Progress in Fuel Cell Technology

A REPORT OF THE UNITED STATES NATIONAL SEMINAR

An annual forum for the exchange of information and for discussion of progress in the fuel cell field is provided by the United States National Fuel Cell Seminar, which this year was held in Norfolk, Virginia during June. Although mainly concerned with efforts in the United States of America, delegates from many countries attended.

The development of fuel cells has been briefly reviewed in this Journal (1); following their acceptance as reliable power sources for space applications, interest turned to their potential for the terrestrial generation of electrical power from a variety of fuels. The main theme of this year's meeting was the move towards commercialisation of the phosphoric acid electrolyte fuel cell, which utilises platinum-catalysed electrodes. R. W. Fri of the Energy Transition Corporation described how two user groups had been set up, reflecting the differing requirements of the electricity and gas supply utilities. It is intended that these should be international bodies, and several Japanese utilities are already actively participating and conducting some of the first trials. Fuel cell technology is now regarded as being available "off the shelf" and ripe for much greater commercial exploitation. Thus the purposes of the user groups are to study applications, to share information, and to set standards for fuel cell manufacturers.

Multi-Megawatt Generators

A 4.5 MW generator manufactured by United Technologies Corporation, and incorporating platinum-containing catalysts supplied by Johnson Matthey, is being sited in Tokyo by the Tokyo Electric Power Company, and start-up is planned for February 1982, as reported by M. Kobayashi. A 4.8 MW generator from the same manufacturer is being built in New York City for the Consolidated Edison Company, and Kenneth Glasser reported on progress. Installation has been delayed, principally by frost damage to heat exchangers in the ancillary systems during certification tests. When certification is complete, the fuel cell will be the first power station to be installed in New York City for some fifteen years.

Speakers from United Technologies Corporation presented papers on their technology improvements programme (L. Handley), projected new fuel cell systems (R. Cohen), and 40 kW integrated energy systems that enable waste heat produced during the on-site generation of the electricity to be recovered for purposes such as air conditioning or industrial processing (P. Grevstad). By increasing the fuel cell electrode size and raising operating temperature and pressure, the output of the present 4.5 MW configuration can be raised to 11 MW with little or no cost penalty. Under the latter conditions, thermal efficiency is also raised, the fuel requirement falling from 9300 to 8300 BTU/kWh after 40,000 hours of operation. With detailed improvements now in the pipeline, a heat rate of 7400 BTU/kWh is anticipated—this compares with 11,000 to 12,000 BTU/kWh for conventional turbine generators.

Details of the Westinghouse Electric Corporation programme to build fuel cell power plants, using technology supplied by Energy Research Corporation, were provided by Joseph J. Buggy. The objective is again to produce a number of different sized cells, ranging from kilowatt units for on-site energy production to 7·5 MW utility generators. Westinghouse propose to use their own coal gasification technology to produce the hydrogen used as fuel in their cells.

On-Site Generators

As mentioned above, the use of electric generating equipment located at or close to the point of use, rather than centrally sited, enables

the associated thermal energy to be recovered and used for a variety of purposes, so increasing the efficiency of fuel utilisation and thus conserving energy resources. In addition, on-site location reduces the losses that normally occur during the transmission and distribution of electric energy.

G. K. Johnson reported progress on the Engelhard Industries project to build a 50 kW generator for on-site installation, with heat recovery facilities, for completion in late 1982. It is intended that the system will operate on methanol fuel, rather than the naphtha, coal or natural gas proposed for most of the competing systems.

The various advantages of fuel cells, including low pollution, high efficiency, and quiet vibration-free operation are leading to the identification of a large number of potential applications in military areas. R. Barthelemy of the U.S. Air Force Wright Aeronautical Laboratories described uses being considered, and current programmes by the U.S. Army, Navy and Air Force to evaluate fuel cells ranging from 1.5 to 60 kW capacity. The U.S. Army Mobility Equipment Research and Development Command are developing and testing a family of 1.5 to 5.0 kW mobile generators, in collaboration with Energy Research Corporation. These are indirect methanol/air systems involving steam reforming of methanol to produce a hydrogen-rich gas.

Platinum Alloy Catalysts

Future hopes of the electric power utilities were expressed by A. J. Appleby of the Electric Power Research Institute (E.P.R.I.). Various fluorinated acid compounds hold the promise of achieving heat rates as low as 7000 BTU/kWh. E.P.R.I. funded work has yielded a technique for catalysed, low temperature (1200°C) graphitisation of carbons. Criteria for advanced, platinum-base metal catalysts such as carbon supported platinum-vanadium, platinum-zirconium and platinum-tantalum were also described. Synthesis of strong fluorinated organic acids with high temperature stability and low vapour pressure, as alternatives for the phosphoric acid electrolyte, was described by Miles Walsh of ECO Incorporated.

Second and Third Generation Fuel Cell Concepts

Various papers described work on second generation, molten carbonate electrolyte fuel cells. These are envisaged as large, coal fired plants for electric utility use. Application studies carried out by United Technologies Corporation were described by J. M. King, and a programme is in progress to evaluate these cells; in addition, work aimed at defining cell construction parameters was described by H. Healy. H.C. Maru gave details of a molten carbonate cell under development at Energy Research Corporation, in which natural gas or methane is reformed internally in the cell stacks, eliminating the need for a separate fuel conditioning unit.

Westinghouse Electric Company are working on thin film, high temperature solid oxide electrolyte fuel cells, operating at between 700 and 1100°C. Methods of preparing the ceramic based electrodes for these cells were given by G. E. Zymboly. Edward Federmann described studies of industrial co-generation to provide comparison with other energy sources in the year 1990, high temperature cells generally being regarded as a third generation concept.

Conclusions

The various fuel cell demonstration programmes now in progress are being studied with great interest by both electric and gas utilities. The results of these programmes will determine the rate of installation of new types of generators with their multitude of environmental and fuel saving benefits. In the meantime, the formation of fuel cell user groups demonstrates, and can be expected to contribute to, a growing awareness of the exciting commercial potential for fuel cells. A major role now seems to be assured for supported platinum catalysts in this application. D.S.C.

Reference

1 D. S. Cameron, *Platinum Metals Rev.*, 1978, **22**, (2), 38