Running SOFCs on Biogas

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Biogas represents a readily available, renewable but very under-exploited energy reserve which is often ignored because of its variable composition and often low level of methane that prevents its use in conventional power systems. Consequently, large quantities of biogas are presently vented to the atmosphere, making a significant contribution to greenhouse gas emissions, whilst at the same time wasting a potentially clean, renewable energy resource.

Biogas can be considered as a possible source of fuel for the solid oxide fuel cell. At carbon dioxide levels which are too high for conventional power generation systems, SOFCs could, in theory, still extract power from the methane content of the biogas, and thus utilise even biogas that is depleted in methane, acting as an environmental clean-up device at the same time as producing useful energy.

The feasibility of operating a solid oxide fuel cell on biogas has been studied over a wide compositional range of biogas, using a small tubular SOFC system operating at 850°C [1]. In addition the response of the SOFC towards waste ammonia has been studied. It is possible to run the SOFC on biogas, even at remarkably low levels of methane, at which conventional heat engines would no work, thus offering a valuable and environmentally friendly use for poor-quality biogas that is currently wasted by detrimental venting to the atmosphere. The influence of the methane/CO_2 ratio on the cell performance and the exit gas composition was studied. Useful power was obtained even at methane contents less than 10%, with maximum power production occurring at 45% methane, corresponding to maximal production of H_2 and CO through internal dry reforming.

We have shown that SOFCs are tolerant to ammonia, actually utilizing the ammonia present in biogas to produce electrical power, at the same time acting as an environmental clean-up device breaking down the ammonia pollutant to N_2 and water, with no formation of any undesirable nitrogen oxides.

The potential use of biogas as a fuel for SOFCs will be discussed.

[1] J. Staniforth and R.M. Ormerod, Green Chemistry, 2 (2001) G61