others feeling that decision makers should try to educate the public by relating the risks associated with waste disposal to commonly accepted risks of life.

The urgency for a solution to waste management problems and the UK policy on high-level waste disposal attracted considerable comment. There seemed to be a consensus that once high-level waste has been solidified there is no pressure to move from storage to disposal on technical or safety grounds, although indefinite storage would not be acceptable. The UK has yet to choose between the three high-level waste disposal options which are currently the subject of research (i.e. emplacement in geologic formations on land, burial beneath the seabed and disposal on the floor of the deep ocean). There was agreement that the temptation to foreclose options prematurely should be resisted, despite potential international opposition.

In summary, the symposium went some way towards bridging the gaps in communication between those who are involved in waste management decisions and those who would like to be, given sufficient information and the opportunity.

A report of this symposium was published by the NRPB as a supplement to the September 1980 issue of the *Radiological Protection Bulletin*.

M D Hill NRPB

Magnetic fluids

2nd international conference on magnetic fluids
24–27 March 1980 at the Marriott Inn, Orlando, Florida, USA

In recent years the mechanics, physics and chemistry of liquids with strong magnetic properties have been actively investigated. Colloidally suspended solid magnetic particles of subdomain size do not separate from the liquid carrier, because they are kept in constant agitation through random thermal molecular motion. Monomolecular coatings on the magnetic particles serve as particle 'bumpers' and overcome the tendency of the particles to clump together. Applications using these unusual magnetic fluids currently include vacuum and high pressure rotary seals and feedthroughs, speaker fluids and damping systems. Other applications being studied include material separators, fluid printers, medical techniques, visualisation and display systems, bearings, activators, sensors, switches and magnetocaloric heat pipes and engines which rely on the temperature dependence of the fluid magnetisation. New scientific advances and the increasing importance of the technological applications led to widely dispersed but growing research groups of all disciplines. However, there was a lack of active exchange of scientific information and experience, as well as a need for fruitful discussion on future engineering applications of magnetic fluids.

To meet these needs UNESCO sponsored the international advanced course on the thermomechanics of magnetic fluids from 3–7 October 1977 at the International Centre for Mechanical Sciences (CISM), Udine, Italy. Participants there realised that the study of magnetic fluid mechanics was a growing discipline and that to help coordinate and direct future advances a full programme second international conference on magnetic fluids was necessary. The conference was sponsored by the IEEE Magnetics Society, the US National Science Foundation, the US Department of the Interior Bureau of Mines, Exxon Corporation, and Ferrofluidics Corporation; about 55 attended from 13 countries.

The conference was divided into six sessions: preparation and physicochemistry of magnetic fluids, magnetic fluid theory, magnetic fluid experiments and measurements, magnetic fluid hydrodynamics, magnetic fluid thermomechanics and magnetic fluid applications. There was a total of 40 scheduled papers, with five invited papers providing tutorial reviews on the state of knowledge on selected topics. All papers were published in the *IEEE Transactions on Magnetics* (March 1980) which served as the conference proceedings. Some representative magnetic fluid topics presented at the conference include mechanics and force densities, heat and mass transfer, nonlinear interfacial waves, ferrohydrodynamic stability and instability, magnetic ink jet printing, ferrofluids as an acoustic transducer, visualisation of magnetic domain walls, magnetic fluid sealing, filtering, and lubrication, magnetic fluid birefringence and dichroism.

Some authors could not attend so it was possible to devote one afternoon session to valuable impromptu presentations, discussions and films. These included (i) a film by M Zahn and R E Rosensweig showing stabilisation against the fingering instability in a Hele–Shaw cell when a more viscous fluid pushes a less viscous fluid by using a uniform magnetic field tangential to the interface between a magnetic and nonmagnetic fluid; (ii) a film by M Zahn and Choi Tae In showing ferrofluid and magnetisable particle rotations and velocity reversals in a travelling wave magnetic field; (iii) a film by G Reimers showing the US Bureau of Mines work on sink–float separation using a magnetic fluid; (iv) a report by R E Rosensweig on magnetically stabilised fluidised beds of ferromagnetic particles (which is a new but analogous science and technology to magnetic fluids) and a short presentation on a new understanding based on the Kelvin–Helmholtz instability as to why ferrofluid seals perform poorly against liquids.

To help introduce newcomers to the field as well as inform all investigators of past and current work, an extensive bibliography of magnetic fluid publications and patents was prepared by a

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computerised literature search and published in the conference proceedings. Overall, the conference was very successful in meeting its goals of aiding the active exchange of scientific information and experience with magnetic fluids, assessing the current state of knowledge, identifying both specific problem areas and promising directions for future research and applications, and assisting in the establishment of active relations between international research groups.

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Water jetting technology

5th international symposium on jet cutting technology
BHRA Fluid Engineering
2–4 June 1980 at Hanover, FRG

Over 170 delegates attended this symposium which was organised in conjunction with and co-sponsored by the Institut für Werkstoffkunde of the University of Hanover.

After two theoretical sessions devoted to fluid mechanics and the mechanics of cutting, delegates got down to the practical applications of water jetting. It was soon apparent that the use of water jets in rock cutting, tunnelling and coal mining has reached the point of technical success but that economic viability has still to be proved. A series of papers from Japan, West Germany, the UK, the USA and the USSR indicated that jets are most successful when used in conjunction with mechanical methods, the water jets being employed to weaken the material under attack so as to ease the task of various mechanical cutters.

For a new generation of tunnelling machines now under test, L Baumann of Bergbau Forschung claimed improvements of 100% for cutter discs assisted by high-pressure water jets. Other benefits which he discussed included a reduction in the proportion of small particles in the drilled material, reduced wear on the drilling heads, the virtual elimination of dust (making dust extraction devices unnecessary), and the absence of sparks. Safety was also stressed in a paper from the National Coal Board and the Health and Safety Executive, which described the development of a pulsed jet intensifier to provide a pulsed water jet for use with an impact ripper. The intensifier design was part of a project aimed at finding a method of driving roadways through hard rock which was safer than explosives. In the machine produced, the water jets will be used to pre-cut roadway profiles before the impact rippers excavate within the profile.

The use of jets in preparing for blasting in tunnel excavation was described in an interesting paper from Japan. Holes drilled to take the explosive charge had notches cut along their length by water jets. These notches or nicks provided the 'crack guides' along which the rock broke when blasting actually took place. Tunnels blasted at the Kamioka mine in Gifu prefecture using this technique showed very good smooth surfaces and were much more stable, making the introduction of roof supports, for example, much easier. The amount of explosive required was also reported to be less than that needed for conventional blasting. In such applications, although the jetting component was small, it was very important, not least in the contribution made to reducing or containing costs.

Concrete trenching at pressures up to 3400 bar (340 MPa) was described in a paper from the USA, which gave details of a lorry-mounted device designed and developed for cable laying by Flow Industries Inc. and the Electric Power Research Institute. Potential benefits listed included speed of operation, no dust, less noise and the need for only a single operator. The main problem appeared to be the thickness of some road surfaces; concrete up to 30 cm thick had been encountered. A new design of cutting head had been produced, capable of penetrating material 40 cm thick, and evaluation tests were going ahead.

The variety of jet-assisted coal mining machines (rotary, slicers and ploughs for example) now at the prototype stage were the subjects of papers from Canada, W Germany, the USA and the USSR. A clever use of water jets to sense the position of the cutting drums relative to the top and bottom of a coal seam was outlined by D A Summers *et al* from the University of Missouri-Rolla, USA. The present method of identifying the coal–shale interface uses a nucleonic device which has to be calibrated for every seam condition. Summers' water jet interface detector is based on differences in material response to cutting and is linked with an automatic focusing device taken from a camera which locates the cutting drum relative to the interface. The jet is able to penetrate more than 15 cm into the coal and identify the interface accurately. Moreover, it does not need calibrating for varying seam conditions. Tests have indicated these benefits and it is to be hoped that the detector will soon be in use.

Another interesting beginning had been made in the jet cutting of oil sands by R R Gilpin *et al* of the University of Alberta, Canada. The basic problem here was that the material itself was very abrasive and therefore mechanical devices had to be replaced very quickly. High pressure jets were used in field tests aimed at discovering the water and energy requirements. One interesting aspect of the investigation was that the field trials gave better results than laboratory tests, chiefly because undisturbed oil sands were penetrated along their natural bedding planes by the jets, which broke the material up more easily.

Finally, it was refreshing to encounter a paper which frankly discussed the problems involved in