# EXPERIMENTS WITH PHOTOVOLTAIC SYSTEM FOR HYDROGEN PRODUCTION

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**Abstract:** A photovoltaic panel connected directly to an electrolyzer was used to produce hydrogen by electrolysis of a sodium hydroxide solution. The system was run for several days and it showed its suitability and capability to produce hydrogen. The quantity of produced hydrogen is linearly dependent on the solar radiation intensity reaching the photovoltaic panel.

**Keywords**: Electrolyzer, Hydrogen, Photovoltaic, Solar energy

## INTRODUCTION

Among the renewable energies, solar energy can contribute significantly to world energy supply because of both the limited amounts of fossils fuels and environmental reasons. The use of solar energy is usually used in three main categories, namely: (a) passive solar heating and cooling of buildings, (b) thermal conversion systems and (c) photovoltaic systems. When exposed to the sun, the photovoltaic convert directly the radiant energy into electric current which can be immediately used in electric supplies [1,2].

As an alternative to conventional fuels, hydrogen seems to be a potential candidate. It is directly obtained from water and can be used in both non-polluting burning process or fuel cells.

Many experimental and theoretical references studied the production of hydrogen by electrolysis using photovoltaic electricity [3-5]. The effect of the electrolyte temperature on the rate of hydrogen production was considered [4]. Mathematical modeling of the performance of large scale photovoltaic electrolyzer systems, both with fixed and tracking arrays has been considered [5]. The performance, safety and maintenance of photovoltaic plant using hydrogen as energy storage and fuel cells technology have been reported [6]. Recently, Ahmad and El-Shenawy [7] studied the photovoltaic system for hydrogen production in Egypt with and without maximum power point tracker.

In this paper, the experimental results of photovoltaic system for hydrogen production are presented. They were obtained during March 2006 in Ouargla (South-East of Algeria).

## EXPERIMENTAL APPRATUS

The photovoltaic system for hydrogen production consists of the photovoltaic panel and the water electrolyzer.

The photovoltaic panel is monocrystalline silicon type with an overall surface of 1.6 $m^2$. The open circuit voltage and short circuit current are 40 V and 4.5 A respectively. The panel is mounted on an inclined steel frame. The tilt angle is maintained at 30° with the horizontal and the frame is placed such that the panel is facing south direction.

The electrolyzer is a plastic container with 10 cm of diameter and 8 cm of height. The electrodes are made of nickel and fixed to the bottom of the electrolyzer and connected directly to the photovoltaic array. The solution used is sodium hydroxide with a concentration of 1.2 %. The volume of hydrogen produced at the cathode is measured every 15 minutes using a calibrated glass tube. Two voltmeters and an ammeter are used to measure the load voltage $V_L$, the panel voltage $V_P$ and the load current $I_L$. The solar radiation is measured with a digital pyranometer. Thermocouples are used to measure the ambient and solution temperatures.

## RESULTS AND DISCUSSION

The photovoltaic system for hydrogen production was tested several days in march and the data for 22-03-2006 are recorded and reported for discussion.

The solar radiation H recorded for the 22-03-2006 are shown in Figure 1, while the load current $I_L$ and voltage $V_L$ at the end of the electrolyzer are shown in Figure 2, they both show maximums around noontime. To have an idea about the losses in the circuit, the load voltage $V_L$ at the end of the electrolyzer and the panel voltage $V_P$ are compared in Figure 3. The panel voltage is slightly higher than the load voltage because of electric losses.

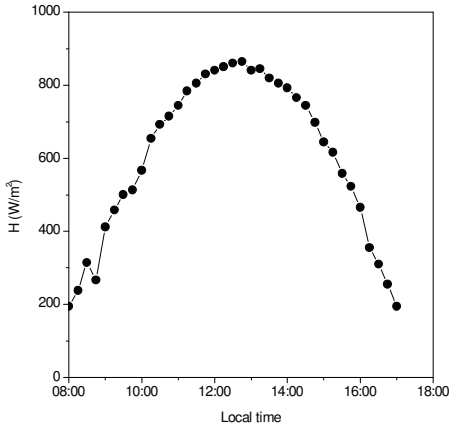


**Figure 1.** Solar radiation intensity.

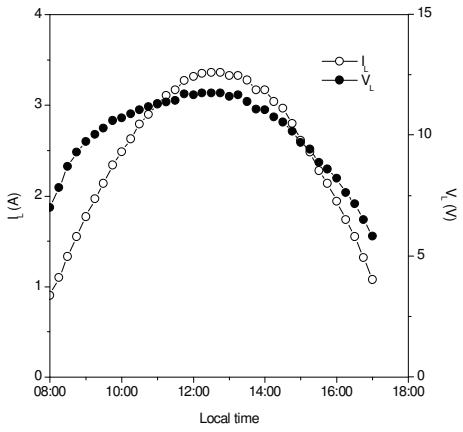


**Figure 2.** Load current and load voltage

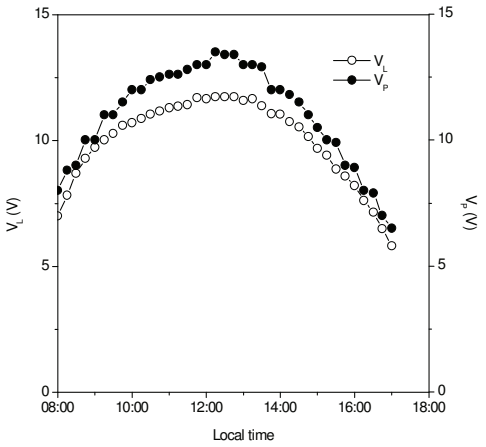


**Figure 3.** Load voltage and panel voltage.

The correlation between the load current $I_L$ and the solar radiation H is illustrated in Figure 4, as it can be noticed, a linear relationship is found. The temperature of the electrolyte $T_s$ is plotted in Figure 5 along with ambient temperature $T_a$ for comparison. The electrolyte temperature is high because of Joule's effect.

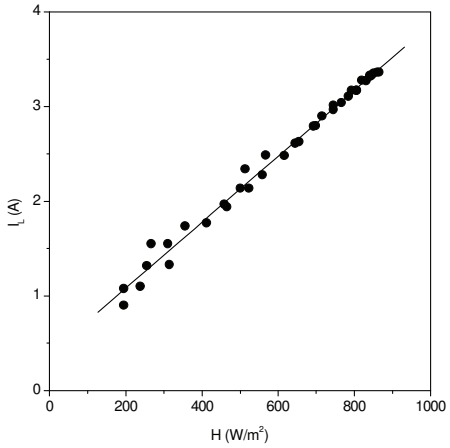


**Figure 4.** Load current versus solar radiation intensity.

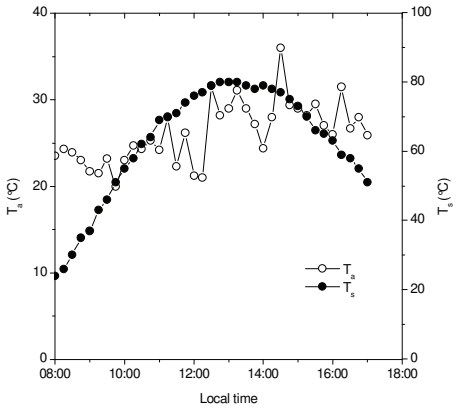


**Figure 5.** Electrolyte and ambient temperatures.

Figure 6 illustrates the relation between the hydrogen volume $V_{H2}$ produced and the solar radiation intensity H. As the solar radiation intensity increases, the hydrogen volume increases.

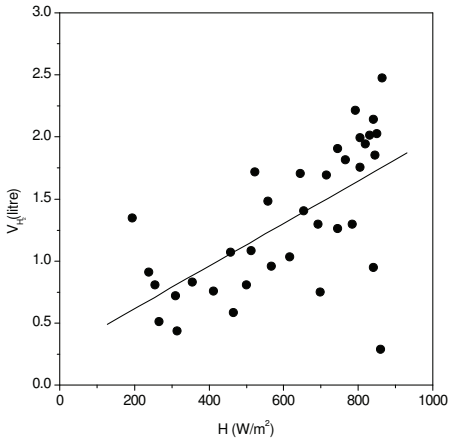


**Figure 6.** Hydrogen volume versus the solar radiation intensity.

## CONCLUSION

An experimental photovoltaic system for hydrogen production was installed in Ouargla (South-East of Algeria) and tested during several days in March 2006. The system showed its capability to produce hydrogen by direct coupling to a photovoltaic panel. The amount of produced hydrogen is found to be strongly dependent on the amount of solar radiation intensity.

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