INDIAN CHEMICAL ENGINEER

[Sections A & B]
Vol. 48, No. 3, July-September 2006

CONTENTS

INDIAN INSTITUTE OF CHEMICAL ENGINEERS, DR. H. L. ROY BUILDING,
Raja Subodh Mullick Road, P. B. No. 17001, Kolkata - 700 032, Tel : (033) 2414-6670, 2412 9314
Fax : 091-33-2414 6670, HQ E-Mails : iicheme@dataone.in, iichehq@vsnl.com, iiche@giascl01.vsnl.net.in
Journal Website : www.ice.org.in
Journal E-mails : ice.journal@yahoo.com, ice.iiche@yahoo.co.in

Energy Conversion Alternative: Fuel Cell Technology

Fuel cell science and technology has been evolving fast for the past two decades as it is thought to be the alternative path of transforming chemical energy of hydrogen-rich compounds to electrical energy. In fuel cell, the Gibbs free energy of the chemical reaction is converted into electrical energy. The essential difference between a fuel cell and a battery is that fuel cell can continuously generate power as long as fuel is supplied. Further, the electrode material in fuel cell works as catalyst to facilitate redox reaction and it does not take part in the reaction or does not get exhausted. Every fuel cell has two electrodes, cathode and anode, which act as catalyst as well as current collector, and, thus, they are also called electrode-catalyst. Fuel cell has an electrolyte in between electrode-catalyst, which helps in transport of electrically charged particles from one electrode to the other. Electrons are produced at anode due to oxidation of fuel, which is transported to outer circuit to do useful work, such as powering an electric motor or illuminating a light bulb. The electron migrates to the cathode completing the electrical circuit and takes part in the reduction reaction along with oxygen supplied through air.

The idea of direct conversion of chemical energy to electrical energy was first demonstrated by Sir William Grove in 1839. It was only in the middle of the twentieth century that Bacon's pioneering work led to the use of fuel cell in space missions. The interest on commercialisation of fuel cell for civilian use is caught up with the Government organizations and private corporations for the past two decades since it became obvious that the conventional fossil fuel, which is the primary source of gasoline, is not going to last more than hundred years in the face of ever increasing demand in the developed and developing countries. Although natural gas, coal and tar sands may last another three to four hundred years with the current rate of production, the process of their conversion is not efficient and pollution free. Thus, scientists all over the world should take up the task for fuel cell development for faster growth.

Future development and implementation of fuel cell technology would depend on uptrend in global oil price, depletion of oil wells, fall in oil well discovery and the improvement of hydrogen energy infrastructure. The concern for environmental pollution by automobiles, thermal power plants, petroleum-crude refineries, etc., would catalyse the process of development unless financial benefits are perceived by users and the manufacturers. Infrastructure development of the hydrogen energy encompasses production, distribution, dispensing and safety regulations of fuels (e.g., hydrogen, alcohol, esters and natural gas, naphtha and synthesis gases), which is directly fed to the fuel cells or to the fuel processor. Out of these, hydrogen and alcohols can be generated from renewable sources (wind, solar power in water electrolyses, biomass gasification and fermentation). They can also be generated from fossil fuel. In case of the former, green house gas emission is much lower and almost negligible. One can dream of zero emission of air pollutant and green house gases from automobiles and distributed power plants except for the case of biomass gasification. In case of the latter, air pollutants will be generated in a centralized location and cities will be free of pollution, which is otherwise generated from automobiles using internal combustion engine.

It should be noted that the hydrogen fuel cell vehicle (H_2FCV) and H_2FCV-hybrid electric vehicle offer the least environmental damage among all the advanced options. When fuelled with hydrogen derived from natural gas, pollution damage costs are 1/8 larger the cost of today's gasoline internal combustion engine vehicles without CO_2 sequestration and 1/15 more than that with CO_2 sequestration. Economics does not work out at present for PEMFC (Proton Exchange Membrane Fuel Cell) based automobile or SOFC (Solid

Oxide Fuel cell) based stationary power plant with present inadequate hydrogen infrastructure. However, it is hoped that with the increase in crude price, no new crude or gas reserve findings, increase in fuel cell stack efficiency and decrease in cost of the fuel cell and improvement in hydrogen energy infrastructure facility, the Fuel Cell Vehicle (FCV) and distributed power generation from fuel cell will become more profitable leaving aside the cost benefits due to less environmental pollution. Optimists are looking at 20% use of FCV worldwide, 10% share of the domestic power generation from fuel cell source and 50% share of portable electronic equipment powered by fuel cell by 2025.

Dr. S. Basu
Department of Chemical Engineering
Indian Institute of Technology Delhi
New Delhi 110016
Tel: +91 11 26591035 (O) Fax +91 11 26581120

Dear Authors and Readers:

We are striving to do better in each issue of *Indian Chemical Engineer*. From next issue onwards *Indian Chemical Engineer* will be printed, published and distributed by Anamaya Publisher in India and abroad on behalf of Indian Institute of Chemical Engineers. I hope this will improve print quality and increase circulation of our journal. The improvement in quality of articles lies in constructive reviewing, followed up with appropriate revision by the author. I request authors and reviewers to take necessary action towards this end and help us in improving the impact factor of the journal.

Yours Sincerely,

Dr. S. Basu,
Editor, Indian Chemical Engineer
(On behalf of Editorial Board Members and Publication Committee)

Correspondence relating to publication : Dr. S. Basu, Honorary Editor, Indian Institute of Chemical Engineers, P.B. No. 17001, Kolkata 700 032,
Edited by Dr. S. Basu, IIT, Delhi and printed and published by Dr. P. De on behalf of the Indian Institute of Chemical Engineers, Dr. H. L. Roy Building, Raja Subodh Mullick Road, P. B. No. 17001 Kolkata 700 032.
Printed by Rohini Printers, 19/1B, Creek Row, Kolkata 700 014 Phone : 2216-5983
Registration No. R. N.5004/59