FORMULATING LIQUID HYDROCARBON FUELS FOR SOFCS

Gary J Saunders and Kevin Kendall
Chemical Engineering
University of Birmingham
Edgbaston B15 2TT, UK

ABSTRACT

Liquid fuels such as gasoline, diesel and kerosene are favoured for mobile systems on economic grounds. Existing manufacture and distribution infrastructure, along with a transportation market encompassing a major proportion of the global population make these fuels suited to the introduction of fuel cells worldwide. However the difficulty of reacting these fuels directly with oxygen at temperatures near 800 ^{o}C gives considerable carbon formation problems in SOFCs. Also, sulfur must be removed to the 1-10 ppm level if nickel based anodes are to be used.

Synthetic fuels (Fischer-Tropsch) have great potential in SOFCs and are currently being studied by several major oil companies around the world. Additionally, synthetic fuel components are currently being added to commercial fuel supplies as a means of meeting increasingly strict environmental legislation. Free from organometallics, sulphur and nitrogen compounds, these fuels are also less complex in composition than crude distilled fuels. A wide range of quality parameters can be accurately controlled during manufacture to produce a fuel that suits a particular engine technology and/or distribution network. Fuels produced from gas-to-liquid processes would provide an additional resource base for automotive fuels. It is expected that greater volumes of synthetic fuels will become available as the fuel cell-vehicle industry begins to develop.

This paper first considers octanes (linear and 2,2,4-trimethyl pentane) as models for gasoline-type fuel (1). Of particular interest is the differing behaviour of n-octane and iso-octane in SOFCs, especially during steam reforming reactions. Then mixtures of iso-octane and other molecules such as methanol and ethanol were tested in the SOFC, with results shown in Fig 1. This demonstrates that little carbon is formed at the SOFC anode below 800 ^{o}C. Finally, compositions including iso-octane, alcohol and water were formulated with surfactants to form micro-emulsions. These fuels were found to react cleanly in the SOFC and also to provide the correct octane number for IC engine operation. The conclusion was that synthetic hydrocarbons can be formulated to fuel both IC engines and SOFC power generators for mobile applications (2).

References

1. G J Saunders and K Kendall, J Power Sources 106(2002)258-63.
2. G J Saunders, PhD thesis, University of Birmingham 2003.

Fig 1. Reactions of a mixture of iso-octane and methanol on an SOFC