PERFORMANCE OF A GRID CONNECTED SOLAR HYDROGEN PV SYSTEM IN MALAYSIA

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ABSTRACT

In this project, an experimental grid connected solar hydrogen energy system (GCSHES) has been setup and tested. The important element of GCSHES is that it has the capability of overcoming the problems that occur on the grid connected power system (GCPS) when there is no electricity. The system will converts the electric energy-generated from a PV module into hydrogen. The polymer electrode fuel cell generates electricity using the hydrogen stored in the storage tank. The GCSHES consists of a subsystems photovoltaic array, inverter, electrolyser, hydrogen tank and fuel cell. It has been found that the monthly efficiency and performance of PV array is 12.7% and 26%, and for inverter is 95.1% and 98%, respectively. The efficiency of electrolyzer subsystem and fuel cell is 51% and 25%, respectively. The results have shown that GCSHES gave a very good performance and can effectively be used in Malaysian climate conditions for renewable energy generations.

1. INTRODUCTION

Solar-hydrogen energy system has been regarded as the future energy system that is clean and environmental- friendly [1]. The grid connected solar hydrogen energy system has been developed in Malaysia to investigate the performance under the local climate conditions. The important element of the grid connected solar hydrogen energy system (GCSHES) is that it has the capability of overcoming the problems that occur on the grid connected power system (GCPS) when there is a black out of grid electricity. During the condition of excess electric supply, the excess supply will be delivered to the grid system and it will be re-delivered again if there is inadequate sun light. Current stand alone power system (SAPS) disadvantages are that it requires batteries and larger hydrogen tank capacity for higher energy generation. [2-5]. In SAPS, electric energy is stored either using battery or hydrogen and battery [6,7]. The capacity of battery to store energy is limited, so that the large number of batteries and bigger hydrogen storage tank are required for larger energy requirement.

2. GRID CONNECTED SOLAR HYDROGEN ENERGY SYSTEMS

The technology concept of connected solar hydrogen energy systems (SHES) consists of two stages. The first stage is the direct conversion of energy sources from solar energy to DC electric energy to alternating current (AC) and delivers to the grid. The second stage is the indirect conversion of energy sources through certain stages of energy storage in the form of chemical energy (hydrogen energy technology: production, storage and utilization), and then the chemical energy can be converted again becoming the electric energy. The solar energy is converted to the electric energy by using the photovoltaic, when the excess electric supply occurs and this excess supply will be delivered to the grid or change to the chemical energy (hydrogen). The grid electric will be used whether there is adequate or inadequate solar energy. When there is no sun light and grid electric, for example at night, hydrogen is reconverted to the electric energy by fuel cell. The produced hydrogen can be used too for other purposes, such as for stove, internal combustion engine and laboratory research study. The schematic of grid connected solar hydrogen energy systems is shown in Fig. 1.

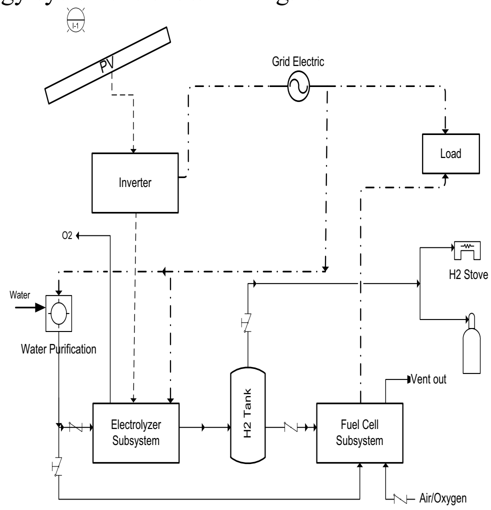

Fig.1 Schematic of grid connected solar hydrogen energy system

2.1 Photovoltaic Panels

Photovoltaic solar system employs module produced from semiconductor material to generate the electric energy from solar energy. Figure 2 shows processes occurring in an irradiated PV cell.

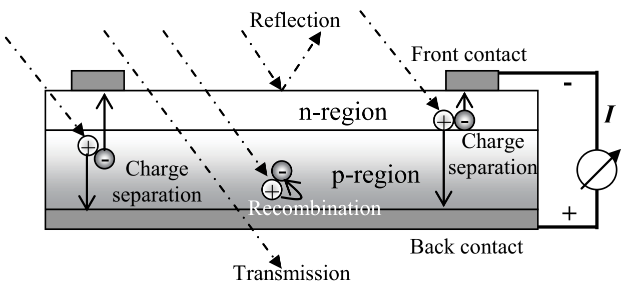

Fig. 2 Processes occurring in an irradiated PV cell

PV operation using the maximum power point tracker (MPPT). The comparison of PV power data is shown in Fig. 3.

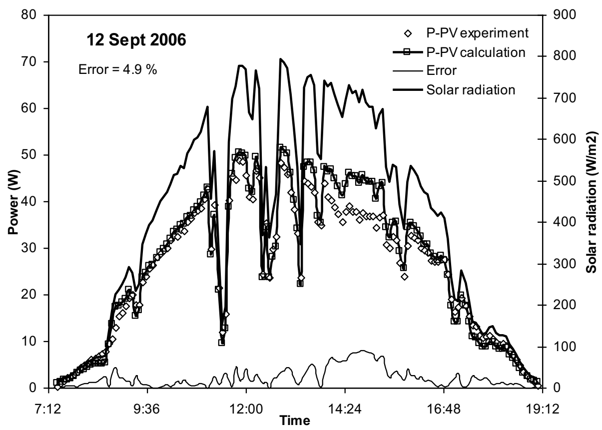

Fig. 3 Comparison of PV module power between experimental and predicted data in 12 September 2006

2.2 Electrolyzer

Electrolyzer system was used for the purpose of hydrogen production from water. It consists of water supply unit, electric supply, oxygen gas disperser from water and hydrogen purification unit. The schematic subsystem of electrolyzer is shown in Fig. 4.

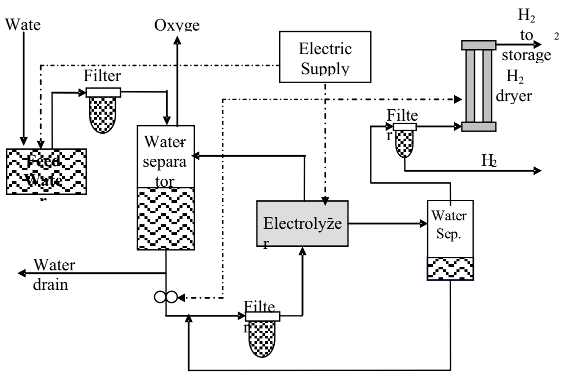

Fig. 4. Schematic of electrolyzer subsystem

2.3 Fuel cell subsystems

The fuel cell subsystems consists of fuel cell stack (FC), hydrogen and oxygen delivery unit, water cooler and inverter to convert the DC electric to AC. Fuel cell subsystems is employed to convert the re-convert hydrogen chemical energy to electric energy. This subsystem is operated when grid electric disconnection occurs. The schematic subsystem of fuel cell is shown in Fig. 5.

Scott [8] mentioned that the delivered electric current is depend on the amount of hydrogen molecule that consumed by fuel cell. The ideal current delivered by fuel cell is at the voltage of 1.23 V if assuming the exergy efficiency equal to 100%. Fuel cell delivers the electric current with voltage below 1.23 V. The efficiency of fuel cell exceeds above 25% with the voltage of 13 V and current of 10 Ampere. At the power around 500 W, the efficiency of fuel cell is 25.35%

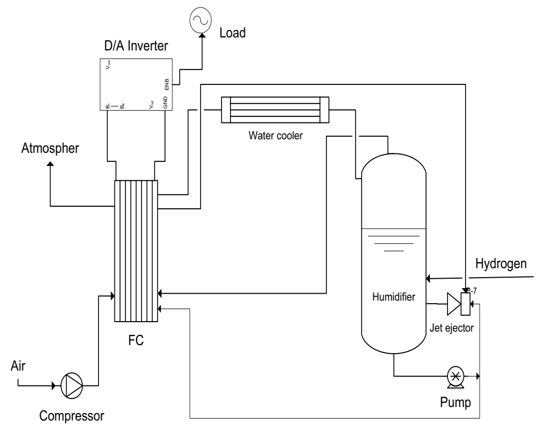

Fig. 5 Schematic of fuel cell subsystem

3. CONCLUSIONS

Solar-hydrogen energy system has been regarded as the future energy system that is clean and environmental- friendly The grid connected solar hydrogen energy system has been developed in Malaysia. It has a very high potential to be implemented on the grid connected transmission system and shift the use of conventional fuel to the renewable energy. The results have shown that GCSHES gave a very good performance.

4. REFERENCES

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