Combined Heat and Power Systems

AN OPPORTUNITY FOR PLATINUM CATALYSED FUEL CELLS

To provide a forum for discussion, a one day symposium organised jointly by the Institute of Energy and the Institution of Chemical Engineers was held at Sheffield University earlier this month to consider the advantages that can be obtained from the co-generation of electricity and heat. This note is based upon a paper presented there by Donald S. Cameron of the Johnson Matthey Technology Centre.

It is no longer considered acceptable to site large power stations, whether nuclear powered or fossil fuelled, close to centres of population. Fortunately the ease with which electricity can be distributed to most users enables generators to be located near to fuel supplies or major transport facilities. To benefit from the economies associated with size, modern steam turbine driven generators have a unit capacity of about 660 MW, with each power station having multiples of these. Despite this, electrical efficiencies are not high, the best being only around 36 per cent, and may be considerably less when the generator is not running close to its maximum designed output. All the energy not converted to electricity is released as heat, and for these large power stations it is simply not feasible to distribute the vast amounts of waste heat to consumers.

The ability of fuel cells to generate electrical power efficiently and reliably without the production of polluting emissions or obtrusive noise has been firmly established over the past decade. The chemical reaction that combines oxygen and hydrogen to produce the electric current also gives rise to potable water and this has proved advantageous for some space applications. Since their efficiency is largely independent of size, it is feasible to construct small units which can be sited close to, or even on the premises of the consumer, making it possible to use the waste heat in the form of steam or hot water. The temperature of this water depends largely upon the type of fuel cell employed and the quantity of heat can account for 40 per cent of the chemical energy input. More importantly existing fuel cells utilising phosphoric acid electrolyte and a supported platinum or platinum alloy catalyst are capable of generating AC power from natural gas or naphtha at better than 40 per cent efficiency.

The largest installation to be brought into use to date is a 4.5MW AC prototype generator constructed by United Technologies Corporation and installed in 1983 by Toshiba, close to Tokyo. Although this generator is not employed for heat recovery, this is perfectly feasible. Some forty-six smaller demonstration units each of 40 kW output have been used in a combined heat and power mode for a variety of applications including swimming pools, laundries, and sports and recreational facilities. Following these successful trials, during the past two years a 200kW prototype combined heat and power unit was built by United Technologies and this has been on test for several months. With load settings varying from 30 to 100 per cent of the rated load, the electrical efficiency is over 40 per cent. Overall efficiency at full load is 80 per cent, and one-third of the heat recovered is above 120°C. It seems probable that this size of fuel cell will be adopted as the first commercially available model for gas utilities in the United States.

While it is not suggested that the generating capacity of fuel cells will ever approach that of the large traditional generators, it is predicted that there are many situations where they will become the preferred source of heat and power. To facilitate this Johnson Matthey, who have provided platinum catalysts for all the current fuel cell demonstration programmes, are striving to improve the composition and the performance characteristics of the catalyst. This work is already resulting in even lower platinum loadings, and hence reduced capital equipment costs and lower day to day running costs.