

SUPER-POWERED
EARTH

ENERGY from the Heart of Hydrogen



HYDROGEN AND FUEL CELL: EVERYTHING YOU EVER
WANTED TO KNOW ABOUT CLEAN, GREEN POWER!



गाँव गाँव बिजली, घर घर प्रकाश

Ministry of New and Renewable Energy
Government of India



First published in 2009 by
The Energy and Resources Institute and Ministry of New and Renewable Energy, Government of India
at TERI Press
Darbari Seth Block, IHC Complex, Lodhi Road, New Delhi - 110 003, India
Tel. 2468 2100/4150 4900, Fax: 2468 2144/2468 2145
India +91 • Delhi (0)11
E-mail: teripress@teri.res.in • Website: <http://bookstore.teriin.org>

© The Energy and Resources Institute, 2009
The series has been brought out with the support of Ministry of New and Renewable Energy, Gol

ISBN 978-81-7993-140-0

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The Energy and Resources Institute.

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Prepress: Mahfooz Alam

Printed and bound in India

This book is printed on recycled paper

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Message

India has witnessed healthy economic growth during the last few decades. This progress has resulted in faster consumption of our natural resources. Increasing exploitation of fossil fuels such as coal, oil and natural gas has led to various environmental problems such as global warming and climate change.

As a nation, we need to adopt a sustainable path of development, not just for our continuing economic growth, but also to protect the environment. Increased use of renewable energy sources, coupled with energy conservation, will lead to sustained supply of energy and sustainable development. The promotion of renewable energy sources in the country needs widespread publicity, so that these can be accepted and adopted by people at large.

As future citizens, children can make a major contribution in protecting the environment and natural resources. They can take the lead in organizing actions that support conservation of resources and greater use of renewable energy sources at the community level.

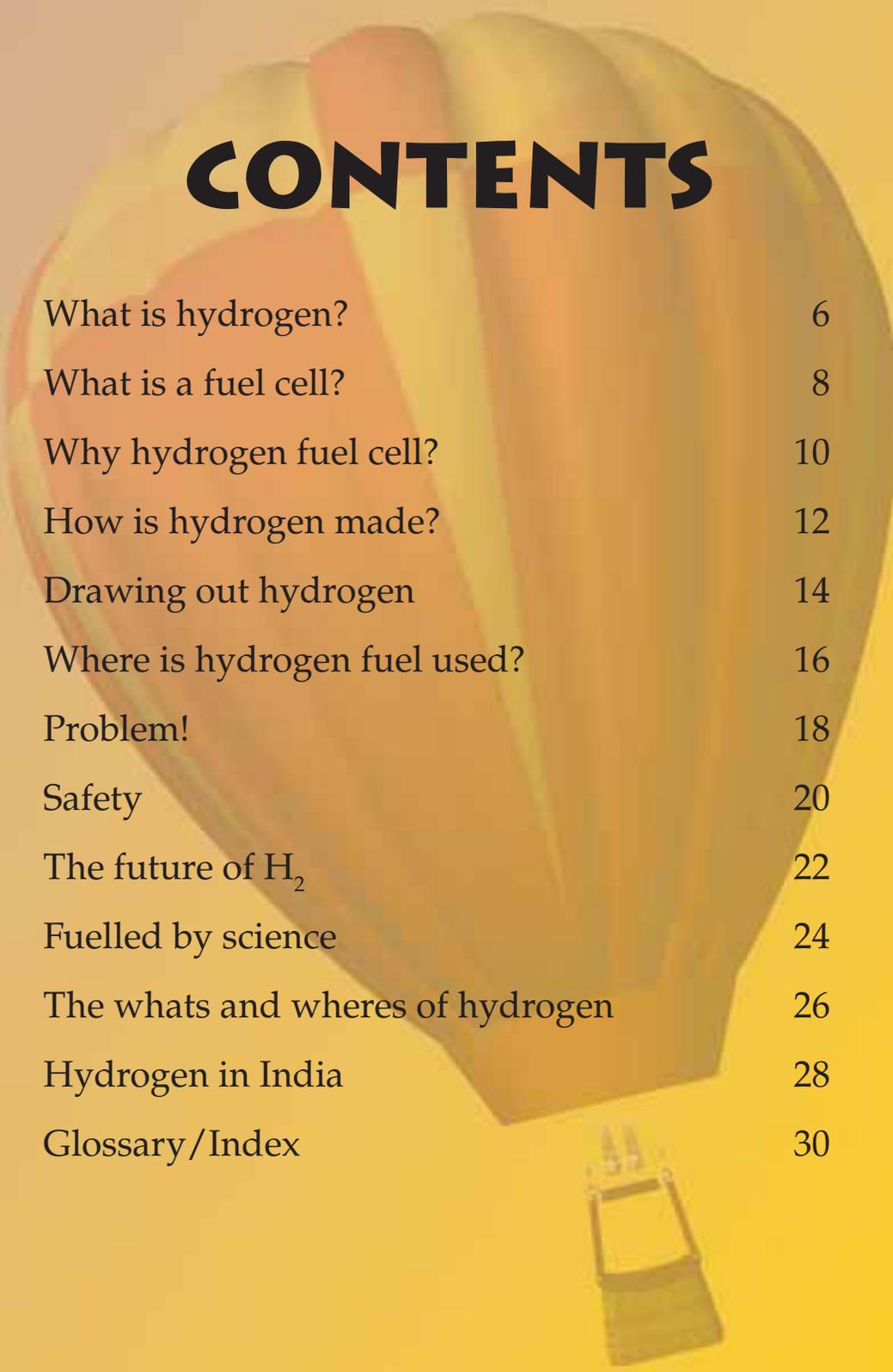
It gives us immense pleasure to put forth this series of books on renewable energy sources. We hope that children who read these books will not only enjoy them greatly, but also feel inspired to bring about a positive change, so that we leave a healthy and beautiful world for generations to come.



R K Pachauri
Director-General, TERI
Chairman
Intergovernmental Panel on
Climate Change



Shri Vilas Muttemwar
Minister of State
Ministry of New and Renewable Energy
Government of India



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What is hydrogen?

*Twinkle, twinkle little star
How I wonder what you are...*

The sun is made up of more than 70 per cent hydrogen, and about 27 per cent helium!

Have you really ever wondered what that twinkling star is made of? Stars are mainly made of hydrogen. Even the sun is a huge ball of two elements, hydrogen and helium, with traces of other elements.

Simple does it!

An element is the simplest known substance. There are more than a hundred known elements. Hydrogen is the simplest of them all. It has no colour, no taste, and no smell. It catches fire very easily. Hydrogen is available only in bound form and not independently on the earth.

Up, up and away

Remember the colourful hydrogen balloons? How fast they whoosh up! Hydrogen is the lightest element and that's why a hydrogen balloon rises up, up, and away into the sky. This proves that hydrogen is lighter than air!

Some of the largest hydrogen balloons were used in the eighteenth century. The French army used a hydrogen balloon to spy on the Austrian army during the Battle of Fleurus in 1794.



The name is Hydrogen

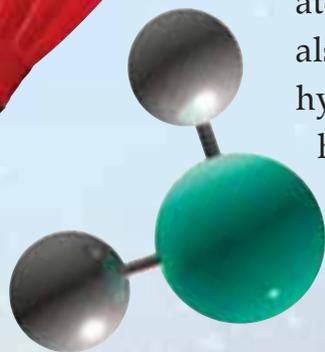
Hydrogen gets its name from the Latin word 'hydrogenium', which means 'something that forms water'. In 1783, French chemist Antoine Lavoisier, who found he could make water by putting together hydrogen and oxygen, gave hydrogen its name. In 1670, Irish scientist Robert Boyle produced hydrogen while working with metals and acids. But he didn't know what he had produced. It was almost a hundred years later, in 1766, that a British scientist named Henry Cavendish recognized the element as hydrogen.

Guess which gas makes hot air balloons fly? Hydrogen!

Hi, shake my paw!

If all the hydrogen just whooshes past us into the atmosphere, how do we use it? Hydrogen is a friendly element. It gets along well with oxygen. When two hydrogen atoms hold hands with one oxygen atom, we get water (H_2O)! Carbon also bonds well with atoms of hydrogen, and together they form hydrocarbons. All we have to do to obtain hydrogen, is to break down the chemical bonds.

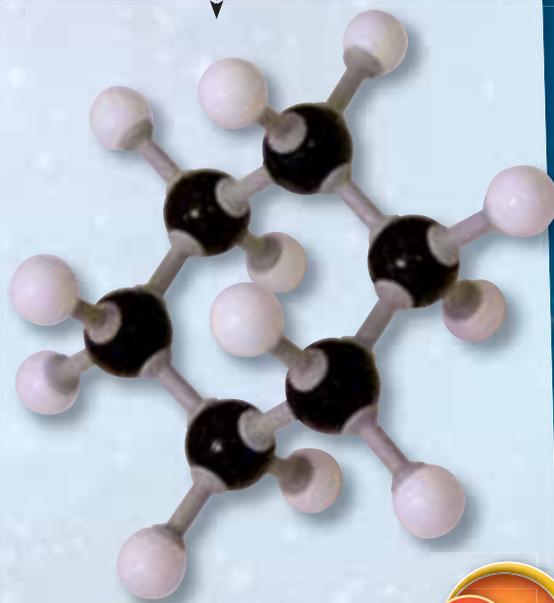
Water molecule



The big bang

On May 6, 1937, the Hindenburg airship, which used hydrogen to fly, exploded. The Hindenburg, piloted by Max Pruss, was flying from Frankfurt to Lakehurst. Thirty-six people and two dogs died in the blast.

Hydrocarbon



What is a fuel cell?

A cell stores energy and gives out an electric current after a chemical reaction. A fuel cell can do a little more. It can convert energy from one form to another.



Your torch battery is a cell. So is the car battery.

No charge? You're kidding!

In the simplest fuel cell, hydrogen and oxygen combine to produce electricity and water. But no fumes! A fuel cell is a clean, green way to produce electricity. And it can keep supplying heat and electric current as long as it is fed with hydrogen and oxygen.



It's everywhere

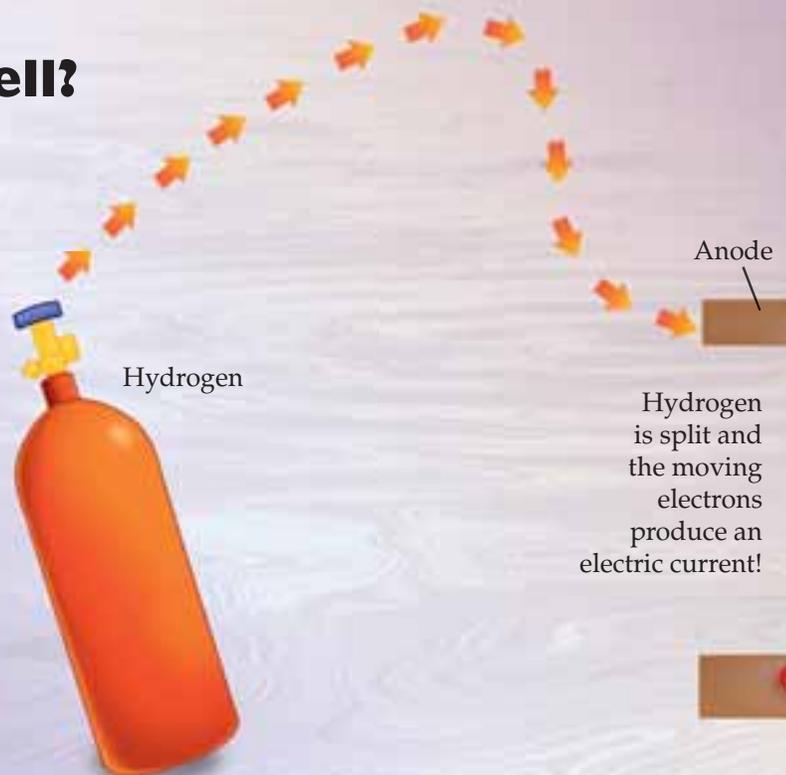
Seventy per cent of the total mass of the universe is contributed by hydrogen.



So, what's in a fuel cell?

A fuel cell is made up of electrodes that let electricity pass through it. If the electrode has more electrons, it becomes negative and is called an anode. An electrode with more protons has a positive charge and is called a cathode.

In a fuel cell, hydrogen splits and releases electrons. The moving electrons produce electric current.

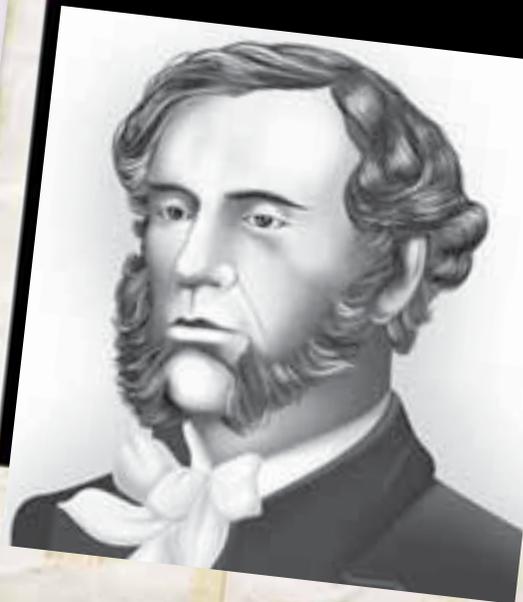


Here we go, hydrogen!

In 1839, William Robert Grove discovered that he could produce a current by arranging two platinum electrodes, with one end dipped in acid and the other end sealed in bottles containing oxygen and hydrogen. This was the first fuel cell.

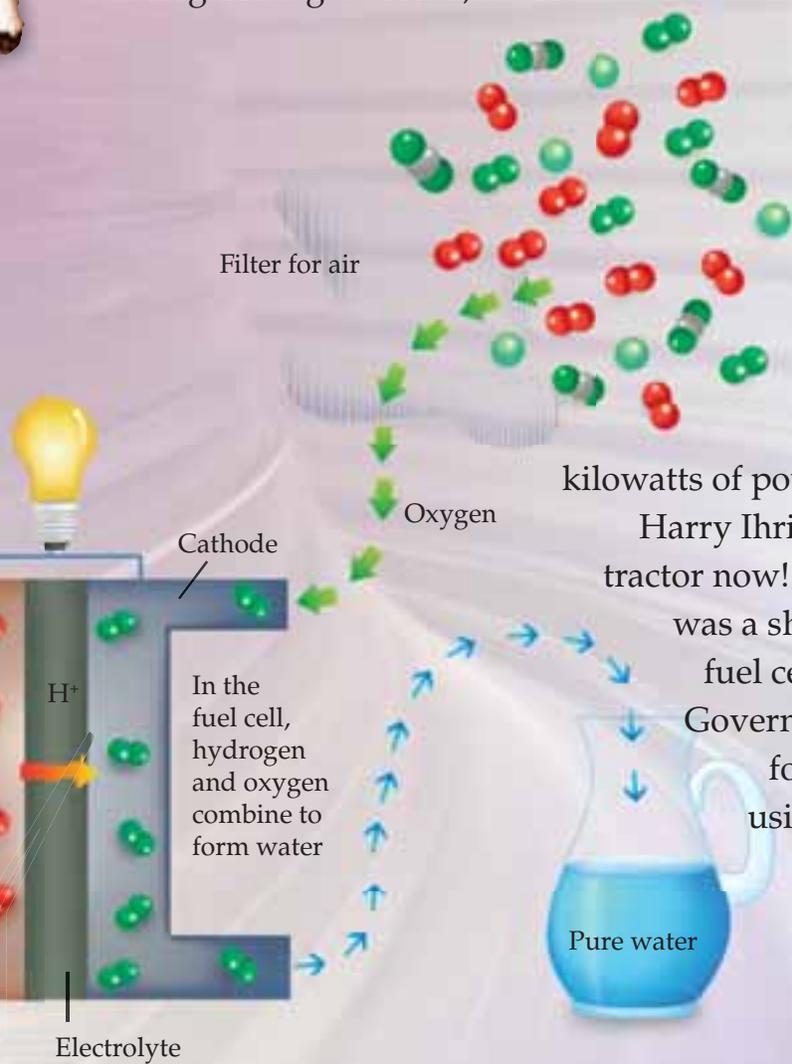
In 1955, W Thomas Grubb improvised it with a new polymer membrane. Three years later, Leonard Niedrach added a layer of platinum to the membrane. This accelerated the reaction between hydrogen and oxygen. Even the National Aeronautics and Space Administration (NASA) used fuel cell technology to power its Gemini space project. Since the 1960s, fuel cells have been on almost all space missions. A great flight record, indeed!

William Robert Grove



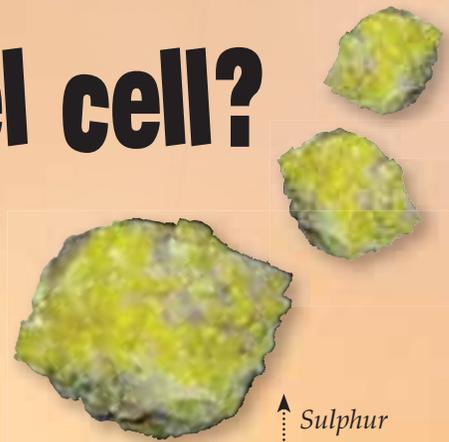
Hip 'n' hydrogen

The year 1959 was a happening one for the fuel cell technology. Francis Thomas Bacon developed a fuel cell that could produce five kilowatts of power and could run a welding machine. Later, Harry Ihrig and his team improved it. It could power a tractor now! During the oil crisis of the 1970s, when there was a shortage of oil supply and oil prices increased, fuel cell technology began to be developed further. Governments and companies began to test fuel cells for more commercial applications. They began using it hospitals and universities. By the 1980s, automobile makers had started seeing the hydrogen fuel cell as an alternative to fossil fuels. In 1993, Ballard, a Canadian company, rolled out the first fuel-cell-powered bus.



Why hydrogen fuel cell?

Hydrogen is just one of the many elements in this world. So, why do we use hydrogen and not, say, sulphur? And why are scientists working so hard on the fuel cell?



Clear winner

When we use energy from fossil fuels like coal and petroleum, they release harmful greenhouse gases that make the earth warmer. Nuclear energy leaves behind poisonous substances, which needs to be disposed of safely. But hydrogen is a clean, safe fuel. When hydrogen combines with oxygen in a fuel cell, it gives out only electric current, heat, and water. Still wondering why we use hydrogen?



Don't start the fire!

The fuel cell is safe, but it is highly inflammable. So do not light a matchstick or candle close to it, lest the hydrogen is leaking.

Efficient energy

Fuel cells convert fuel into energy through a chemical reaction without burning it. This not only produces more energy but also keeps the earth's atmosphere clean and cool!

Spreading warmth

When you use a fuel cell, it gives out heat. You could warm your bath water with this heat to make sure no energy is wasted.

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Publisher : TERI Press

ISBN : 9788179931400

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Type the URL : <http://www.kopykitab.com/product/8457>



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