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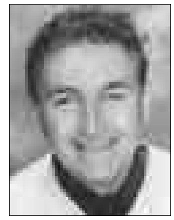

Guest Editorial

Fuel Cells:
A Chemical Engineering Opportunity

Any discussion of energy and the environment is not complete without an engineer's perspective of the present and future scenario for fuel cells. In August, General Motors announced that it is developing stationary proton-exchange-membrane (PEM)-based fuel cell systems for homes and office buildings. These systems will be powered by hydrogen that will come from reformed natural gas. GM also revealed it has the capability to produce "clean" hydrogen from a variety of fossil fuels, including gasoline. It even has a light truck so powered, already on the road.

In order to penetrate the automotive market, the manufactured price of the fuel cell stack must reach \$50/kW; for stationary power, a price an order of magnitude higher is acceptable. After the first batch of units at the higher price is produced, the costs will plummet, as with any consumer product. Whether it reaches the \$50 target is still unknown, but this commitment by GM is a strong positive signal. This is in addition to the commitments of Ballard, DuPont and International Fuel Cells, to name a few.

Reforming gasoline is complicated by the PEM's intolerance to carbon monoxide (CO). Presently, only about 100 ppm CO can be handled without unacceptable power loss. Needless to say, chemical engineers will have the premier role in solving this problem, either with more tolerant PEM cells, more efficient reformers, or both.

The solid oxide fuel cell (SOFC), operating near 1,000°C, has the advantage of total CO tolerance (in fact, CO is used as a fuel). With an obtainable price of \$400/kW, these systems could provide all the electricity needs of a commercial or industrial park along with high-temperature heat for absorption refrigeration and hot-water heating; and with an efficiency of over 50%. This will result in a severe reduction in CO_2 emissions without sacrificing productivity or comfort. Materials issues, for all components, still remain. A totally sulfur-tolerant fuel electrode remains elusive, but not impossible.

While the PEM and SOFC have garnered most of the attention, two other types of fuel cells are also viable candidates. The molten carbonate fuel cell (MCFC), operating at 650°C has many of the advantages of the SOFC. Large-scale MCFC systems have already had successful long-term demonstrations.

The direct methanol fuel cell is a relative newcomer. Protons and CO_2 are produced using liquid methanol in an aqueous solution as the fuel with water being a reactant on the fuel side. PEMs are currently used in these devices, but they suffer from carryover of unused methanol from the fuel to the air electrode, thereby lowering the efficiency. Methanol-impermeable membranes that can operate at higher temperatures are key here. These devices, constructed at the microscale, could one day reasonably power personal electronics. They could also be the source for remote applications, such as unmanned communications sites.

This is an exciting time for chemical engineers. Our impact on the world energy, environmental and political scene could be dramatic. If we are serious about energy sufficiency and environmental action, the current generation of chemical engineers will have a profound impact.

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