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Electrolyte process of hydrogen production by solar energy

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Abstract

This study relates to the design of a hydrogen generating station by water vapour electrolysis at high temperatures (700–1000°C) whose energy resources are solar. The electricity supply is done by photovoltaic cells and the water vapour is ensured by a solar concentrating power station. The numerical simulation of the hydrogen production for the installation proposed is made while being based on the characteristic equations governing the electrolysis of water, the photovoltaic panels and the solar concentrating power station. The hydrogen production rate is given for various values of the solar radiation and several sites of Algeria. The results obtained by the established computer code, and of which the required goal is the determination of the most favourable conditions for a better production of hydrogen, are presented and discussed.

Keywords: Electrolyte; Hydrogen; Solar energy; Photovoltaic cell; Linear parabolic collector

1. Introduction

To consider the generalization of an energy system based on the solar contribution, it is necessary to ensure a uniform and controlled distribution. This requires developing a storage technology of solar energy in order to uncouple the request and the energy production, and to allow its transport; this one must be profitable and in addition compatible with strong productions. In this work, we consider the study of a production system of solar fuels (synthetic fuel, hydrogen, i.e. solar). The fuel can be transported by pipelines

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or be stored in tanks, to be conveyed to point of consumption (automobile, industry, etc.) and to restore its energy value. The hydrogen, associated with other elements, abounds in nature, its combustion is not polluting. It constitutes, for that, a perfect solar fuel [1]. Taking into account the promising prospects for the fuel cells and thermal engines with hydrogen, a system of energy to hydrogen can then be proposed as replacement solution or at least complementary, of the current system of energy production [1]. Hydrogen is produced by solar way mainly using thermal processes, photo electrochemical and electrolytic [2]. We choose the third case. The electrolytic process consists in water dissociating oxygen and hydrogen by means of continuous electrical current which crosses an electrolyte laid out between two electrodes. There are mainly three types of electrolysers which are the subject of many research works [3–5]: alkaline electrolysers, with membrane and finally, at very high temperature [6–8]. The suggested system is that of the electrolyser with water vapour at very high temperature where electricity is produced by photovoltaic cells and the water vapour supply is ensured by a solar concentrating power station. Fig. 1 shows the synoptic diagram of the system. The generating station of hydrogen is made up mainly of three parts:

- The electrolyser with water vapour at high temperature.
- A set of photovoltaic panels to supply the electrolyser with electricity.
- A solar concentrating power station supplying the water vapour to the electrolyser.

2. Simulation of the water vapour unit

The solar water vapour system configuration is shown in Fig. 2.

Water (state 1) and with a flow ( ), penetrates the solar boiler and it leaves there at high pressure and temperature (state 2) where it is received and slackened by the turbine which will produce work W necessary to the compressor. At the exit of the turbine, a mixture (liquid + vapour) is recovered: the liquid (state 3′) with a flow ($\dot{m}_{3'}$) is recycled towards the water tank and the water vapour (state 3) with a flow ($\dot{m}_3$), is divided by a separator, in two quantities:

- The first (state 4) with a flow ($\dot{m}_4$) is used to feed the cells of electrolysis, once treated (heated and compressed) at the desired conditions (state 5).
- The second (state 4′) with a flow ($\dot{m}_{4'}$) is recycled towards the water tank.

The vapour station uses two heat generators:

- The first supplies the solar boiler of power Q_{12};
- The second supplies the solar heater of power Q_{45}.

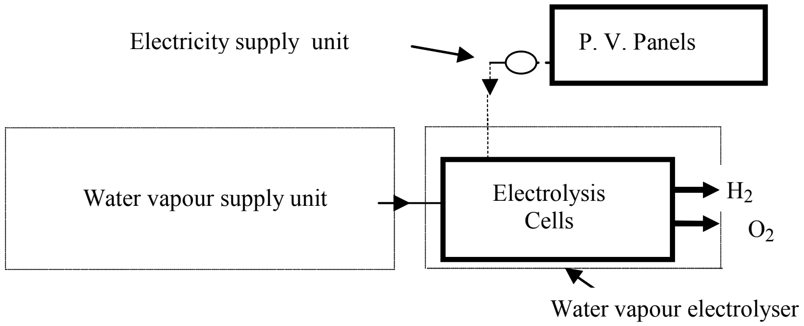

Fig. 1. General diagram of the solar hydrogen production station.