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A System and Method for Generation of Power Using Hydrogen Gas

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Abstract: The most common methods of hydrogen production are burning of fossil fuels such as coal, natural gas, heavy oils which release carbon oxides including carbon dioxide into the atmosphere as a greenhouse gas. Yet another cleaner method of hydrogen production is electrolysis. Electrolysis is currently the most feasible means of producing hydrogen. Electrolysis involves the dissociation of water into hydrogen and oxygen by passing a current through an electrochemical cell, and has been available commercially for decades. Again the problem with electrolysis is the fact that it is economically challenging. Our present method provides suitable alternatives to generate power without any carbon emission as with the other power generation systems and an efficient method which also addresses the cost of hydrogen production.

Keywords: Hydrogen gas, Reaction, Generation.

I. INTRODUCTION

Renewable energy such as wind, wave, ocean currents, geothermal, biomass, solar energy are alternative sources of power to the existing exhaustible oil and natural gas reserves. To a great extent, power generating facilities employing renewable energy are very regional and site specific and have the potential to generate the most power but they are proving to be more expensive than expected. Similarly, with the use of nonrenewable energy resources for generating power there are other problems that need to be addressed. Nonrenewable energy resources include fossil fuels such as coal, oil, natural gas and nuclear fuels. These resources are being used faster than nature could ever replace them and also when fossil fuels such as coal, oil, natural gas burn and these carbon-based fuels release millions of tons of carbon dioxide into the atmosphere and contribute to global warming. Currently, among resources being used to generate electricity, fossil fuels are the most common means of power generation followed by nuclear resources and lastly renewable resources. Hence there is a need to generate power using "clean or green energy" which refers to energy that is environmental friendly. When we generate electricity with these resources, very few pollutants, if any, enter air or water. One such clean energy may be achieved by the use of hydrogen gas for power generation. Hydrogen is an ideal substitute for fossil fuels and contain almost three times as much energy as natural gas and when burnt, emits pure, plain water. Hydrogen is being treated as the perfect environmental friendly fuel of the future as it will still be available even when fossil fuels are exhausted. It is the earth's tenth most abundant element and is the most abundant element in the universe. Hydrogen produced by steam reformation i.e. hydrogen production from hydrocarbons and water, costs approximately three times less the cost of natural gas per unit of energy produced, also since hydrogen is found combined with other elements, the challenge is to separate hydrogen from other naturally occurring compounds in an efficient and economic manner.

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II. FIELD OF INVENTION

1. To provide a simple power generation plant that is relatively inexpensive for generating electricity.
2. To produce electricity in an efficient and environmental friendly way by the use of hydrogen.
3. To extract the energy from hydrogen which has three times the energy of most hydrocarbon fuels hence providing a source of alternate energy and an ideal substitute for fossil fuels.

III. SYMMARY OF THE PROJECT

The method for power generation consists of the following units / sub systems -

1. Reaction Unit

It is the main reactor in which Hydrogen gas is produced by reacting a metal with water in presence of an alkaline solution.

$$2nM + 6nH_2O \rightarrow 2nM(OH)_3 + 3nH_2;$$

Where: M = Metal

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The products formed from the reaction are Metal Hydroxide and Hydrogen gas is released. The Hydrogen gas is produced by exothermic reaction of the alkaline solution. The temperature of the reaction increases with time.
The temperature and time relation obtained is as follows:

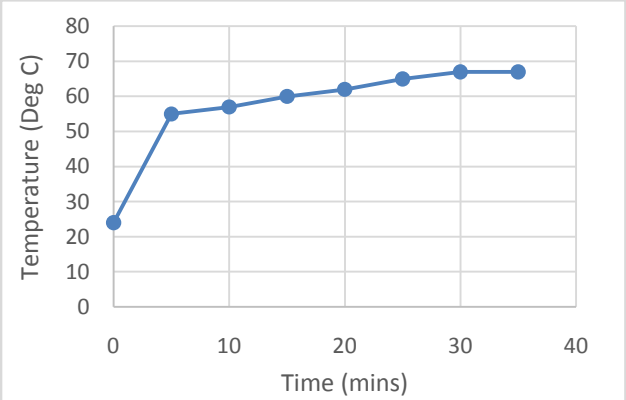

Fig. 1 Temperature Vs Time for Main Reactor

2. Purification Unit

The Hydrogen gas produced is purified in the Purification unit. The Purification unit consists of water which helps in purification of the Hydrogen gas. In this unit, the heat is transferred from Hydrogen gas to water. The temperature of water increases with increase in the rate of reaction. The temperature of water with respect to time is shown as:

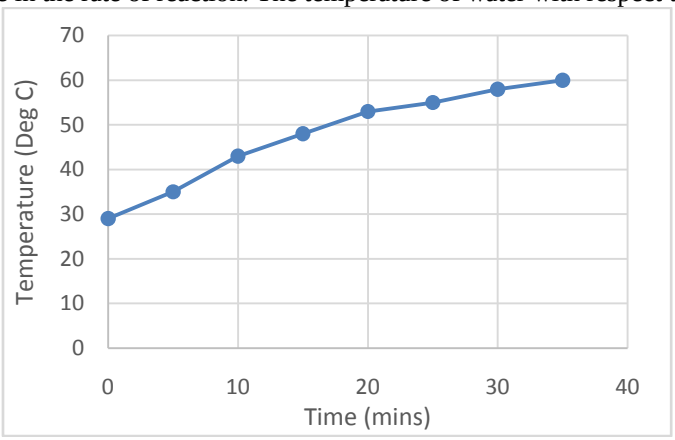

Fig. 1 Temperature Vs Time for Purification unit

3. Steam Generation Unit

1) Gas Furnace / Burner Unit:

The purified Hydrogen gas obtained from the Purification unit is fed into the Gas furnace / Burner, where it combusts in presence of Oxygen. The temperature of Hydrogen obtained is as follows:

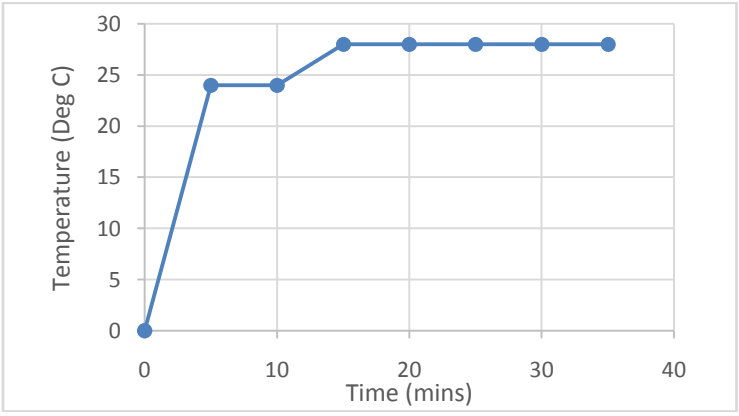

Fig. 2 Temperature Vs Time for Hydrogen gas

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The heat produced during combustion depends on the Calorific value of the Hydrogen gas.
$Q = m.C.\Delta T$
Where,
Q = Heat produced, KJ
m= Mass of Hydrogen gas, Kg
C = Specific heat of Hydrogen gas, KJ/Kg.K ΔT = Temperature difference, K

2) Boiler Unit:
In the boiler unit, the water is converted into water vapour with the heat generated from the combustion of Hydrogen gas in the Gas furnace. The steam generated is then imparted on the turbine. The power generation system comprising the steam generation unit, generates 572kJ energy, when 2 molecule of hydrogen gas reacts with one molecule of oxygen gas, producing two molecule of water, as illustrated by the following chemical reaction:

$$\mathbf{2H_2 + O_2 \rightarrow 2H_2O + \Delta\ 572kJ} \qquad \textbf{(286kJ/mole) ---- (}\text{exothermic reaction}\textbf{)}$$

4. Electricity Generation Unit
It consists of -
1) Turbine:
The steam generated in the boiler is first superheated and pressurized. This pressurized steam is then imparted on the blades of the turbine, which causes the turbine to rotate. Thus the energy of the steam is converted to the mechanical energy of the turbine, which results in rotation of the turbine. Superheated steam possesses tremendous internal energy that can be used for driving the turbine blades of the turbine thereby producing mechanical energy from steam energy. The value of superheated steam lies in its ability to release tremendous quantities of internal energy yet remain above the condensation temperature of water vapour at the pressures at which reaction turbines operate. Employing superheated pressurized steam to rotate the turbines, ensures that the steam flow through the turbine, always remains as a compressible gas, which will not damage the internal moving parts of the turbine through which the steam passes.

2) Alternator:
The shaft of the turbine is coupled to an alternator. The rotational energy of the shaft of the turbine is converted to electrical energy in the alternator. The electrical energy generated by the system can be used for a variety of purposes such as commercial and domestic purposes. The system for power generation using hydrogen gas produces electricity as long as the system generates hydrogen gas.

IV. ADVANTAGES

1. Hydrogen when burned in presence of oxygen produces enormous amount of energy and this energy is utilized for the conversion of water into steam. Hydrogen contains almost three times as much energy as natural gas and when used or burnt, its only emission is pure, plain water hence provides an environment friendly way of generating electricity.
2. The power generation system of the present invention utilizes less amount of cooling water.
3. The power generation system employing hydrogen gas emits negligible amounts of pollutants to the environment thus producing green or clean energy.
4. The installation time of the power generation system of the present invention is less and installation procedure is simple as compared to any other power generation plants.
5. The metal hydroxide by-product formed from the reaction producing hydrogen gas can be used as a raw material in industries like pharmaceutical industries, automobile industries, aircraft industries, packaging industries, constructions, industries manufacturing household utensils, extraction process of the metal.
6. The alkaline solution can be reused once again as reactant to produce hydrogen gas.
7. The operating cost of the power generation system is low as it does not utilize any fossil fuel.
8. All of the generated hydrogen gas is converted to electricity in the power generation system and thus eliminates the hurdles of storage and distribution of hydrogen gas.

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