



Clean Fuel Hydrogen

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Why in News

Recently, researchers at the **Indian Institute of Technology, Delhi (IIT-D)** have come up with a way to **generate clean fuel hydrogen from water at a low-cost.**

- It is a significant step towards efforts across the globe that are being made to look for cleaner and greener energy sources.
- Hydrogen gas is a viable choice as **a renewable substitute for fossil fuels**, and can help **mitigate emissions to reduce pollution.**

Key Points

About:

- The researchers at IIT-D have successfully split water by a process known as **Sulphur-Iodine (SI) thermochemical hydrogen cycle (SI Cycle)** to **generate low-cost**, clean hydrogen fuel for industrial consumption.
- Generally in **SI Cycle, the separation of Hydrogen from oxygen requires a high amount of heat** (generally from non-renewable sources such as coal, oil and natural gas). This makes the large-scale production of hydrogen gas economically non viable and non environment friendly.
- The main achievement has been **designing a suitable catalyst** for the energy intensive, corrosive step of sulphuric acid conversion to sulphur-dioxide and oxygen.

Sulfur-Iodine Cycle

- **Process:**
 - The sulfur–iodine cycle (**SI cycle**) is a three-step **thermochemical cycle** used to produce hydrogen. In this cycle, all the chemicals are recycled. The SI process requires an efficient source of heat.
 - Heat enters the cycle in high-temperature endothermic chemical reactions in the initial process and heat exits the cycle in the low-temperature exothermic reaction in the final stage of obtaining hydrogen gas.
- **Three-Step Thermochemical Cycle:**
 - **Step 1:** Iodide (I₂) is reacted with Sulphur dioxide (SO₂) to produce Hydriodic acid (HI) and Sulphuric acid (H₂SO₄).
$$\mathbf{I_2 + SO_2 + 2 H_2O \rightarrow 2 HI + H_2SO_4}$$
 - **Step 2:** The water, SO₂ and residual H₂SO₄ is separated from the oxygen byproduct by condensation so as to obtain Hydriodic acid (HI).
$$\mathbf{2 H_2SO_4 \rightarrow 2 SO_2 + 2 H_2O + O_2}$$
 - **Step 3:** It is the Hydriodic acid (HI) from which Hydrogen gas (H₂) is obtained.
$$\mathbf{2 HI \rightarrow I_2 + H_2}$$
 - The difference between the heat entering and leaving the cycle exits the cycle in the form of the heat of combustion of the hydrogen produced.
- Major **challenges** of the sulfur–iodine cycle are to **reduce the surplus of water** and iodine and find separation **processes that consume less energy** than distillation.
- Traditionally development of the SI cycle has been pursued by several countries for hydrogen production with the **Generation IV nuclear reactors**.

- **Significance of the Discovery:**

- **Enhancing Hydrogen Fuel Cell Technology:**

Enabling availability of low cost hydrogen through this discovery will enhance and improve the application of **Hydrogen fuel cell technology** which offers the advantages of a clean and reliable alternative energy source to applications such as – electric vehicles, primary and backup power for a variety of commercial, industrial, and residential buildings; and more futuristic-sounding applications like air taxis.

A hydrogen fuel cell is an electrochemical power generator that combines hydrogen and oxygen to produce electricity, with water and heat as by-products.

- **Help Adhering Emission Targets:**

It could help India to adhere to its commitment in the **Paris Climate Agreement** and its **Intended Nationally Determined Contribution (INDC) Targets** and ensure that its mobility in the future is with zero emissions.

- **Complements FAME India Scheme:**

It will complement the implementation of the **FAME India Scheme** launched with the objective to support hybrid/electric vehicles market development and manufacturing ecosystem.

- **Advantages of Hydrogen as Fuel:**

- **Environment Friendly:**

- The advantage of using hydrogen as an energy carrier is that when it combines with oxygen **the only byproducts are water and heat.**
 - No greenhouse gasses or other particulates are produced by the use of hydrogen fuel cells.

- **Non Toxic:**

Hydrogen is a non-toxic substance that is rare for a fuel source. It is environmentally friendly and does not cause any harm or destruction to human health.

- **Highly Efficient:**

Hydrogen is an efficient energy type since it has the ability to convey a lot of energy for every pound of fuel compared to diesel or gas.

- **Ideal Spaceship Fuel:**

Hydrogen energy's efficiency and power make it an ideal fuel source for spaceships. Its power is so high that it's able to quickly rocket spaceships to exploration missions.

- **Disadvantages of Hydrogen as fuel**

- Compared to gas, hydrogen lacks smell, which makes any **leak detection almost impossible.**

- Hydrogen is a highly flammable and volatile substance, its potential dangers make its **transportation and storage very challenging.**

Source:TH