imperial innovations

Carbon-Air Fuel Cells

Our ref no: 2725

Background

Fuel cells hold great promise as more efficient sources of power. However, one significant inhibitor is their ability to cope with a range of fuels; with the exception of DMFCs, hydrocarbon fuels typically need to be reformed before they can be used in fuel cells. This innovation concerns a fuel cell which can be directly powered by a range of carbonaceous fuels, including solid hydrocarbons.

Technical Features

The key innovation in this design is the separation of the 'fuel cell' process from the 'combustion' process. This is done by linking a conventional solid oxide fuel cell to a separate combustion reactor, using a circuit of high-temperature, oxygen-carrying liquid. This 'indirect' design has several distinct advantages:

1. Poisoning is reduced: By separating the production of exhaust gas from the fuel cell components, it is possible to isolate the fuel cell from chemicals which would otherwise poison the cell and reduce its life. This enables much greater flexibility in fuels.

2. Pure CO2 for CCS: Only oxygen from air which is transported across the metal oxide electrolyte to the anode. Unlike with conventional combustion, therefore, the exhaust from the fuel cell is concentrated CO2 + H2O (for hydrocarbons), undiluted by nitrogen and excess oxygen, thereby making it suitable for Carbon Capture and Storage without further processing.

3. Greater charge transfer: In 'direct' fuel cells, which have been attempted previously, if a carbonaceous fuel is oxidised completely, bubbles of CO2 will be formed at the electrode surface. This limits the transfer of charge, effectively blocking the fuel cell and rapidly reducing its performance. A liquid circuit removes this problem, by separating the production of exhaust gas from the fuel cell.

4. Contact with fuel: With a solid fuel and a solid electrode, there is necessarily a limited contact area between the two, which limits charge transfer. A liquid circuit removes the problem of surface contact by surrounding the fuel completely..

5. Anode corrosion is reduced: The corrosion of fuel cell electrodes is a known problem, mainly caused by the action of oxygen ions on solid electrodes. Over time, solid anodes essentially 'fall apart' as they corrode reducing the cell's lifetime. This design eliminates the problem by not requiring a solid anode.

Target Market

Applications are significantly broadened by the ability of the cell to accept numerous fuels. In principle, any carbonaceous fuel could be used, such as coal, biomass, waste plastics, bitumen, oil sands, and crude oil (although liquid hydrocarbons will present greater challenges due to volatilization).

In the long term, we expect this to be applied to medium-to-large size, stationary, coal-powered generation. Coal is the world's fastest-growing energy source [US EIA, 2007], and one of the cheapest, accounting for about 26% of primary energy and 40% of global electricity. Coal-fired generating capacity could double by 2030, creating an urgent need for more efficient and environmentally-benign methods of generation. China, is expected to be a major market for this technology.

Development Stage

A patent has been filed and most of the theoretical stage completed. A commercial feasibility study has been conducted. The next stage is the construction of a laboratory-scale prototype. We are currently seeking industrial partners who wish to be involved in this development stage as part of a joint venture.

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About Imperial Innovations

Imperial Innovations is one of the UK's leading technology transfer and commercialisation companies. The company was founded in 1986 and its ordinary shares admitted to trading on the AIM Market of London Stock Exchange plc in July 2006, raising £25 million at an offer price of 365p and £1 million by means of a public offer.

The company's integrated approach encompasses the identification of ideas, protection of intellectual property, development and licensing of technology and formation, incubation and investment in technology businesses. A wide range of technologies are commercialised within the areas of healthcare, energy, environment and emerging technology trends.

Based at Imperial College London, the company has established equity holdings in 70 technology businesses and has completed 116 commercial agreements. Imperial Innovations also commercialises technologies originating from outside Imperial College through incubation contracts with the Carbon Trust and WRAP and has commercialisation contracts with a number of multinational corporations.

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About Imperial College

Rated as the world's fifth best university in the 2007 Times Higher Education Supplement University Rankings, Imperial College London is a science-based institution with a reputation for excellence in teaching and research that attracts over 12,000 students and 6,000 staff of the highest international quality.

Innovative research at the College explores the interface between science, medicine, engineering and management and delivers practical solutions that improve quality of life and the environment - underpinned by a dynamic enterprise culture.

With 66 Fellows of the Royal Society among our current academic staff and distinguished past members of the College including 14 Nobel Laureates and two Fields Medallists, Imperial's contribution to society has been immense. Inventions and innovations include the discovery of penicillin, the development of holography and the foundations of fibre optics. This commitment to the application of our research for the benefit of all continues today with current focuses including interdisciplinary collaborations to tackle climate change and mathematical modelling to predict and control the spread of infectious diseases.

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