B. Barp, R. Diethelm, K. Honegger and E. Batawi of Sulzer Innotec, who are working on developing the SOFC for this application.

For **transportation**, heavy-duty vehicles such as transit buses or trucks represent the best opportunity for early market entry. The U.S. DoE figures show that in North America the current annual demand is for 25,000 buses and 900,000 trucks (> 10 klbs). S. Chalk, of the U.S. DoE, reported that if the forthcoming zero emission regulations were adopted by California and the North Eastern states, there would be a total requirement of 353,000 zero emission vehicles (ZEVs) in the year 2003.

In the near term these will be geared to battery cars, and the DoE predict that fuel cell cars will not enter the market until 2007, and will attain 8 to 10 per cent of new annual sales by 2030 (currently 16 million new vehicles per year in North America). The DoE model makes the assumption that fuel cells and all other competing new technologies would be equally successful in meeting technical and economic goals.

Since cost was viewed by several speakers as the most critical factor influencing the rate of commercialisation, they believed that stack developers should not put undue emphasis on factors such as stack efficiency at this stage. For example, the much simpler partial oxidation now appears the more acceptable fuel processing route despite the slightly lower system efficiency projected by most model analyses.

Conclusions

The PAFC co-generation plants continue to demonstrate highly efficient and reliable operation, but large markets are needed before a fully cost effective product can become widely available. The PEMFC system has made rapid progress with the development of high power density stacks which meet targets for transportation applications. Early market opportunities lie with fleet vehicles, such as transit buses, which can tolerate larger sizes, higher costs, and on-board hydrogen fuel storage and depot refuelling. Commercialisation is on schedule for the end of the decade. Opportunities for light-duty passenger cars have been provided in the United States by the zero emission regulations, to be enacted in 1998, and the programme to improve vehicle fuel economy.

The technical progress over the past three years is such that attention is moving away from fuel cell stack technology to issues of cost, market entry opportunities and the fuelling infrastructure. These are the key challenges for the latter half of the 1990s, in the development of a commercial market for power generation based on fuel cell technology. G.A.H.

Osmium, the Densest Metal Known

Until recently much confusion existed in the literature as to which is the densest metal, osmium or iridium. Crabtree reviewed the experimental data, but his calculated densities of 22.59 ± 0.02 g/cm^3 and 22.57 ± 0.02 g/cm^3, respectively, led to an overlap in the uncertainties and a suggestion that the problem had not been solved (1). However, in a similar review by the present author, calculated densities at 20°C of 22.588 ± 0.015 g/cm^3 and 22.562 ± 0.009 g/cm^3, respectively, suggested that the problem just may have been resolved in favour of osmium (2).

Although the uncertainties calculated for the densities are usually dominated by the accuracies assigned to the lattice parameters, the accuracy of the atomic weight can also contribute significantly – if it is poorly known, as was the case for osmium until quite recently. However with newly accepted atomic weights of 190.23 ± 0.03 for osmium and 192.217 ± 0.003 for iridium the contribution to the uncertainties of the densities is now minor (3).

Using the lattice parameters selected previously by the present author (2), the calculated density of osmium is revised to 22.587 ± 0.009 g/cm^3 while that for iridium remains the same. On these grounds it is suggested that osmium can now unambiguously be considered to be the densest metal at 20°C. J.W.A.

References

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