Opportunities and Challenges for High Temperature Fuel Cells Power Generation in India

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Abstract: The global climate change due to combustion of fossil fuel in power plant is responsible for the majority of greenhouse gas emission all over the word. The main focus to reduce the emission of carbon dioxide gas, the high temperature fuel cell (Molten Carbonate Fuel Cell) can be use an alternative source of power generation. Fuel cells have been called as the "microchip of the hydrogen age," this clean ren ewable energy source is seen as alternative to fossil fuel used in running world's economy (Gaurav Vasu). This Paper addresses the long-term potential of high-temperature fuel cell systems. The high temperature of the cell can be used to extract hydrogen from other more readily available fuels, such as natural gas and coal synthesis gas, g a s i f i c a t i o n p r o c e s s using the method of fuel reforming technique. Currently, CHP based on high-temperature fuel cell systems is not financially competitive compared with conventional systems. How ever this could change if, for example, the lifetime of fuel cell stacks increased and the capital costs reduced. Lower local emissions and reliable and quiet operating performance could also be an advantage (Powell, 2004).The rural areas where electricity supply is currently unavailable and difficult because of infrastructure problems (T SR Prasada Rao).These areas would typically use locally available opportunity fuels such as biomass. The stationary power generation using fuel cells particularly if technologies using molten carbonate and solid-oxide fuel cells become cost effective and commercially available. A significant problem with the Indian power industry is T&D losses of the order of 20-25% of total electricity generated, as compared to less than 2% in the U.S (P Lako). India with over a billion people, many of whom lack access to reliable power, represents a huge prospective market for fuel cells (Fuel Cell Today).

Keywords: *High Temperature Fuel Cell, MCFC, Stationary Power.*

1. Introduction:

Use of fuel cells in power generation promises to greatly reduce greenhouse gas emissions through its relative efficient operation when compared to conventional technologies. In addition a fuel cell system with no moving parts offers a noise-free operation and can op-erate on a variety of fuels, therefore offering several benefits while used in several of the identified applications today [1].The Ministry of New and Renewable Energy (MNRE) has supported research and demonstration activities to develop hydrogen and Fuel Cell technologies and their applications in the country. The Ministry recently setup the Na-tional hydrogen Board to draft the National Hydrogen Energy Road Map. The main ob-jective of the National Hydrogen Energy Road Map is to identify the path that would lead to a gradual introduction of Hydrogen Energy in the country [2].

2. Molten Carbonate Fuel Cell (MCFC)

The electrolyte of this type of fuel cell is a mixture of alkali metal and carbonate (usually, a binary mixture of lithium and potassium or lithium and sodium carbonate). At high op-erating temperatures, the alkali carbonates form a highly conductive solution with car-bonate C032- ions providing the ionic conduction. The electrolyte solution is contained in a matrix of LiAl02.The operating temperature of a molten carbonate fuel cell is in the range of 600-900 C. In a molten carbonate fuel cell, C02 gas is supplied along with 02 at the cathode side. Important advantages of this type of fuel cell are, noble metal catalysts are not required, and a wide range of fuels can be utilized [3,4]. For example, hydrocar-bons and even carbon monoxide are used, as they can be internally reformed to produce H2 or C0 gas. The electrochemical reactions occurring at the electrode are

Anode: $2H_2 + 2C0_3 \quad 2H_2 0 + 2C0_2 + 4e^-$

Cathode: $0_2 + 2C0_2 + 4e^- \quad 2C0_3$

3. Development of Fuel cells in India:

The majority of organizations involved with fuel cells in India are R&D orientated some

of India's leading Institutes of Technology and partly the nature of several companies who are working on fuel cells but have yet to commercialize them. In the development of high temperature fuel cell (MCFC, SOFC) major companies are involved are Bhabha Atomic Research Center, Mumbai (BARC) is carrying out basic research on anode, cath-ode, electrolyte and interconnector materials for SOFC technology in conjunction with Indian Institute of Technology, Chennai. Banaras Hindu University (BHU) is carrying out research and development of metal hydride storage methods for hydrogen and the use of hydrogen in internal combustion engines.

Bharat Heavy Electrical Ltd (BHEL) is working on developing PAFC and MCFC for dis-tributed power generation and also focuses on preparing catalyst and fuel reformers to be used in fuel cell power plants. They have demon- strated distributed power systems. Bharat Heavy Electricals Ltd is involved in the development of PAFCs and plans to de-velop a 50 kW stack. One possible application of this technology is in remote stationary power and backup power for villages.Tata Motors, India's third largest maker of passen-ger cars, is currently in talks with manufacturers of hybrid engines and fuel cells. Central Electrochemical Research Institute (CECRI), Karaikudi is said to have has developed and tested a MCFC-stack. Indian Institute of Science (IISc), Bangalore and Central Glass & Ceramic Research Institute (CGCRI),. Work on developing a DMFC is underway at IISc. In addition, research on SOFC is being done at IISc and CGCRI.Indian Institute of Tech-nology, Kharagpur, Department Metallurgical and Materials Engineering have been work- ing on materials for solid oxide fuel cells since 2003. They have developed

SOFC anodes and electrolytes and are currently developing a complete SOFC unit of 5-10 kW capacity.

Some other companies are also involved in the development of direct fuel cells are Gas Authority of India Ltd (GAIL), Indian Institute of Chemical Technology (IICT) and BHEL, Indian Institute of Technology (IIT), Madras (Chennai) in collaboration with the Southern Petrochemical Industries Corporation Science Foundation (SPIC-SF), Indian Oil Corporation Indian Railways is currently building a FC powered shunting locomotive using a 500 kW PEM stack and battery bank for research purposes. Mahindra & Mahindra, Ministry of New and Renewable Energy Sources (MNES) is working with the Delhi Transport Corporation (DTC) Banaras Hindu University (BHU). National Chemical Laboratory (NCL) Tata Energy Research Institute (TERI), Telecommunications Consultants India Ltd (TCIL) etc [3,5,6].

4. Challenges and opportunities:

The high operating temperature and stationary application and large start-up time are the major's challenges in power generation through high temperature Fuel cell. The fuel cell technology and a good amount of expertise among the academic community, India re-mains a relatively small market for fuel cells at present. India's government is committed to renewable energy technology, including fuel cells. Despite high profile objectives, such as the National Hydrogen energy roadmap, the biggest challenges to fuel cell commer-cialization remain affordability and the shortage of skills in manufacturing and maintain-ing fuel cells. Fuel Processing Issues The availability of fuels for either direct use or re-forming to produce hydrogen will be a critical issue. Hydrogen, natural gas, methanol, gasoline, and diesel are all typical fuels or hydrogen sources for fuel cells. The gasoline and diesel are currently produced in surplus of demand in India. However, consumption rates for both are going to increase substantially in the near future [7].

5. Future Aspects:

The high temperature fuel cells both Solid Oxide Fuel Cell (SOFC) and Molten Carbonate Fuel Cell (MCFC), are attractive power generation devices, when these are launce in the Indian markets in near future. The Molten Carbonate Fuel Cell hybrid with the gasifica-tion process is the better source of pollution free energy generation in the future.

6. Conclusion:

Several economic and environmental drivers are motivating developing countries like India to evaluate fuel cells. The development of new fuel cell technology that is cost effective, suited to local needs, and employs region specific and opportunity fuels should be commercially successful. This paper has highlighted the Indian situation with respect to the need for fuel cells, the power generation needs, and identified specific fuel supply strategies to meet any growth in fuel cells.

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