Conference Report II

Advances in Non-Newtonian Fluid Mechanics (INFFM Annual Conference 2013)

Institute of Non-Newtonian Fluid Mechanics, Chicheley Hall, United Kingdom
March 25 – 27, 2013

A carpet of white snow greeted the delegates as they arrived at Chicheley Hall. Despite this having been the coldest March in the UK for over 40 years there was definite warmth at the buffet lunch which opened the conference. A majority of the delegates had known each other for decades and there was no need for the ubiquitous nametags and lanyards.

The presentations on the first day covered a variety of subjects mainly devoted to rheometry and the opening session was chaired by Peter Townsend. Roger Tanner spoke about the effect of pretest deformation on the rheology of soft solids and showed some nice data produced with samples of dough. When measuring doughs in a parallel plate geometry loading of the sample produces a compression which results in a pre-strain being imposed upon the sample, the greater the pre-strain the greater the storage modulus. This effect was attributed to the alignment of non-

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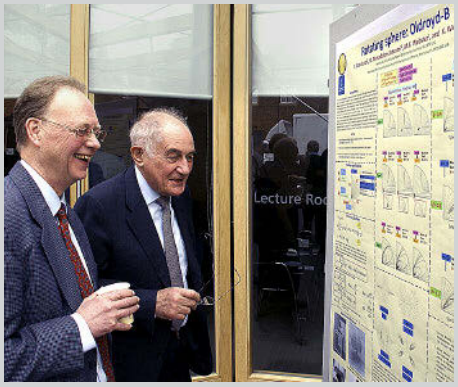

Figure 2 (left): Tim Phillips is being presented with the BSR Annual Award by chairman Bill Frith.

Figure 3 (middle): Mike Webster with Marcel Crochet (I believe) in another picture.

Figure 4 (right): Jeffrey Giacomin in conversation.

oped his own design which is in essence based on Meissner's technique but can be incorporated into the oven of a rotational rheometer and enables much higher Hencky strains to be produced on melts (> 8.0). Last but not least Jörg Läuger from Anton Paar introduced the MCR702, a new instrument which extends the capabilities of rotational rheometers. Electrically commutated motors are incorporated both above and below the sample which enables measurements in 3 different modes (combined motor transducer, separate motor transducer and counter rotation). Some impressive data was shown at very low torques (nNm) along with some new applications made possible by counter rotation (eg. Stagnation planes for rheo-optics as described above).

Tuesday morning opened with some interesting talks relating to rheology in everyday life with Gerry Fuller outlining the role of rheology in contact lens comfort and Oliver Harlen showing how viscoelastic behavior affects the jettability of inkjet printer inks (some fascinating imagery of satellite drop formation here). Simon Cox reminded us of the many everyday applications of foams before discussing numerical methods for generating two dimensional foams. Suzanne Fielding took us up to the coffee break by showing her work in deriving fluid universal criteria for banding and necking instabilities in time dependent flows of complex fluids. The majority of Tuesday was devoted to a mini-symposium in honour of Russell Davies of the University of Cardiff (Fig. 1), who is retiring this year after many years of rheological activity. This was split into two sessions – one before and one after lunch – showcasing various talks on Theoretical Rheology as befits the head of a Mathematics department. The first talk was from Bob Anderssen, who gave an insight into the interrelationship between the shear relaxation modulus G(t) and the shear creep compliance J(t) for a linear material. Closely related was Igor Emri's contribution, discussing the extraction of a spectrum of relaxation times from experimental modulus measurements and the use of "windowing" to reduce the effects of experimental noise. Sean McKee showed how difficult it can be to simulate liquid crystal flows, using channel flow as his example. This flow can be solved analytically, but contains boundary layers of many orders of magnitude smaller than the channel, making it an extremely challenging numerical problem. Finally Helen Wilson gave an overview of linear instabilities in polymeric fluids (ranging from interfacial instabilities through shear-banding to bulk mechanisms such as curved streamlines and chain stretch relaxation) to lead us into lunch. After lunch Jonathan Evans gave a wide-ranging overview of the many years of work on the problem of flow of a viscoelastic fluid around a corner. The solutions involve multiple regions both in terms of distance away from the corner, and angle from the walls: a thoroughly knotty mathematical problem. Gareth McKinley explained how critical gels at the crossover point between fluid-like and solid-like behaviour can be modelled (as far as linear viscoelasticity is concerned) using the neat mathematical trick of fractional derivatives, a formalism which captures the dynamics of random walks whose mean displacement grows more slowly than the standard square root of time. A graph showing particles moving through cheese stuck in my mind simply because I can't imagine why particles would be in cheese in the first place ... Bruce Caswell talked about sickle cell anaemia, in which usually malleable red blood cells become hard (and sickle-shaped) and eventually plug up blood vessels, with fatal effect. The life expectancy for sufferers is around 50 years: seeing experiments on these sickled cells, the mystery is less why there is a problem, more as to how people can live so long. The closing presentation was from Michael Renardy (using slightly distracting Energiser Bunnies as his cursor), talking about boundary layers in Newtonian and viscoelastic flows. His take-home message was simple: usually, we solve the Newtonian case first, and the viscoelastic problem is harder; for Prandtl boundary layers, the Newtonian problem is still open but the viscoelastic problem may be tractable. It still looked pretty difficult to the audience though. Gerry Fuller and John Dealy formed the judging panel for the poster prize which was awarded to Claire Mcil-

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roy from the University of Leeds. Claire is a student of Oliver Harlen who accepted the prize on her behalf. The winning poster illustrated work undertaken in modeling the flow of inkjet printer inks.

The British Society of Rheology hosted the final session on Tuesday with Tim Phillips giving the BSR Annual Award Lecture – Modeling the Dynamics of Gas Bubbles near Free surfaces (Figure 2). Bill Frith gave the Presidential Address in his penultimate task as president and described how rheology is used at Unilever with products such as ice creams and surfactant polymer mixtures such as shampoos. Following this Bill chaired the AGM during which a new council was formed and Rhodri Williams took over the reign of President. On Tuesday after dinner entertainment was provided courtesy of Peter Townsend and Jeffrey Giacomin. Both speakers were exceptionally entertaining and in his role as President of the SOR Jeff finished his speech by announcing that Gareth McKinley had been awarded the Bingham Medal for 2013. This will be formally presented at the SOR meeting in Montreal later this year.

On Wednesday morning Xue-Feng Yuan talked about experiments and simulations of dilute and semi-dilute polyethylene oxide solutions in microfluidic geometries, paying particular attention to the role played by extensional viscosity in flows with strong extensional components. Paco Chinesta spoke about the Proper Generalised Decomposition method in general. Paul Slatter talked about waste suspensions in the mining industry and the importance of understanding open channel flows for complex fluids showing an inelastic theory for this so-called "sheet flow", together with experimental data for laminar and turbulent flows. The theoretical agreement with laminar flow data was good but the transition to turbulent flow was not well predicted or understood. Ian Frigaard gave a lovely overview of his work over the past 15 years on yield stress fluids encompassing both linear stability analysis, experiments and computations. Rob Poole delivered the penultimate talk of the conference, his subject being viscoelastic flow in a serpentine (wavy) channel. Curved pipes can give rise to secondary flows which wouldn't have occurred in a straight channel and Robs work covered viscoelastically induced secondary flows plus purely elastic instabilities produced in non-linear channels. A cheerful Adam Burbidge concluded the conference by discussing extensional coalescence and its suppression, as well as the difficulties encountered in gaining agreement between theoretical models and practical observations.

By the time delegates dispersed the snow had pretty much disappeared and many admired both the architecture and gardens of Chicheley Hall. From a transport perspective "everything flowed" and most peoples thoughts turned to the journey home and the forthcoming Easter Break.

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Figure 5:
Evening meal at Chicheley Hall.

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