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ScienceDirect

Energy Procedia 112 (2017) 418 – 425

Energy Procedia

Sustainable Solutions for Energy and Environment, EENVIRO 2016, 26-28 October 2016, Bucharest, Romania

Hydrogen production using solar energy - technical analysis

Gheorghe Badea[a], George Sebastian Naghiu[b], Ioan Giurca[a,]*, Ioan Aşchilean[c], Emanuel Megyesi[b]

[a]*Technical University of Cluj-Napoca, Faculty of Building Services Engineering, Boulevard December 21, no. 128-130, Cluj-Napoca, 400604, Romania*

[b]*S. C. Klever System S.R.L., str. 1 Decembrie, no. 30 A, Bistriţa, 420080, Romania*[c]*SC ACI Cluj SA, Avenue Dorobanţilor, no. 70, Cluj-Napoca, 400609, Romania*

Abstract

This paper presents a case study concerning a plant for hydrogen production and storage, having a daily capacity of 100 kg. The plant is located in Cluj-Napoca, Romania. It produces hydrogen by means of water electrolysis, while the energy is provided using solar energy. We performed the calculations for four different technical solutions used for the hydrogen production and storage plant, and also we considered three scenarios regarding the sub-systems of the hydrogen production and storage plant efficiency. The conclusion of this study is that one can maximize the conversion of solar radiation into chemical energy in the form of hydrogen by hybridizing the solar hydrogen production system, namely using both electrical energy as well as thermal energy in the form of steam.

Peer-review under responsibility of the organizing committee of the international conference on Sustainable Solutions for Energy and Environment 2016

*Keywords:*solar energy; photovoltaic energy; photovoltaic systems; hydrogen; technical analysis.

1. Introduction

The worldwide spread technologies for the production of hydrogen are as follows: steam reforming, partial

* Corresponding author. Tel.: +40-0723 371 760; fax: +40-0258 841 127.
*E-mail address:*giurca_ioan@yahoo.com

Peer-review under responsibility of the organizing committee of the international conference on Sustainable Solutions for Energy and Environment 2016
doi:10.1016/j.egypro.2017.03.1097

oxidation, auto-thermal reforming, water electrolysis, biomass, Kvaerner process, thermochemical process, photochemical process, photobiological process [1].

This paper focuses on the technical analysis of the hydrogen production systems by means of water electrolysis, having solar energy as the energy source.

Hybrid systems producing electrical energy by means of photovoltaic energy have some disadvantages due to changing weather conditions by one hand and to difficulties related to storage of electrical energy produced in excess. Electrolytic hydrogen could be the solution for leveling the sporadic consumption and the peaks of consumption, as well as for the storage of electrical energy produced in excess, followed by the reintroduction of the energy into the system, when required.

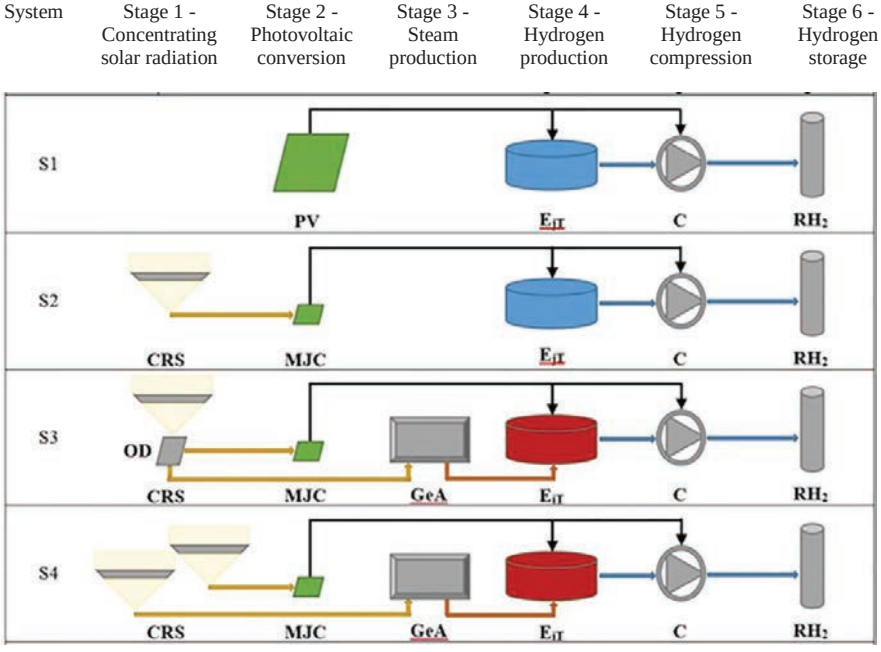
This paper is one of the first studies dealing with the production of hydrogen using water electrolysis by means of solar energy, using both electrical energy and thermal energy in the form of steam.

2. Materials and methods

2.1. Materials

Water is used as raw material in order to obtain hydrogen by means of electrolysis, and wind power, solar, water and nuclear forms of electricity or electricity made of coal or natural gas can be used as forms of energy. In this paper we analyze the production of hydrogen by means of water electrolysis, using the solar energy as the type of energy for obtaining hydrogen.

The designs for the four technological solutions regarding the hydrogen production system using solar radiation analyzed in this paper are comparatively presented in Fig. 1, where one can notice the system's components involved in each stage of the process and the interaction between them.



Legend: CRS - solar radiation concentrator; PV - single-junction solar cells; MJC - multi-junction solar cells; OD - dichroic mirror; GeA- steam electric generator; EjT- low temperature electrolyzer; EiT- high temperature electrolyzer; C - hydrogen compressor; RH_2- hydrogen tank; → - concentrated solar radiation; →- hydrogen distribution pipe; → - steam distribution pipe; - wires for electric connection of components

Fig. 1.The designs for the four technological solutions regarding the hydrogen production system using solar radiation.