Hydrogen Production Processes

All that is required to produce Hydrogen is electricity and water. These are widely available and allow Hydrogen to be produced in a range of locations. Through the use of relatively simple technology it is possible for Hydrogen to be produced in people's homes. This could offer great benefits in the area of stationary residential power supply. The Hydrogen that is produced in the home could then be used to run a fuel cell system. This would allow houses not connected to the national grid to have a power supply. It could also allow houses that are connected to the national grid to have a fuel cell system with a Hydrogen supply to provide back-up power or have a fuel cell system as the homes primary energy source. Currently such technology is not financially available, however if in the future costs were to decrease then this could be an extremely significant development.

There are a number of processes that can be used to obtain Hydrogen. The different processes vary in their success and their position in terms of development. The most basic method of producing Hydrogen is the simple chemical process of Electrolysis. This involves the passing of an electric current through water to separate it into oxygen and hydrogen. Oxygen gas collects at the anode and hydrogen gas at the cathode.

The Hydrogen produced by Electrolysis is extremely pure but substantial quantities of electricity are required to produce the amount of Hydrogen required by the fuel cell. If this electricity is derived from renewable forms of energy such as PV cells or wind turbines then the fuel cell can be an environmentally friendly energy source. However if the electricity is produced by burning fossil fuels that produces harmful emissions and these emissions than the direct pollution of fossil fuels in traditional power stations fuel cell technology would not be delivering the desired environmental benefit.

Coal gasification is a method of Hydrogen production that is gaining increased market acceptance. Rather than burning coal this process involves the coal reacting with steam and regulated quantities of air or oxygen under temperatures exceeding 2300ºF and pressures of 26.5 atm. The product of this process is typically a gaseous mixture comprising of Hydrogen and Carbon Monoxide. The gasification process is versatile process that can be applied to virtually any carbon-based fuel and can achieve efficiencies of 45-50%.

Petroleum coke, municipal waste and biomass are all carbon-based fuels that the gasification process can be applied to. Typically Biomass gasification utilizes sources including wood chip and Hydrogen rich agricultural waste. This is heated and the biomass converts into gas that primarily consists of carbon monoxide, carbon dioxide and hydrogen. Although Hydrogen is produced carbon dioxide is also a product of gasification that contributes towards global warming. Another product of gasification is Carbon Monoxide, a gas that is harmful to the human body.

A technique that is currently being researched and developed is Photo Electrolysis. This uses sunlight to split water into Hydrogen and Oxygen through the use of a semi-conducting material sandwich. The light stimulates a semi-conductor that in turn splits the Hydrogen. This technology does appear promising but at present is still only in the research stage.

The method of Hydrogen production that is emerging as the solution for the present is Steam-Methane reformation. Currently steam Methane reformation is responsible for 48% of the

industrial supply of Hydrogen in the United Kingdom[1]. The Hydrogen is generated through a process that requires temperatures in between 650ºC and 850ºC and the presence of a catalyst. The process is comparatively efficient mainly through the increased efficiency available through cogeneration. The cost of the Hydrogen produced through Steam Methane Reformation can vary but is typically 5.4 $/GJ for a large plant and 11.2 $/GJ for a small plant. Hydrogen produced through coal gasification can cost between 9.9 $/GJ and 11.6 $/GJ and through biomass gasification 8.7 $/GJ and 13.1 $/GJ[2]. When we evaluate these figures we can see that steam methane reformation is a comparatively inexpensive process in comparison to other Hydrogen production techniques. This form of Hydrogen production does produce modest emissions of carbon dioxide.

One of the most exciting developments in the Hydrogen production field is related to the research and development of Bio-Hydrogen. It has been acknowledged for some time that certain green algae produce Hydrogen in the presence of sunlight. Scientists have manipulated the photosynthesis process of a spinach plant so that Hydrogen is a product. Currently these developments are still in their infancy, however if this Hydrogen production method does prove successful it could be a significant development into the ways in which electricity is produced.

Presently there is no clear and definitive method that must be used to produce Hydrogen. The question could be posed as to why so much research and development is going into such varied areas of Hydrogen production. However when Hydrogen is examined, and it's suitability as a fuel becomes apparent it becomes obvious why such quantities of energy and time are being expended on this area of research.

Hydrogen fuel also has numerous other properties that potentially render it as a very attractive fuel. Hydrogen is a virtually inexhaustible energy source differing greatly from fossil fuels economically recoverable quantities of which are quickly running out. Although Hydrogen must be manufactured the supply of the element is plentiful. Water is available worldwide and is composed of Hydrogen and Oxygen. This is a vast source of Hydrogen that can be accessed through a number of different techniques.

Hydrogen is highly combustive and its safe use demands greater care and cost.

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[1] DUTTON Dr A G, (2002), **A Review of Potential Hydrogen Production and Delivery Systems**, H2NET
Hydrogen Energy Systems

[2] DUTTON Dr A G, (2002), **A Review of Potential Hydrogen Production and Delivery Systems**, H2NET
Hydrogen Energy Systems