

**Subject:** Science

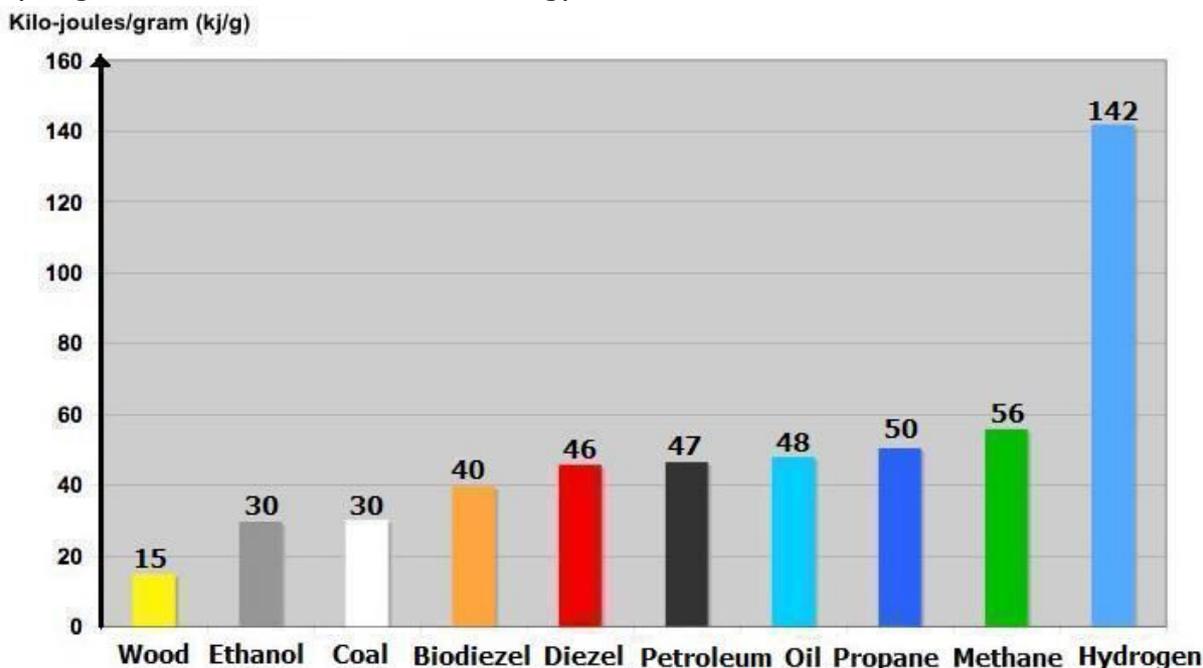
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## Hydrogen Energy

Doç. Dr. Haluk BERKMEN

Energy sources can be classified into two distinct categories as: renewable and nonrenewable sources. Nonrenewable sources originate from the ground. Coal, petroleum, natural gas and uranium are nonrenewable energy sources. It is a well known fact that these sources are limited and cannot be replenished in a short term. All these sources produce carbon-dioxide when burned and therefore increase global warming and pollute the air. Thus, it is imperative to find an energy source that is abundant in nature and does not harm the environment.

Hydrogen (H) is the third most abundant element on earth and is found in water as well as in all organic matter. H atoms bind together to form  $H_2$  which is a colorless, tasteless, and nontoxic gas. Hydrogen atoms bind easily to Oxygen atoms forming water ( $H_2O$ ) and releasing heat. The energy obtained from Hydrogen is much larger than the energy obtained from any other fossil fuel. Below we see a comparison chart. The energy obtained from Hydrogen is more than 4.5 times the energy obtained from coal.



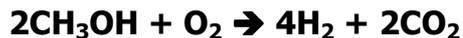
Hydrogen gas can be obtained in a clean and abundant form, without polluting the environment, with the help of a **High Temperature Nuclear Reactor**. In this method the Hydrochloric acid is broken into its components at  $900^{\circ}C$ . At this temperature the acid separates into water, sulfur-dioxide and oxygen. The chemical formulae are as follows:



In this chain of chemical reactions the Hydrochloric acid is not lost and can be reintroduced in the process. The same is valid for sulfur-dioxide and the iodine vapor. In this process no **SO<sub>2</sub>** or **CO<sub>2</sub>** is released into the atmosphere, which is the case for fossil fuels. But the process requires a nuclear reactor, which uses Uranium extracted from the earth. Japan has developed such a High Temperature Test Reactor (HTTR) and has reached 950<sup>o</sup> C in 2004. Japan plans to build a **High Temperature Gas-Cooled Reactor** (HTGR), powered with ceramic-coated Uranium particles as fuel and helium gas as primary coolant.

Hydrogen is easy to store and to transport. Because of its high energy output it has been used as a fuel for rockets launched into space. Many industries worldwide have already begun to produce hydrogen-powered vehicles, hydrogen fuel cells, and other hydrogen products. One of the main proponents of this energy source has been Prof. **Nejat Veziroğlu**. Dr. Veziroğlu was born in Istanbul but is living in the US. He organized the first major conference on Hydrogen Energy and proposed the **Hydrogen Based Energy Economy** as a permanent solution for the depletion of the fossil fuels and the environmental problems caused by their utilization. He is the founder of the **International Centre for Hydrogen Energy Technologies** in Istanbul. Dr. Veziroglu has co-authored the book "**Solar Hydrogen Energy: The Power to Save the Earth**" and started publication of the **International Journal of Hydrogen Energy** (IJHE). He is also the Founding Editor-in-Chief of IJHE (\*).

Presently, Hydrogen gas is obtained from Methanol (CH<sub>3</sub>OH). The process is rather easy since at 250-300 degrees C, Methanol breaks into water and carbon-monoxide (CO). But since CO is poisonous, Methanol is reacted with Oxygen to produce H<sub>2</sub> and CO<sub>2</sub>. The chemical reaction is as follows:



Hydrogen powered vehicles use **Fuel Cells** to produce electricity. Inside a fuel cell H<sub>2</sub> flows through a negative electrode where a catalyst strips electrons from the H atoms. The free electrons flow from the negative to the positive electrode generating an electric current. The produced free H atoms are then joined with Oxygen atoms to produce water vapor. The electric current is directed towards the electric motor of the vehicle. Japan has already built the first hydrogen fueled car and will start to sell it commercially in 2015.

Hydrogen is now considered as being the ideal fuel and the best environment friendly energy source of the future. This is due to its abundance, non-toxic characteristics, and international availability.

The technology is now available and it is time to begin converting from a petroleum-based economy to a hydrogen-based economy. With such advantages all three energy sectors (transportation, industry, and heating buildings) will benefit. I have no doubt that the main energy source of the future will be Hydrogen energy.

(\*) <http://www.journals.elsevier.com/international-journal-of-hydrogen-energy/>