is £30 including postage. If you would like a copy please send a cheque or money order (payable to the British Society of Rheology) to Nick Hudson at the address inside the front cover.

VINOGRADOV MEMORIAL SYMPOSIUM

The fifteenth All-union Symposium on Rheology was held in Odessa from 2-5 October 1990 and was dedicated to the late Professor G. V. Vinogradov on the occasion of the 80th anniversary of his birth. The event was a memorable one for the small number of guests from western Europe, the U.S.A., Japan and China and, I believe, equally memorable for our Soviet hosts who numbered (I guess) around two hundred.

The programme consisted of three full days, each with a morning session of six invited lectures, an afternoon poster session and (later) a round table discussion session. The plenary lectures were shared between distinguished Soviet rheologists and the guests from abroad, and covered a large range of topics which appropriately reflected the breadth of interest and achievement of Professor Vinogradov. The genial atmosphere of the conference makes it seem more natural to refer to Georgii Vladimirovich but that might seem wilfully obscure here. I come back with a strong impression of a Soviet rheological community with the same sort of friendliness that I find in the British Society of Rheology, and indeed in most rheological groups. This is not to say that there are no rivalries, no strong personalities dominating groups, no serious disagreements and even attempts to ignore fellow-rheologists, in Britain or the U. S. S. R.. However these negative aspects are insignificant beside the sense of being a family in which Vinogradov occupies a place equivalent to that of someone like Scott Blair or Oldroyd or both.

The conference started with a lecture by Professor Malkin entitled "60 — 25 — Where are we going to?". He was introduced by Professor Kulichikhin as Vinogradov's best pupil and as the opening plenary lecturer at our Golden Jubilee Conference in Edinburgh. The title referred to 60 years (at least) of Soviet rheology and 25 years since the first Soviet conference on rheology (held in Moscow and organized by Vinogradov). There is not space here (nor am I a suitable author) for a biography of Vinogradov. Malkin's lecture was, among other things, a tribute to Vinogradov and emphasizes his ability to take an overall view of a phenomenon or problem (a holistic approach). He had a sense for what was significant among new ideas coupled with an ability to change direction and lead the endeavours of others. His work as a teacher and his feeling for international community and the need to overcome political and nationalistic attitudes were mentioned, as was his view that competition is good for science.

The other members of the "home team" were Professors Deinega, Froishteter, Kulichikhin, Volkov, Ur'ev, Shul'man, Entov, Stolin and Budtov, who range from contemporaries of Vinogradov to his last

doctoral student, and come from Kiev, Minsk and Moscow. The foreign guests coped with the Russian language generally by having a Soviet colleague delivering an English translation into one ear as the lecture was being delivered. We were all grateful for the efforts of colleagues and were able to understand more than we do in some lectures in English (as I hope the notes from Malkin's lecture testify). The round table discussion which I attended was lively and interesting. The problems aired sounded all too familiar: how to interest industrial rheologists in good science, or indeed how to interest industry in rheology. There were more than sixty posters scheduled for each afternoon, so it seems that Soviet rheology is healthy. Soviet rheologists are certainly keen to improve international communication and increase contact with other societies. They have officially founded the Soviet Rheological Group and it is my earnest hope that this will become affiliated to the International Committee on Rheology.

Most of the visiting team (Porter, Marucci, Petrie, Asada, Mewis, White and Meissner) spoke in English — with summaries in Russian from Malkin and others. Ivanov and Han Shifang were both able to use Russian. Many of us were able to introduce, alongside the scientific content of our lectures, memories of Vinogradov as a globe-trotting colleague, a collaborator on working parties, a poet in his soul and a deceptively good darts player. The latter is one of my personal memories, and it was with great pleasure that I was able to present Academician Plate (genial chairman of the organizing committee of this conference and also Director of the Institute in which is situated the laboratory of which Vinogradov was head) with a set of darts as a memento of the occasion.

Professor Valery Kulichikhin and others whom I will not single out individually can be justifiably proud of the organization of a very successful meeting. The "hospitality room" (mainly for foreign guests) was run by Mrs Shul'man who was seen going to market each morning to ensure a supply of fresh fruit. Efforts such as this effectively insulated us from any shortages there may have been. I have very happy memories of the hospitality shown to me and my wife, Ann, in Odessa and in Moscow; this went far beyond the call of duty and we are left with a feeling of genuine friendship. After this experience, I would strongly encourage any British (or other) rheologists to take any opportunity of visiting the Soviet rheological community. You only need to be prepared for unstoppable hospitality, a real interest in discussing rheology and the possibility of hearing at a banquet someone announce without warning to the assembled company that you are about to give the next toast.

CHRIS PETRIE

NEW COUNCIL MEMBERS

DR N. E. HUDSON, TD, BSc, PhD

Nick Hudson graduated at the University of Liverpool in 1968 with a BSc(Hons) in Mathematics. Three years later, he received a PhD from the same University for his research in the field of colour measurement and physical optics. He was appointed as a Research Fellow in the Department of Mathematics of the University of Strathclyde in 1971, working on mathematical models of the fibre spinning process. After two years, he transferred to the Department of Fibre Science, to join Dr Jim Ferguson in the development of the first commercial elongational viscometer.

Nick left University service at the end of 1977, and qualified as a secondary school teacher in 1979. He survived a number of educational 'reforms', and was progressing up the ladder when, early in 1984, he was made 'an offer he couldn't refuse', to return to Strathclyde University as a Research Fellow. Promotion to Senior Research Fellow came in 1989. Areas of expertise include the rheology of polymer solutions, particularly in elongational flow, pigments and printing inks, and aerosol technology. He was co-organiser of two BSR conferences in Edinburgh, the first in 1977, and the latest, the Golden Jubilee Meeting of 1990. In conjunction with Jim Ferguson, he regularly organises and lectures on rheology courses for students, academics and scientists in industry.

Nick married a widow, Anne, in 1981, and has two step daughters (and two step grand daughters!). His main interests outside rheology are renovating his Victorian house in Glasgow, and the Territorial Army. A member of the Society from 1972 to 1978, he rejoined in 1984, and was elected a Council member at the AGM in September 1990.

DR M. R. MACKLEY

Malcolm Mackley graduated in Physics from Leicester University and then went to the H. H. Wills Physics Laboratory at Bristol where he worked under the supervision of Professor Andrew Keller and Sir Charles Frank. Between 1970 and 1976 he developed a number of novel extensional flow devices including the double jet, and the two and six roll mill. Using these apparatuses, localized flow birefringence of polymer solutions was seen for the first time. Between 1976 and 1979 he was a lecturer in Materials Science at Sussex University where he developed an interest in unsteady flows. Since 1979, Malcolm has been a lecturer in the Department of Chemical Engineering at Cambridge University where he runs a Polymer Fluids group which has a broad range of interests in the areas of process engineering and fluid rheology.

AWARDS 1991

ANNUAL AWARD

Council makes an Annual Award for furtherance of the Science of Rheology. This award is designed to reflect either contributions made over a prolonged period or it can be used in appreciation of a particular contribution to the field including a single published paper. Council is always pleased to receive nominations for such an award particularly from the peers or supervisors of younger members of the Society whose contributions are judged to be of especial merit or promise. Nominations should be sent to the President.

SCOTT BLAIR SCHOLARSHIP AND SCOTT BLAIR BIORHEOLOGY SCHOLARSHIP

In memory of the work and example of Dr G. W. Scott Blair, the Society and Pergamon Press make available a series of scholarships to encourage excellence in research. The Scott Blair Scholarship of the Society is for research in any field of rheology while the Scott Blair Biorheology Scholarship funded by Pergamon Press, but administered by the Society, is for research in biorheology. The aim is to enable the scholars to undertake activities which would not normally be possible without such a grant, such as a period of work at an overseas University. Both scholarships are available for award in 1991.

PhD students, or equivalent, who are completing their first year of research, and are members of the British Society of Rheology, may apply to become a Scott Blair Scholar. PhD students, or equivalent, who are completing their first year of research in the field of biorheology, and are members of the British Society of Rheology, may apply to become a Scott Blair Biorheology Scholar.

The scholarships will have a value of £500 per annum (or such value as shall from time to time be decided by Council) to be used at the absolute discretion of the scholar. Subject to a satisfactory report from their supervisors, the scholarships will be renewable for a maximum of one more year. Thus they will usually be available during the second and third years of a normal PhD project.

In addition to the annual payment, Council will consider applications for additional funding to attend conferences. The scholars will be expected to present the results of their research at meetings of the Society, and to make occasional contributions to the Bulletin.

The Awardees of the Biorheology Scholarships will be expected to present the results of their research at meetings of the British Society of Rheology, and will be encouraged to publish them in the Journal "Biorheology" in accordance with its editorial policy.

The award of the Scholarships will be decided by Council who cannot enter into correspondence with unsuccessful applicants, and who reserve the right not to award a scholarship in any particular year.

Applications for the Scholarships should be sent to the Secretary of the British Society for Rheology as soon as possible. The application should be on no more than two sides of A4 paper and contain: personal details of the applicant, a description of the research, notes on any special uses envisaged for a proportion of the scholarship, and an endorsement from a person with supervisory responsibility for the research.

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 titles and date of 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.

COMMENTARY ON 263RD COUNCIL MEETING

NORTH OF WELWYN

Nine rheologists gathered on a cold and wintry afternoon in the small back room of a motel somewhere north of Welwyn. The air was thick with smoke from Anthony's pipe and the cigarettes of Dick and Nick. The carefully laid plan was set in front of us written on Carole's stylishly prepared headed notepaper. The meeting began. Would David adopt the assertive style of ex-premiere Thatcher or would he follow the Machiavellian approach of her tormentor Geoffrey Howe? The matters arising gave little away, except for a cunning suggestion by Dick, that payments to the Society could be made by credit card. In future U. K. and overseas members can pay a £15 annual subscription, or £10 subscription by bankers order.

Tension mounted when we discussed advertising rates in the Bulletin. Phil wanted a swingeing increase, Carole would have none of it and then drama. At the crucial moment a miracle of modern technology occurred; a FAX arrived from Roy. With the ink jet print barely dry, Carole read out an impassioned plea to keep rates down. We were now drawn into a debate that tested our inner beliefs in the role of the Society with a final confused vote resulting in a very modest increase being agreed.

There was also some confusion on just how many scholarships the Society runs. It was finally established that there were two, The Scott Blair Memorial Scholarship which is funded by the B. S. R. and also the Scott Blair Biorheology Scholarship which is funded by Pergamon Press. Both are very worthy awards and members should be encouraged to nominate suitable PhD students.

It became clear from the meeting that the Society was extremely fortunate in having a very conscientious set of officers. Reports from the Secretary, Membership Secretary, Abstracts Editor and Bulletin Editor all reflected the great amount of work that they had done in maintaining and indeed improving the data bases of the Society.

Concerning meetings, all were agreed that the Edinburgh meeting had been a great success and roughly of £6,000 spent by the Society to support invited guests and people from the Eastern Bloc countries was a worthwhile expenditure. We discussed the future Elongational Flow meeting at Glasgow in March 1991, the proposed Engineering Rheology meeting at Bristol in September 1991 and a Theoretical Rheology meeting in Cambridge in 1993. All this took some five hours of serious debate which left little time to discuss David's plans for a Rheological Handbook and the formation of a pressure group to

persuade manufacturers to be more open with some of the procedures used in data analysis for some of their rheological devices.

Our leader had a good scheme and we adjourned to Kenny Wong's. In a most relaxed atmosphere we then enjoyed one of the best Chinese meals I have ever had in this country. The Peking duck, Deep Sea Bass and Toffee apples were all particularly good. It was then that I knew why we had all come North of Welwyn for the day to meet for the 263rd B. S. R. gathering.

Malcolm Mackley

THE SCOTT BLAIR COLLECTION

The Librarian at U. C. W. Aberystwyth would like to thank all those members of the Society who, in response to the appeal published in Bulletin Vol. 33, No 2, have donated publications to the Scott Blair Collection which is housed in the Hugh Owen Library.

A supplement, noting these additions, to the Catalogue which was published in Bulletin Vol. 32, No 2 is being prepared and should appear in the next Bulletin. In the meantime members who wish to use the Collection or have books which they wish to donate are advised to check first with either Dr Mervyn Jones or Mrs Chris Ghosal, Assistant Librarian in the Hugh Owen Library (telephone 0970-622393).

Those who have donated books are listed below:

P. F. Gill (2), J. Hutton (5), Z. Rigbi (4), K. Walters (3), Groupe Française de Rhéologie (1), British Society of Rheology (1).

MEMBERSHIP NEWS

The following applications for membership were approved at the Council Meeting, December 7, 1990.

Mr T. Banks
Dowelanco Europe

(petsa FGH)

Mr J. Cronin
AEA Technology
Windscale, Cumbria
(fea GO)

Dr D. R. Kitching
S. P. Christie & Partners
Leicester
(petsa GHKO)

Mr J. Konupek
Research Institute of Non-metallic
Raw Materials, Karlovy Vary
Czechoslovakia
(petsa GHIN)

Dr K. Koyama
Dept. of Polymer Materials
Yamagata University
Japan
(fesa DG)

Mr K-H Krause
Beiersdorf AG
Hamburg
Germany
(petsa FGJLM)

Mr B. Lockwood
Kelco International Ltd.

(fea DGO)

Dr H. Luyton

(fetsa BJLM)

Mr S. A. Mortimer
Courtaulds Research
Coventry
(pea DE)

Mr S. A. Munro
Jacobs Bakery
Aintree
Liverpool
(fea GL)

Mr C. O'Driscoll
Loctite R & D
Dublin
Eire
(feta CDFGKLMNO)

Mr T. O'Reilly
Loctite R & D
Dublin
Eire
(fetsa CDFGKLMNO)

Dr F. Petruccione
University of Freiburg
Germany
(fetsa CDHN)

Mr J. A. Roberts
Dept. of Geology
University of Wales
(fetsa O)

Dr G. Sazonova
Soviet-British Joint Venture
Moscow, U. S. S. R.
(fetsa BO)

Dr Jay Scheiber
Dept. Of Chemical Engineering
McGill University
Canada
(fetsa D)

Dr T. A. Suck
Suck Wissenschaftliche
Geräte, Siegen
Germany
(fetsa DFGJM)

Dr L. de Vargas
School of Science of Materials
Aldolfo Lopes University
Mexico
(fetsa AD)

Mr P. D. Williams
Astor Chemical Ltd.
West Drayton
Middlesex
(fetsa CFG)

Mr R. W. Winter
School of Chemistry
University of Wales
Cardiff
(petsa CDJ)

Mr P. H. Wolfenden
Courtaulds Research
Coventry
(pea D)

The following have resigned: M. Appello, M. Athertini, L. M. Cheng, M. N. Court, R. Falabella, R. D. Hutton, R. N. F. Pinfold, S. Richardson and T. D. Smith.

DR E. W. J. MARDLES

Dr Ernest Mardles, who died in mid 1990 at the incredible age of 99, was one of the early members of the British Rheologists' Club. Just when he joined I am now unable to ascertain; but he seems to have been around from the beginning. His was a prominent influence in the early development of the Club; and he served for many years as Abstractor and on Committee. He took over as Secretary from George Scott Blair in 1945 and continued in that capacity until 1951. He was Editor of the Bulletin from 1955 to 1957.

Mardles was for much of his life Principal Scientific Officer at the Royal Aircraft Establishment at Farnborough; and this position brought him many contacts which he used to good advantage when organizing Club activities. He was able, quite early on, to arrange short residential conferences of Club members, frequently at University Halls of Residence. These were greatly welcomed at the time, since opportunities for meeting and discussion of scientific problems during the war years were very restricted. It is worth recalling, too, that although the bombing and killing had stopped in 1945, the years immediately thereafter were in many respects more austere than the war years themselves. Almost everything was rationed. Fuel for heating and lighting was scarce and we had some very cold winters. I remember gas pressure so low that it took more than twenty minutes to boil a kettle of water. The food at these early conferences was therefore spartan and the rooms were cold; but these discomforts were more than overcome by the warm and friendly atmosphere of the Club meetings; and for this, Mardles was largely responsible.

To supplement the formal sessions, Mardles was able to arrange visits to local, and often little-known, places of rheological interest. I remember vividly a china clay pit in Cornwall, from which we all emerged looking like snowmen. In the evenings, Mardles, aided and abetted by his charming wife Annie, put on musical entertainments and even party games. During such evenings the coldness and drabness of the surroundings was soon forgotten. I note with pleasure the friendly, informal nature of B.S. R. meetings to this day, and I think this pleasant atmosphere must stem to some extent from those early meetings under Mardles' leadership.

Besides his ability as a scientist, Mardles was also a competent watercolour artist. He could probably have earned a living as a landscape painter if circumstances had been different. For many years we used to receive from him at Christmas a watercolour sketch, "dashed off" somewhere or other, with a calendar attached. Several of

these are now framed and hanging on our walls, not only in memory of a dear friend but also because they are, in my judgement, good pictures.

Mardles also worked hard as a Reader in the Church of England. I have no first hand knowledge of this side of his activities, but it is evident from local press notices that he was highly regarded by the Anglican Communion in the Farnborough district.

As a correspondent and secretary, Mardles was reliable and efficient. He was however supremely indifferent to the *trivia* which upset so many of us. He could (and did) turn up at meetings wearing one brown shoe and one black; and when teased about the oversight, he would regard it as a huge joke. My wife and I remember one occasion when he had mislaid his belt and appeared wearing a length of pyjama cord to support his trousers. Sartorial elegance meant nothing to him: after all, the pyjama cord served its purpose.

It is a matter of history that the infant British Rheologists' Club, despite our expectations, did survive, grow and develop into the Society we know today. For this the first credit must undoubtedly go to George Scott Blair for his energy, enthusiasm and knowledge. Second, and not far behind, I would certainly place Ernest Mardles. The Society owes much to him. Those elders among us who knew him personally will recall his great kindness and good humour. We have lost a good friend.

Vernon Harrison

COMPETITION NO 2

Last issue's competition, the Rheogram, seems to have been too much for most people, although it should not have presented too much difficulty to avid solvers of the *Times* crossword. The solution is given below.

Probably the most difficult clue was No 11, the answer to which was 'Heracleitus'. Around 500 B. C. Heracleitus made a statement that is variously translated as 'everything flows', 'everything moves', or 'all is in a state of flux'. Perhaps the following explains all!

A philosopher named Heracleitus
Had opinions designed to excite us
He affirmed *πάντα ῥεῖ*
Until one awful day
He developed a form of arthritis

The competition this time is to write a limerick or a clerihehew on a subject that has some connection with rheology.

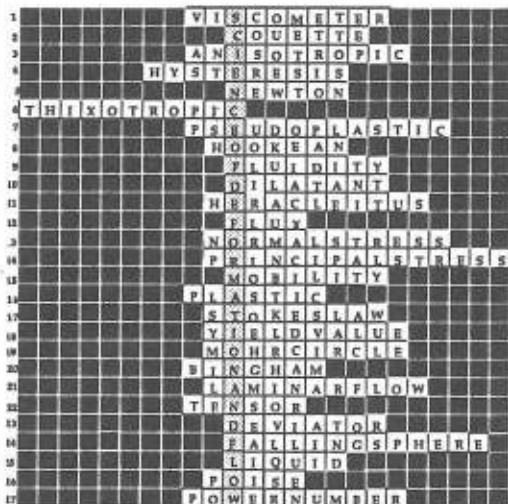
If you don't know what a Clerihew is then

The verse of E. Clerihew Bentley
Didn't scan, except incidentally
He had no respect for etymology
And had never even heard of rheology

If you are still in doubt, you are recommended to stick to the limerick.

Entries (more than one attempt if you wish) to Dr G. H. Tattersall 174 Millhouses Lane, Sheffield S7 2HE. Closing date March 15th 1991. As usual, a B. S. R. tie or £5 book token for the best. Commendation for all entries published in the next issue.

SOLUTION TO RHEOGRAM



The term defined by the letters on the vertical shaded line is "Science of Deformation and Flow".

NEWS OF OTHER SOCIETIES

GROUPE FRANÇAISE DE RHÉOLOGIE

The 25th meeting was entitled "Rhéologie des Matériaux du Genie Civil" and was held at Grenoble, November 28-30, 1990. The topics covered were concrete, rocks, soils, geomaterials, bitumens, timber, natural risks and novel materials. For further information or copies of the proceedings contact: E. Flavigny - Institut de Mécanique, B. P. 53 x, 38041 Grenoble, Cédex, France.

POLYMER GROUP OF SWITZERLAND

On April 24, 1990, a rheology section of the Polymer Group of Switzerland was founded as "Fachgruppe Rheologie". The purpose of this new group is to bring together individuals who are interested in their field of rheology, and to demonstrate in which areas rheological activities exist in Switzerland. The following were elected as members of the council: Prof. Dr F. Escher, Institut für Lebensmittelwissenschaft, ETH Zürich, Dr D. Hadjistamov, Ciba-Geigy AG, 4133 Schweizerhalle, Prof. Dr J. Meissner, Institut für Polymere, ETH Zürich and Dr Th. Raible, Geberit AG, 8640 Rapperswil. Dr Meissner will be the chairman of this group for the next two years.

THE SOCIETY OF RHEOLOGY, JAPAN

The 17th annual meeting was held on May 17 and 18, 1990 in Chiba. Twelve lectures on rheology in general and 5 invited lectures in a "Symposium on Paint and Painting Technology" were delivered. The S. R. J. award for 1989 was given to Dr Eiichi Fukada on "Studies on Piezoelectric Phenomena of Polymers and Biorheology". The S. R. J. awards for young rheologists were given to Dr Eiichi Kamei on "Behaviour of Polymeric Materials in Extension and Fracture" and to Dr Hidero Takahashi on "Properties of Polymers in Ultrahigh Shear and Flow Analysis in Injection Molding".

The 38th Rheology Congress was held at Tsukuba on October 24. About 170 people attended and 51 papers including 4 special lectures were presented.

For further information contact Prof. Kunihiro Osaki, Secretary, The Society of Rheology, Japan (SRJ), 1-101 Izumidono-cho, Yoshida, Sakyo-Ku. Kyoto. 606 Japan.

CONFERENCE ANNOUNCEMENTS

EXTENSIONAL FLOWS IN INDUSTRY
 A One Day Conference
 at the University of Strathclyde, Glasgow
 6th March 1991

The very great influence of extensional flows in industry is only now becoming recognized. They play an important role in processes with obvious uniaxial and biaxial flows such as fibre spinning and film blowing. Only recently has it become clear that they have profound effects in extrusion, mixing, injection moulding, spraying, enhanced oil recovery etc.

Papers are invited for presentation at the Conference on any aspect of extensional flows. Posters will be accepted. A number of invited speakers will also give papers and they will lead the discussions. Audience participation is expected at the Conference which should have the atmosphere of a workshop.

CONFERENCE FEE: £75.00

Please complete the form below and return it to:

Dr J Ferguson, Dept. of Pure & Applied Chemistry,
 University of Strathclyde, Glasgow G1 1XL

I wish to attend/ present a paper/poster at the Conference

NAME:

ADDRESS;

.....

.....

TEL.NO FAX.....

TITLE OF PROPOSED PAPER/POSTER

.....

.....

ENGINEERING RHEOLOGY
WITH EMPHASIS ON IN-LINE PROCESS RHEOMETRY
AN INTERNATIONAL CONFERENCE
AT THE UNIVERSITY OF BRISTOL
9-12TH SEPTEMBER 1991

SECOND CALL FOR PAPERS

The British Society of Rheology is holding an International Conference on Engineering Rheology with emphasis on In-Line and On-Line Process Rheometry at the University of Bristol from 9-12th September 1991.

Papers are invited for this event and Abstracts of about 200 words should be sent as soon as possible to the address at the foot of this notice.

The conference will be held in the new Wills Hall complex on the Downs overlooking the old port of Bristol. It is intended to publish the Proceedings of the Conference, and authors will be required to submit camera-ready copy by 2nd September 1991.

The cost of attending the Conference, including 3 nights full board accommodation in a single room with shower and toilet, Registration Fee, Proceedings, Abstracts Booklet, conference dinner and V. A. T. is:

Members of the British Society of Rheology	£287.50	
Non-Members	£316.25	
Bone-Fide Students	£230.00	

(must have supporting statement from supervisor) (PLEASE TICK AS APPROPRIATE)

TITLE FIRST NAME SURNAME

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ADDRESS

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NOTES (Diet, disability etc..)

(photocopies of this form are acceptable)

To register send application form and cheque to the Organizer:

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

Tel.: 06946-466, Fax: 06946-468, Telex: 9312102287 CB G

**ENGINEERING RHEOLOGY
A SHORT COURSE AT
THE UNIVERSITY OF STRATHCLYDE**

A short intensive course on engineering aspects of rheology will be held in the Department of Pure and Applied Chemistry, starting on Monday 6th May 1991. The course, made up of 15 lectures, will concentrate on industrial aspects of flow of non-Newtonian fluids. No prior knowledge of the subject is required, although the various topics will be dealt with at a level that will enable those attending to apply the work to practical industrial situations. All lectures will be held in the afternoons. A hands-on laboratory element, during the mornings, is included in the course.

This course complements the Theoretical, Experimental and Industrial Aspects of Rheology course to be held 28th to 31st May 1991.

SYLLABUS: Lectures

introduction to rheology; non-newtonian fluids; measurement of flow properties; normal stress effect and memory effects; polymeric fluids; general linear viscoelastic fluids; extensional flow; drag reduction; non-newtonian flow in pipes and granular beds; extrusion; two phase flow (liquid/gas); two phase flow (suspensions/pastes); spraying; coating; pumping and mixing and fibre spinning.

SYLLABUS: Practicals

Weissenberg Rheogoniometer; Controlled Stress Rheometer; Viscoelastic Analyser; Elongational Viscometer; Hollow Fibre Apparatus; On Line Process Control Rheometer; Melt Extruder; Instron; Spray Equipment.

VENUE: Thomas Graham Building, University of Strathclyde

295 Cathedral Street, Glasgow G1 1XL

TIME: 0930-1200, Practical work; 1400-1700, Lectures
Monday 6th to Friday 10th May inclusive

COST: £450.00

ACCOMMODATION: Not included in the fee. Unfortunately, no University accommodation is available but there are many hotels and guest houses within easy reach of the University.

Further details can be obtained from

Dr J. Ferguson or Dr N. E. Hudson, Dept of Pure & Applied Chemistry,
University of Strathclyde, Glasgow G1 1XL. Tel: 041-552-4400 Ext
2161/2162, Fax: 041-552-5664.

I wish to attend the Engineering Rheology course. Please send details to:

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

ADDRESS

.....

.....

TEL. NO

THEORETICAL, EXPERIMENTAL AND INDUSTRIAL ASPECTS OF RHEOLOGY

This Rheology Course, sponsored by Carri-Med Ltd., of Dorking, Surrey, will take place at the University of Strathclyde's Educational and Recreational Centre, Ross Priory, on Loch Lomond, Scotland from 28th to 31st May 1991. The course, which is residential, is intended to cover the basics of rheology, modern experimental techniques (including constant stress rheometry, rheogoniometry, elongational flow and industrial aspects of rheology) and lead to state-of-the-art concepts in flow, data acquisition and interpretation. It complements the Engineering Rheology course to be held 6th to 10th May 1991. Course notes and a copy of the textbook "An Introduction to Rheology" are provided.

The lectures will be given by well known rheologists, namely

Dr H. Barnes, Unilever plc
Dr J. Ferguson, University of Strathclyde
Dr N. E. Hudson, University of Strathclyde
Dr T. E. R. Jones, Plymouth Polytechnic
Mr H. Schimanski, Carri-Med Limited
Professor K. Walters, U. C. W., Aberystwyth

The cost of the course is £440.00. This includes the Course fee, accommodation (full board) and transport to and from the centre of Glasgow, together with course notes and textbook.

Accommodation at the priory is limited and it will be necessary to share a room. Additional accommodation is available in local hotels at a surcharge of £72.00.

If you wish to enrol on the course, please complete the attached form and return it. It should be emphasised that the numbers on the course will be limited, so please book as soon as possible to avoid disappointment.

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

Tel: 041-552-4400 Ext 2161/2162, Fax: 041-552-5664.

I wish (a) more information[†], (b) to attend[†], the Rheology Course.

Please send course details to:-

NAME (Mr, Mrs, Miss, Dr etc)

ADDRESS

.....

.....

TELEPHONE NUMBER

[†] Delete whichever is inapplicable

XIth INTERNATIONAL CONGRESS ON RHEOLOGY

The XIth International Congress on Rheology will be held in 1992 in the Brussels Convention Hall. The technical sessions will begin on Monday morning, August 17, and the Congress will close in the afternoon of Friday, August 21. The registration fee will include attendance to the technical sessions together with a full social programme. A number of social and tourist activities will also be organized for accompanying persons.

The technical programme will consist of invited lectures, scientific communications and poster sessions, some of which will be presented during special symposia. The papers will be published in the Conference Proceedings to be made available at the opening of the meeting. An exhibition of rheological instruments will also be organized during the meeting.

We look forward to welcoming you in Brussels in 1992.

For further information please contact:

Dr Paula Moldenaers, Secretary of XIth International Congress on Rheology, Chemical Engineering Department, Katholieke Universiteit Leuven, W. de Croylaan 46, B-3001 Leuven (Belgium), Fax number: 32-16-22 15 22.

FORMULATING WITH RHEOLOGY MODIFIERS

A one-day meeting will be held on February 27, 1991 at the Clayton Lodge Hotel, Newcastle-Under-Lyme. It will be organized by the Water-Soluble Polymers Group of the British Association for Chemical Specialities (B. A. C. S.) and will consist of talks and demonstrations by five manufacturers of rheology modifiers.

For further information contact:

B. A. C. S., John Marshall House, 246-254 High Street, Sutton, Surrey SM1 1PA Tel.: 081-643-0689

INSTITUTE OF PHYSICS, PRINTING, PACKAGING AND PAPERMAKING GROUP

An afternoon meeting will be held on March 21, 1991 at the Institute headquarters, 47 Belgrave Square, London starting at 2 p. m. There will be three speakers: Dr Ken Beazley, formerly of English China Clays, on the rheology of clay coating mixes, Dr Trevor Gregory of Coates Brothers on the rheology of printing inks and Dr David Cheng, Warren Spring Laboratory on the use of viscometers to mimic coating processes.

For further information contact:

A. E. Ranger, Iggesund Paperboard Ltd., 35 Saffron Court, Southfields Industrial Estate, Basildon, Essex SS15 6SS
Tel.: (0268) 540397.

BEST PRACTICE IN CHEMICAL PROCESSING

A two day conference and technology marketplace will be held on March 26/27, 1991 at Imperial College London with this title. It will include a number of scene setting lectures on heat transfer and fluid flow, rheology and mixing, polymer processing and other topics related to the major unit operations in chemical engineering. There will also be presentations, posters and equipment displays.

For further information contact:

Jane Latin, The R & D Clearing House, 2.22 Whitechapel Technology Centre, 75 Whitechapel Road. London E1 1DU, U. K.. Tel.: 071-375-1382

SECOND SYMPOSIUM ON: "ADVANCES IN PARTICULATE TECHNOLOGY"

UNIVERSITY OF SURREY, GUILDFORD, 15-17 APRIL 1991

This symposium will be a successor to a Symposium with the same title held at UMIST in April 1987. Like its predecessor, it is supported by the Science and Engineering Research Council to disseminate the results of its Specially Promoted Programme (SPP) in Particulate Technology. However, work to be presented at the Symposium is not limited to the SPP, and there will also be substantial international participation. The Symposium is co-sponsored by The British Institution of Chemical Engineers, The Filtration Society and The British Materials Handling Board.

Proceedings will be published as Volume 65 of "Powder Technology", with copies provided to registrants at the Symposium. There will also be opportunities at Poster Sessions to discuss projects in the SPP, the work of interested industrial organizations, and other "work in progress".

During the Symposium, forty five papers will be presented, following a format which has been found successful at other Conferences. At each session, all papers will first be presented briefly. Presentations will be followed by an extended opportunity to view and discuss posters relating to the papers, followed by a plenary discussion of the whole session.

The papers are divided into six sessions as follows:

Interparticle Forces: Friction and Shear

Interparticle Forces: Mechanical Properties and Adhesion

Primary Particle Formation: Precipitation and Crystallisation
Granulation and Attrition

Liquid-Particle Systems: (i) Rheology

(ii) Surface Effects & Tailored Particles

Gas Particle Systems.

Further information and a registration form can be obtained from:

Mrs Jean Libaert, Dept. of Chemical & Process Engineering, University of Surrey, Guildford, GU2 5XH, U. K. Tel.: 0483-506330, Fax.: 0483-303807.

VISCOMETRY SEMINAR
KEELE UNIVERSITY APRIL 1991

Physica U. K. will hold a one day seminar at Keele University on Thursday 25th April 1991. The seminar will provide an excellent opportunity to discuss industrial applications of rheology and viscometry with invited chemists, rheological specialists and instrument designers. Lectures from the guest speakers will highlight a wide variety of applications in areas such as plastics, polymers, pharmaceuticals and foods. During the day there will be practical demonstrations on how to make effective measurements. The seminar will provide an opportunity to evaluate the latest software and equipment while gaining expert advice and first hand knowledge of how rheology can assist your application.

For registration details contact:

Mr Roger Browning, Physica U. K., 594 Kingston Road, Raynes Park, London SW20 8DN Tel.: 081-540-8553

FLOW PROCESSES IN COMPOSITE MATERIALS
THE UNIVERSITY OF LIMERICK, IRELAND 4-5 JULY 1991

The aim of the conference is to discuss issues associated with composite manufacturing processes, with special emphasis on forming of thermoplastic composites. Papers are invited on the topics outlined below. Abstracts should clearly state the objectives, results and conclusions of the work undertaken. The category designation from the list of topics and final acceptance will be based upon review of the full length paper. Selected papers will appear in a special conference edition of 'Composites Manufacturing'. While the closing date for abstracts was January 31st Neil Cogswell has agreed to expedite any late submissions from members of the Society. They should be sent to him at the address below.

Flow Mechanisms in Thermoplastic Composites, Flow Mechanisms in Thermosetting Composites, Rheology of Polymer Suspensions, Manufacturing Applications, Adhesion/Bonding of Advanced Composites, Numerical Modelling of Composites Processing

Mr F. N. Cogswell, ICI Wilton Materials Research Centre, P. O. Box 90, Wilton Middlesbrough, Cleveland TS6 8JE Tel.: 0642-454144 ext. 2663

MEASUREMENT, MODELLING AND COMPUTATIONAL FLUID DYNAMICS

Details of a one day meeting at BHR Group Ltd., Cranfield, Bedford held on December 19th 1990 were received too late for inclusion in the last Bulletin but may nevertheless interest members. Sponsored by the Institute of Chemical Engineers Fluid Mixing Subject Group it was due to cover techniques and applications for modelling mixers including computational fluid dynamics, and experimental validations of models.

Further information may be obtained from:

Mr S. Ruszkowski, BHR Group Ltd., Cranfield, Bedford, MK43 0AJ,
U. K. Tel.: 0234-750422.

APPLIED RHEOLOGY FOR CHEMISTS

A residential school will be held from July 15-18, 1991 at the University of Bristol. The course is primarily aimed at chemistry graduates working in industry and has been specially planned to give them a better understanding of the measurement and interpretation of rheological properties of liquid products and their relationship to microstructure. The course will cover:

Relevance of Rheology, Viscometry, Viscosity Laws, Extensional Viscosity, Mathematics in Rheology, Suspensions (Stabilised), Suspensions (Flocculated), Emulsions, Thixotropy, Polymer Solutions

In addition to the lecture programme there will be practical sessions in the University laboratories which will allow participants to use a wide variety of rheometers and viscometers on model systems supplied, or else on their own samples.

For further information contact:

Ms L. A. Hart, The Royal Society of Chemistry, Burlington House,
Piccadilly, London W1V 0BN Tel.: 071-437-8656

CHINA-JAPAN INTERNATIONAL CONFERENCE ON RHEOLOGY

This conference will be held between October 9-12, 1991 in Beijing, China, sponsored by The Chinese Society of Rheology and the Society of Rheology Japan. It will deal with the following topics:

Fundamental Theory, Fluid Mechanics, Numerical Methods, Rheometry, Polymer Processing, Industrial Rheology, Biorheology and Biomechanics, Solution and Melt of Polymers, Composites and solids, Polymer Alloys and Liquid Crystals, Suspensions

Papers on other relevant topics will also be welcome. Authors wishing to submit a paper are requested to send a 200 word abstract to

either of the persons named below. Deadline for the pre-registration is January 31, 1991. Full text for the proceedings, no more than four pages, in camera-ready form, should be mailed to the following address before June 20, 1991.

Hisashi Odani, Institute for Chemical Research, Kyoto University
UJI, Kyoto-Fu 611, Japan, Tel.: (0774) 32-3111, ext. 2144 Fax: +81 (774) 33-1247.

Chun Fan, Institute of Mechanics, Chinese Academy of Sciences, Beijing
100080, China, Fax: (86-1) 2561284

Rheologists from Asian countries and other continents are also welcome to participate in the conference. The conference language is English. No arrangements will be made for simultaneous interpretation.

CONFERENCE DIARY

DATE	PLACE	DETAILS
27/2/91	Newcastle Under Lyme U. K.	'Formulating with Rheology modifiers', contact: BACS, John Marshall House, 246-254 High Street, Sutton, Surrey SM1 1PA.
6/3/91	Glasgow U.K.	'Extensional Flows in Industry', contact: Dr J. Ferguson, Dept. of Pure & Applied Chemistry, University of Strathclyde, Glasgow G1 1XL.
8-11/4/91	Churchill College Cambridge U. K.	'Deformation yield and fracture of polymers', contact: Conference Dept., Plastics & Rubber Institute, 11 Hobart Place, London SW1W 0HL.
8-12/4/91	Sophia- Antipolis Nice, France	'International course on rheology, rheo-optics and processing of liquid crystalline polymers', contact: Dr Patrick Navard, Centre de Mise en Forme des Matériaux, Ecole Nationale Supérieure des Mines de Paris, Sophia-Antipolis, 06560, Valbonne, France.
15-17/4/91	University of Surrey Guildford, U. K.	'Advances in Particulate Technology', contact: Mrs Jean Libaert, Dept. of Chemical & Process Eng., University of Surrey, Guildford GU2 5XH.
21-24/4/91	Hamilton, Canada	Polymer Processing Society, Seventh Annual Meeting, Ontario contact: PPS-7 c/o Dept. of Chemical Engineering, McMaster Univ., Hamilton, Ontario, Canada, L8S 4L7.
6-10/5/91	Glasgow U. K.	Short Course: 'Engineering Rheology', contact: Dr J. Ferguson, Dept. of Pure & Applied Chemistry, University of Strathclyde, Glasgow G1 1XL.

- | | | |
|------------|-----------------------------------|--|
| 13-15/5/91 | Germany | German Society of Rheology, Annual Meeting, contact: Prof. K. Kirschke, Deutsche Rheologische Gesellschaft, Unter den Eichen 87, D-1000, Berlin 45. |
| 14-15/5/91 | London
U. K. | 'Flow measurement in Industry and Science', contact: K. Lye, IBC Technical Services, Bath House, 56 Holborn Viaduct, London EC1A 2EX |
| 28-31/5/91 | Glasgow
U. K. | Residential Course: 'Theoretical, Experimental and Industrial Aspects of Rheology', contact: Dr N. E. Hudson, Dept. of Pure & Applied Chemistry, University of Strathclyde, Glasgow G1 1XL. |
| 4-5/7/91 | University of Limerick
Ireland | 'Flow Processes in Composite Materials', contact: Dr C. M. O. Bradaigh, Dept. of Mechanical Engineering, University College Galway, Galway, Ireland. |
| 7-12/7/91 | Compiègne
France | International Congress on Surface and Colloid Science, contact: Secretariat of the 7th ICSCS, c/o Wagons-Lits Tourisme, BP 244, F-92307 Levallois-Perret cedex France |
| 15-18/7/91 | Bristol
U. K. | Residential School: 'Applied Rheology for Chemists', contact: Ms L. A. Hart, The Royal Society of Chemistry, Burlington House, Piccadilly, London W1V 0BN. |
| 15-18/7/91 | Prague
Czechoslovakia. | 'Rheology of Polymer Melts', contact: PPM Secretariat, c/o Institute of Macromolecular Chemistry, 16206, Prague, |
| 16-19/7/91 | Southampton
U. K. | Clinical Haemorheology, Seventh European Conference, contact: Dr S. Roath, University Haematology, Room LF64, South Academic Block, Southampton General Hospital, Southampton SO9 4XY. |
| 9-12/9/91 | Bristol, U. K. | International Conference on 'Engineering Rheology', Autumn meeting of the British Society of Rheology. contact: Mr R. E. Carter, Carter-Baker Enterprises 2 Marshbrook Business Park, Marshbrook, Church Stretton, Shropshire SY6 6QE. |
| 11-15/9/91 | Capri, Italy | 'International Conference on Dynamics of Polymeric Liquids', contact: Prof. K. Walters, Dept. of Mathematics, UCW, Aberystwyth, Dyfed, U. K. |
| 15-18/9/91 | Palermo, Italy | Polymer Processing Society, European Regional Meeting, contact: S. Piccarolo, Dipartimento di Ingegneria Chimica, dei Processi e dei Materiali, Viale delle Scienze, 90128, Palermo, Italy. |

17-19/9/91	Leuven, Belgium	'Interfacial phenomena in composite materials '91', contact: Janet Miles, Conference Organiser, IPCM '91, Butterworth-Heinemann Ltd., PO Box 63, Westbury House, Bury Street, Guildford, Surrey GU2 5BH.
18-20/9/91	Brugge Belgium	7th European Congress on Mixing, contact: c/o TH-K.VIV, Attn. Ms Rita Peys, Desguinlei 214, B-2018 Antwerpen (Belgium).
9-12/10/91	Beijing, China	China-Japan International Conference on Rheology contact: Chun Fan, Institute of Mechanics, Chinese Academy of Sciences, Beijing 100080, China.
April 1992	London, U. K.	'Rheology of Building Materials', contact: R. J. Mangabhai, TH Technology, Maple Cross House, Denham Way, Rickmansworth, Herts.
17-22/8/92	Brussels Belgium	9th International Congress on Rheology, contact: Dr P. Moldenaers, Chemical Engineering Department, Katholieke University Leuven, W. de Croylaan 46, B-3001 Leuven, Belgium.

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Contact:

Mr B. Roberts or Mr T. O'Brien,
Pafra Ltd., Bentalls,
Pipps Hill Industrial Estate,
Basildon, Essex SS14 3BU
Tel.: (0268) 280606 Fax: 0268 280904.

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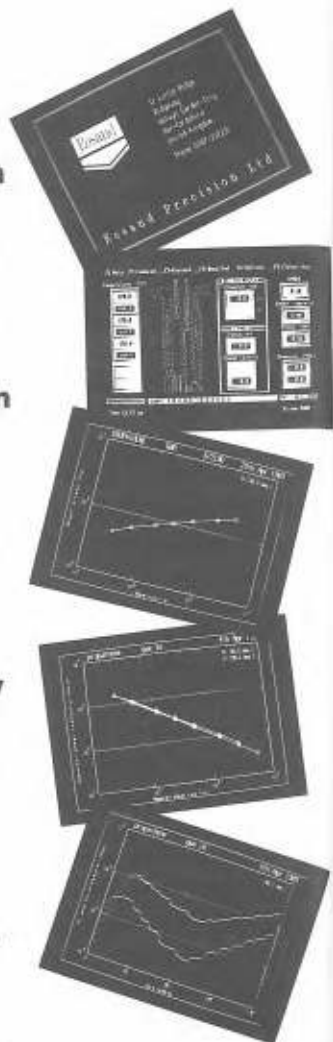
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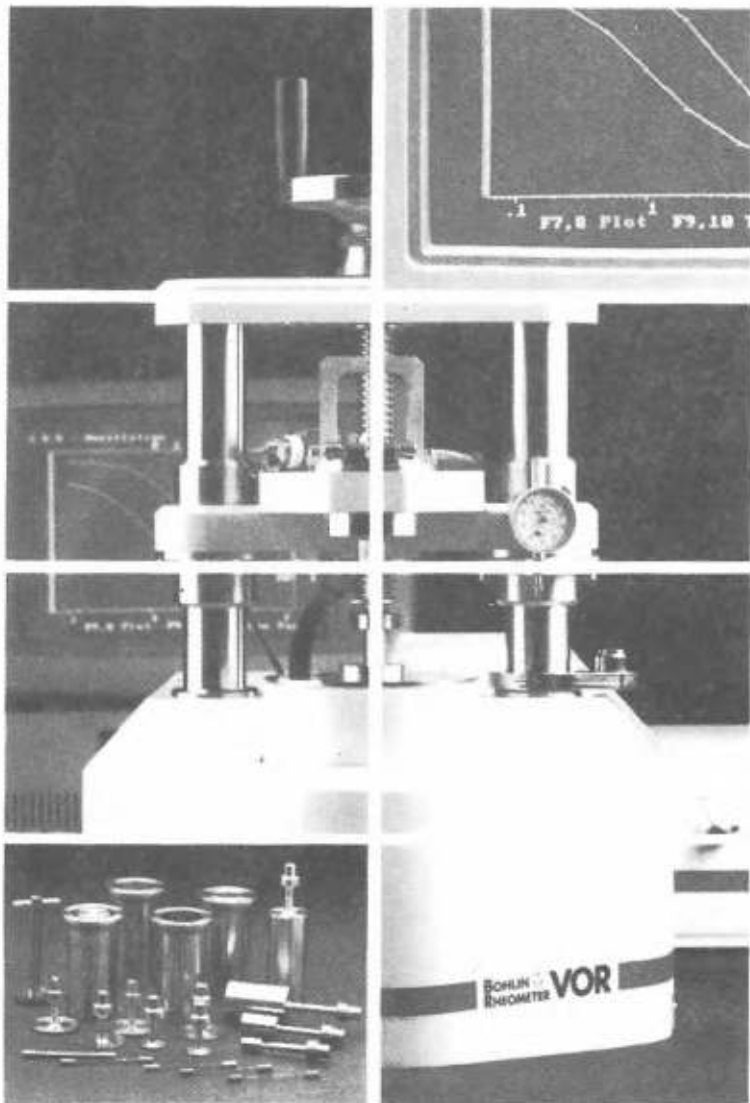
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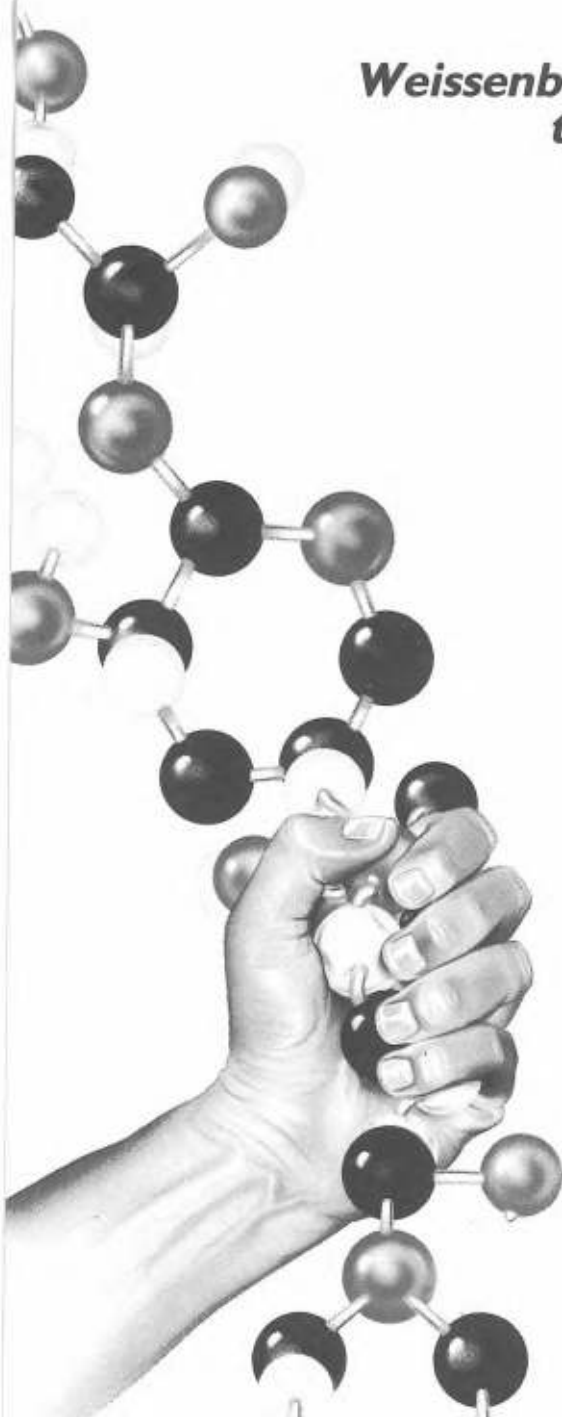
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A detailed illustration of a hand squeezing a polymer chain. The chain is composed of black and white spheres connected by rods, representing atoms and bonds. The hand is shown from the wrist up, with fingers firmly gripping the chain, symbolizing the application of shear stress.

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