HOPES FOR COMMERCIAL USE OF MHD

Magnetohydrodynamics (MHD) is the study of the motion of fluids and gases in magnetic fields. After 25 years of theoretical and experimental work, it seems commercially promising for a new type of power station, where heat would be converted directly into electricity by generators without moving parts. Nuclear reactors would be well suited as the heat sources. At an Agency symposium in Warsaw in July it was felt that international co-operation is essential to develop the technique for industrial use.

The work of the conference was divided into three sections: (1) closed-cycle systems with gaseous working fluids; (2) closed-cycle systems with liquid-metal working fluids; and (3) open-cycle systems. In closed-cycle gas systems, progress has been reported in experimental work on seeding noble gases, on countering ionization and flow instabilities, and in achieving non-equilibrium ionization. The choice of generator type is still an open question.

It has become clear that only a nuclear reactor can be considered as a single-unit heat source suitable for combining with a closed-cycle MHD generator capable of an output of several thousand megawatts electrical. In particular, the ultra-high temperature reactor (UHTR) and such an MHD generator may be a match, but detailed systems study is hampered by the lack of both large reactor and MHD prototypes.

Suitably-sized MHD units can now be designed to be linked via a heat exchanger to the heat sources used for open-cycle systems, allowing the MHD principles to be proved under realistic operating conditions. The existence of commercially viable closed-cycle MHD generators would then provide an added impetus for development work on UHTR.

Good prospects were indicated for closed-cycle systems using molten liquids both for applications with space power stations and for large-scale power generation. Here marked progress was shown. The work on sodium/potassium systems has benefitted from experience gained with the liquid-metal fast breeder reactor. Although the original aim of combining this reactor with a liquid-metal generator is at present not feasible, it was shown that such a generator is already an interesting proposition as an additional auxiliary for existing fossil-fuel steam generating stations and for high-temperature gas-cooled reactor stations. These heat sources can both provide an upper temperature of 850°C in the secondary cycle, which is then followed by a conventional steam plant.

Work on two-phase flows has been extended. A novel idea in which large gas bubbles produce a striated fluid and hence an alternating current output from the generator was described.

There have also been considerable advances in work on open-cycle MHD, and the first prototype generators are expected to start during the next two years; the largest of these, the L-25 at Moscow, will have a net output of 25 MW(e). Factors other than the electrical output are being considered. For example, the progress made in understanding high-temperature flue gas chemistry, and the problems of seed and slag separation, induced authors to discuss not only seed re-circulation, but also the quantity production of nitrogen- and sulphur-containing compounds as chemical by-products. This would in effect reduce the cost of the electricity. In addition, this cleaning of the flue gas results in negligible air pollution, and the improved thermal efficiencies reduce the "thermal pollution" of the environment associated with excessive waste heat discharged in the cooling water.

Associated equipment and materials research were the basis of many contributions. On the subject of heat exchangers, discussion ranged from prototypes that are being tested or undergoing final assembly to the feasibility of ceramic units. Work on electrode materials, however, while progressing is hampered by a lack of real definition of what could ultimately be achieved. Superconducting magnets are now available commercially, backed by experience of hundreds of hours running time.

The cost and manpower requirements of projects for building prototype MHD generators is such that it is unlikely that rapid and methodical progress towards commercial power stations will be achieved unless national resources are pooled into a co-ordinated international research and development programme. An example of such co-operation is given by the successful Franco-Polish Collaboration Agreement which resulted directly from the discussions at the Salzburg meeting. The agreement concerns open-cycle MHD and was concluded between the Commissariat à l'energie atomique, Saclay, and the Nuclear Research Institute at Swierk. A number of participants voiced the opinion that the Agency should lend its experience with international co-operation to promoting further joint projects, especially for closed-cycle MHD. This would also benefit reactor development.

The symposium was the fourth in a series of international meetings on the subject. The others were a 1962 meeting in England organized by the Institute of Electrical Engineers, an ENEA meeting in France in 1964 and a joint IAEA/ENEA meeting in Austria in 1966. In Warsaw 300 engineers and scientists, representing 19 Member States and two international organizations, took part.

The proceedings are to be published in six volumes. Five of them will contain the contributed papers, while the sixth will include the invited lecture, the rapporteurs' statements with discussions, and the round table discussions.