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ENERGY STORAGE AND POWER GENERATION USING HYDROGEN FUEL

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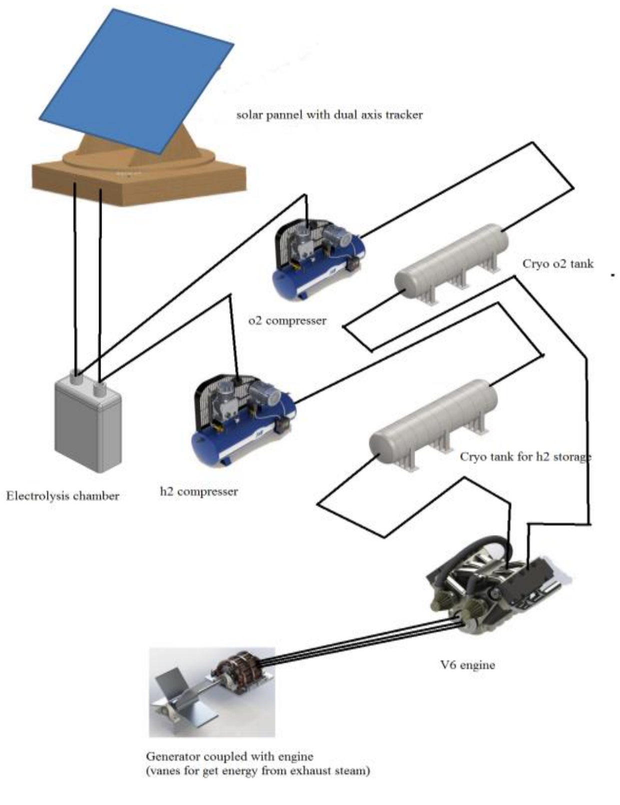
Abstract - This article reports the concept of energy storage using liquid hydrogen and power production by combustion of liquid hydrogen in IC engine. This article also reports the concept of conceptual 8 stroke IC engine and is achieved through the thermolysis process i.e., Thermal decomposition of hydrogen and oxygen from water at a temperature of above 2000°C

Key Words: hydrogen, Eletrolysis, Energy

1.INTRODUCTION

1. MAJOR COMPONENTS FOR PLANT

1. olar panel
2. Electrolysis system
3. Compressor
4. Cryogenic tanks
5. Internal combustion engine
6. Generator



BLOCK DIAGRAM

2.1 SOLAR PANEL:

The solar panel absorbs light energy and converts into electrical energy. With the help of solar tracker and stepper motor the solar panel always kept perpendicular to sun ray direction. Thus the peak time of power production is increased. the drive used for tracker is active drive which has LDR(Light Dependent Resistor).

2.2 ELECTROLYSIS SYSTEM:

Electrolysis is water splitting process in which hydrogen and oxygen are spitted from water through electrode by passing electrical input. The hydrogen production is doubled by coating copper atoms over the platinum electrode.

Energy required for disassociate 1 mole of hydrogen is 285.83 Kj Input Energy given for disassociate 1 mole of

hydrogen= 237.13 Kj (Gibbs free energy $\Delta G = \Delta H - T\Delta S = -237.1$ Kj)

$T\Delta S = 48.7$Kj given by environmental temperature and pressure.

2.3 COMPRESSOR:

In this plant compressor is used to convert the gaseous hydrogen into liquid hydrogen to reduce the storage area and reduce the volume. The power required for compressing 1 Kg of hydrogen from 20 bar and 300K to 350 bar is 1.3Kwh.

2.4 CRYOTANK:

The term "cryotank" refers to storage of super-cold fuels, such as liquid oxygen and hydrogen. The substances which has boiling point below -190°C are called as cryogenic liquids. Incryotank the liquid is insulated from atmosphere through vacuum of about 0.01µmm of Hg. Material of cryo tank is aluminium since it contains low brittleness at such low temperature.

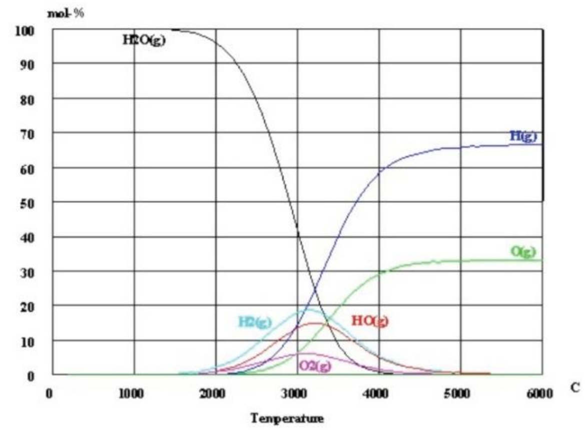
2.5 IC ENGINE:

It is a reciprocating engine which runs on Otto cycle. In this engine it has fuel injector as well as spark plug. Though, it supply heat though constant volume process. Due to ignition of liquid hydrogen high temperature and pressure is created in engine so most parts of the engine.

Alloys	Hardness (HV)	Density (g/cm³)	Melting Point (°c)	Tensile Strength (MPa)	Yield Strength (MPa)	Elastic Modulus (GPa)
Ta - 2.5% W	130	16.7	3005	345	230	195
Ta - 7.5% W	245	16.8	3030	550	460	205
Ta - 10% W	325 - 400	16.8	3025	1035 - 1165	875 - 1005	200

2.5.1 8 STROKE ENGINE:

Since liquid hydrogen is ignited in ic engine the temperature obtain in combustion stroke is above 2500°C. with that elevated temperature we can achieve thermal decomposition of hydrogen oxygen from water molecules through thermolysis process.



2.5.1.2 STROKES IN 8 STROKE IC ENGINE:

1st stroke: The intake valves are open as a result of the cam lobe pressing down on the valve stem. The piston moves downward increasing the volume of the combustion chamber and allowing oxygen gas.

2nd stroke: In this stroke, at the start of compression liquid hydrogen is injected by injector, both valves are closed and the piston moves upward reducing the combustion chamber volume which reaches its minimum when the piston is at TDC. When the piston reaches TDC, ignition begins. The spark plug receives a high voltage pulse that generates the spark which gives it its name and ignites the charge 3rd stroke: The pressure of the combustion gases pushes the piston downward, generating more work than it required to compress the charge. Complementary to the compression stroke, the combustion gases expand and as a result their temperature, pressure and density decreases. When the piston is near to BDC the exhaust valve opens. The combustion gases expand irreversibly due to the leftover pressure—in excess of back pressure, the gauge pressure on the exhaust port—; this is called the blow down.

4th stroke: The exhaust valve remains open while the piston moves upward expelling the combustion gases. For naturally aspirated engines a small part of the combustion gases may remain in the cylinder during normal operation because the piston does not close the combustion chamber completely; these gases dissolve in the next charge.

5th stroke: In this stroke the piston moves from TDC to BDC. Intake of coolant water into the cylinder. The heat created by the combustion of hydrogen fuel is absorbed by the water and converted into steam. The temperature of cylinder wall is decreased. And pressure and temperature of steam increased. Due to this high pressure crated the piston moves from TDC to BDC.

6th stroke: In this stroke piston moves from BDC to TDC. In th oxygen is decomposed from water. When piston reaches the TDC spark plug sparks to ignite the decomposed hydrogen and oxygen.

7th stroke: In this stroke Due to the combustion of hydrogen pressure on the piston gets increased. Due to this high pressure created the piston moves from TDC to BDC.

8th stroke: This stroke is exhaust stroke. In this stroke the combustion product ie,.steam sent to the atmosphere.

Overall efficiency=57.54%

Brake power=81.14 kw

2.6 GENERATOR:

Synchronous generators are used because they offer precise control of voltage, frequency, VARs and WATTs. This control is achieved through the use of voltage regulators and governors. A synchronous machine consists of a stationary armature winding (stator) with many wires connected in series or parallel to obtain the desired terminal voltage. The armature winding is placed into a slotted laminated steel core. A synchronous machine also consists of a revolving DC field - the rotor. A mutual flux developed across the air gap between the rotor and stator causes the interaction necessary to produce an EMF. As the magnetic flux developed by the DC field poles crosses the air gap of the stator windings, a sinusoidal voltage is developed at the generator output terminals. This process is called electromagnetic induction.

3. WOKING PRINCIPLE:

- The solar tracker traces the sun's position and keeps the panel perpendicular to sun rays and the solar panel converts the light energy into electrical energy.
- The output from solar panel is DC current. And is directed toward electrolysis chamber where water

molecules separated into hydrogen and oxygen gas molecules.

- The compressor and liquefier work to convert the gaseous hydrogen into liquid hydrogen.
- This liquid hydrogen is stored in cryotank which is insulated from environment through vacuum technology.
- This stored hydrogen liquid is injected into IC engine liquid oxygen is intake in suction stroke liquid hydrogen is injected just before combustion stroke and combusted with a spark produced through spark plug. Thus crank shaft of engine is rotated.
- By coupling the crank shaft with generator we can convert the mechanical energy into electrical energy.

4. ADVANTAGES OF THE PLANT:

- There is no nuclear radiation
- Pollution free compared to thermal and diesel power plant
- Energy storage done in compact area compared to pumped storage and compressed air storage.
- The area required for the plant is 10 times lesser than pumped storage plant.
- The cost of the plant also 10 to 15 times lesser than other energy storage methods.
- Efficiency of the plant can be increased through the thermolysis concept.

5. CONCLUSION:

From the output of our project we conclude that the plant is emission free and it is efficient in energy storage because it utilize the renewable energy without any cutoff energy due to demand criteria. So the energy can be stored and utilized whenever the demand arises. The area required for this energy storage and power generation plant is less compared to the other energy storage and power generation plant.

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