Indigenous Fuel Cell System

Part of: GS Prelims and GS-III- S&T

On the occasion of the Council of Scientific and Industrial Research (CSIR) Foundation Day, the President of India recently introduced India’s first indigenously developed high-temperature based Fuel Cell System.

- It is developed under the Public-Private Partnership (PPP) model by the Council of Scientific and Industrial Research (CSIR) in partnership with Indian industries.
- It is built under India’s flagship programme named ‘New Millennium Indian Technology Leadership Initiative (NMITLI)’.

Specifications

- The developed fuel cells are based on High-Temperature Proton Exchange Membrane (HTPEM) technology.
- It is a 5.0 kW fuel cell system that generates power in a green manner.
  - It takes methanol or bio-methane as the input and produces heat and water as its bi-products, which can be further used.
- This helps to attain an efficiency that is greater than 70%, which is difficult to achieve by other energy sources.

High-Temperature Proton Exchange Membrane (HTPEM) Technology

- High-Temperature Proton-Exchange-Membrane (HTPEM) is the core of the fuel cells that run above 150 °C. It works on two modes of operation with respect to the source of fuel.
- One mode is based on the conversion of natural gas into Hydrogen by means of steam reforming. This mode is used to fulfill stationary power demands.
  - Steam reforming or steam methane reforming is a chemical synthesis process for producing syngas (hydrogen and carbon monoxide) from hydrocarbons such as natural gas.
- The second mode is based on the operation of Hydrogen with Oxygen obtained by the process of electrolysis. This is generally used in the space-related applications.
  - Electrolysis is a chemical decomposition process in which an electric current is passed through a liquid or a solution containing ions.

Council of Scientific and Industrial Research (CSIR)

- CSIR is an autonomous research and development body established by the Government of India on 26 September 1942.
- It is established under the Ministry of Science and Technology.
- It covers a wide spectrum of science and technology fields from radio and space physics, oceanography, geophysics, chemicals, drugs, genomics, biotechnology, and nanotechnology to mining, aeronautics, instrumentation, environmental engineering, and information technology.
New Millennium Indian Technology Leadership Initiative (NMITLI)

- It is the largest Public-Private-Partnership effort within the R&D domain in the country.
- NMITLI seeks to catalyze innovation centred scientific and technological developments as a vehicle to attain for Indian industry a global leadership position, in selected niche areas. It synergizes the best competencies of publicly funded R&D institutions, academia, and private industry.
- NMITLI has so far evolved 60 largely networked projects in diversified areas viz. Agriculture & Plant Biotechnology, General Biotechnology, Bioinformatics, Drugs & Pharmaceuticals, Chemicals, Materials, Information and Communication Technology, and Energy.

Applications

- This fuel system is most suitable to fulfil distributed stationary power applications demands like in small offices, commercial units, data centres, etc. where highly reliable power is essential with simultaneous requirement for air-conditioning.
- This system will meet the requirement of efficient, clean and reliable backup power generators that are demanded by telecom towers, remote locations, and strategic applications.
- The Fuel Cells fit well in India’s mission of replacing Diesel based Generating (DG) sets with the green and alternate fuels.  
  - This development is therefore expected to reduce India’s dependence on crude oil.
- The technology has placed India in the league of developed nations which are in possession of such a knowledge base.

In the field of clean energy, Fuel Cell distributed power generation systems are emerging as a promising alternative to grid power. The development of indigenous fuel cell technology carries immense national importance in terms of energy security.

PT “PICKUPS”

What is Hydrogen Fuel Cell?

Hydrogen Fuel Cells shows how these fuel cells work, how they came to be, and how they are coming into wider use.

The fuel contains nitrogen oxides as pollutants since hydrogen uses nitrogen as the impurity (here we are talking about the molecule of hydrogen and not the atom). The pollution can be brought down if a little water is added to the container to reduce the temperature. That would deter the reaction between oxygen and nitrogen.

Compared to a petrol tank containing the fuel, a hydrogen gas cylinder in compressed form would weigh much higher. To cool down the hydrogen gas into a liquid state, the temperature has to be brought down at 20 K. Due to these constraints, it is quite difficult to use this fuel efficiently. Hence experts around the world are conducting researchers to find ways on how to use this fuel.

Production of Hydrogen Fuel
Since pure hydrogen is not naturally available in large quantities on earth, it demands primary energy to obtain on an industrial level. Some frequent methods of production are steam methane reforming and electrolysis.

Production **through Steam-methane reforming** –

- Extraction of hydrogen from methane
- Liberating carbon dioxide and carbon monoxide into the atmosphere
- These gases help in the greenhouse effect and contribute to the change of climate.

Production **through electrolysis** –

- Separation of oxygen and hydrogen atoms
- This process can use solar, hydro, biomass, wind, geothermal, fossil fuels, and nuclear energy
- It is a cost-effective method.

**Hydrogen Economy**

1. The term **“hydrogen economy”** or **“economy of hydrogen”** refers to the vision of using hydrogen as a low-carbon energy source. For example, replacing natural gas as a heating fuel or gasoline as a transport fuel.
2. The main benefit of this scheme is that the energy transmission is done in the form of hydrogen instead of electric power.
3. Presently, this fuel is used by mixing it with CNG gas to improve its efficiency. It is expected to be used on a wider scale in the coming years. This fuel is also used in hydrogen fuel cells to create electricity.

**Uses of Hydrogen Fuel**

Hydrogen fuel can provide power for cars, aeroplanes, boats, stationary or portable fuel cell application. It is very difficult to store hydrogen in either cryogenic tank or high-pressure tank which is the main problem for cars.

Thus we discussed hydrogen fuel and its importance and uses for the common man. Let us hope that this fuel would soon be used in our households in an economical manner over the coming years.

**Advantages of Hydrogen Fuel: (PT SHOT)**

- On burning hydrogen, it emits only water vapour,
- When hydrogen is burned it does not produce carbon dioxide.
- Hydrogen deletes little tailpipe pollution and is considered less of a pollutant.
- It has the ability to run a fuel-cell engine when compared to an internal combustion engine.