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A Green Optically Active Hydrogen and Oxygen Generation System Employing Terrestrial and Extra-Terrestrial Ultraviolet Solar Irradiance

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Abstract : Due to Ozone layer depletion on earth, the incoming ultraviolet (UV) radiation is recorded at its high index levels such as 25 in South Peru (13.5° S, 3360 m a.s.l.) Also, the planning of human inhabitation on Mars is under discussion where UV radiations are quite high. The exposure to UV is health hazardous and is avoided by UV filters. On the other hand, artificial UV sources are in use for water thermolysis to generate Hydrogen and Oxygen, which are later used as fuels. This paper presents the utility of employing UVA (315-400nm) and UVB (280-315nm) electromagnetic radiation from the solar spectrum to design and implement an optically active, Hydrogen and Oxygen generation system via thermolysis of desalinated seawater. The proposed system finds its utility on earth and can be deployed in the future on Mars (UVB). In this system, by using Fresnel lens arrays as an optical filter and via active tracking, the ultraviolet light from the sun is concentrated and then allowed to fall on two sub-systems of the proposed system. The first sub-system generates electrical energy by using UV based tandem photovoltaic cells such as GaAs/GaInP/GaInAs/GaInAsP and the second elevates temperature of water to lower the electric potential required to electrolyze the water. An empirical analysis is performed at 30 atm and an electrical potential is observed to be the main controlling factor for the rate of production of Hydrogen and Oxygen and hence the operating point (Q-Point) of the proposed system. The hydrogen production rate in the case of the commercial system in static mode (650°C, 0.6V) is taken as a reference. The silicon oxide electrolyzer cell (SOEC) is used in the proposed (UV) system for the Hydrogen and Oxygen production. To achieve the same amount of Hydrogen as in the case of the reference system, with minimum chamber operating temperature of 850°C in static mode, the corresponding required electrical potential is calculated as 0.3V. However, practically, the Hydrogen production rate is observed to be low in comparison to the reference system at 850°C at 0.3V. However, it has been shown empirically that the Hydrogen production can be enhanced and by raising the electrical potential to 0.45V. It increases the production rate to the same level as is of the reference system. Therefore, 850°C and 0.45V are assigned as the Q-point of the proposed system which is actively stabilized via proportional integral derivative controllers which adjust the axial position of the lens arrays for both subsystems. The functionality of the controllers is based on maintaining the chamber fixed at 850°C (minimum operating temperature) and 0.45V; Q-Point to realize the same Hydrogen production rate as-is for the reference system.

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