A review of thermochemical water splitting cycles

Jeet Prakash Sharma, Ravindra Jilte

Department of Mechanical Engineering, Lovely Professional University, Jalandhar, Punjab, India

Abstract

This paper presents the review of solar thermochemical technologies. Solar thermochemical processes are the most efficient alternative of the fossil fuel. It has been observed that the solar thermochemical cycles are the best way of hydrogen and syngas production out of all five thermochemical processes. Further, the classification and advancement of solar thermochemical cycles also have been discussed. This paper also compares the various solar thermochemical cycles in different aspect to project the most efficient cycle for the solar thermochemical fuel production.

Keywords: Thermochemical cycles, water splitting.

1 Introduction

We are living in a time when 80% primary energy demand of the world has been covered by the fossil fuels, in which petroleum oil covers the major part up to 32% [1]. Even though fossil fuel are the best possible and easily available (currently) option for energy, might not be very good idea in near future due to its close and heavy impact on environment. International energy agency (IEA) report states that to limit the global temperature by 2°C, the CO_2 emission (industrial and energy) has be dropped by 60% [2]. Thus the situation demand to implement the ideas such as carbon capture and development of more efficient non-renewable sources of energy to reduce the factors causing the harm to environment. It has been evident that the hydrogen can be the alternative fuel option for sustainable environment [3]. Hydrogen is the fuel of future because of its high energy density and it comes without harmful emissions. Further it also can be converted into hydrocarbon fuel and electricity.

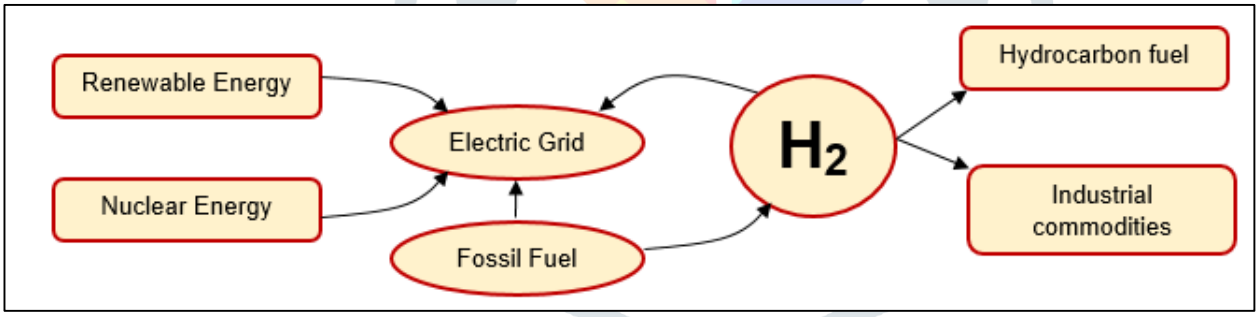

Figure 1: Hydrogen and its integration *[5]*

Hydrogen is the main element in the energy production chain as shown in the Figure *1* and it is also used for the production of industrial commodities such as ammonia, lime and ethanol [4]. Hydrogen is the integrating factor between all the industrial sectors and improve its electricity grid performance. Hydrogen can be produced from biomass and solar thermochemical processes as shown in the figure 2 and can be efficiently converted into electricity. The report of Hydrogen Council [5] states that by the year 2050, hydrogen energy can fulfil the 18% (78 EJ) of global energy demand.

4 Comparison of thermochemical cycles

The thermochemical cycles are in the development stage since past 50 years and yet have not been completed yet. These cycles are seen as the long term solution to the fossil fuel and environment problems.

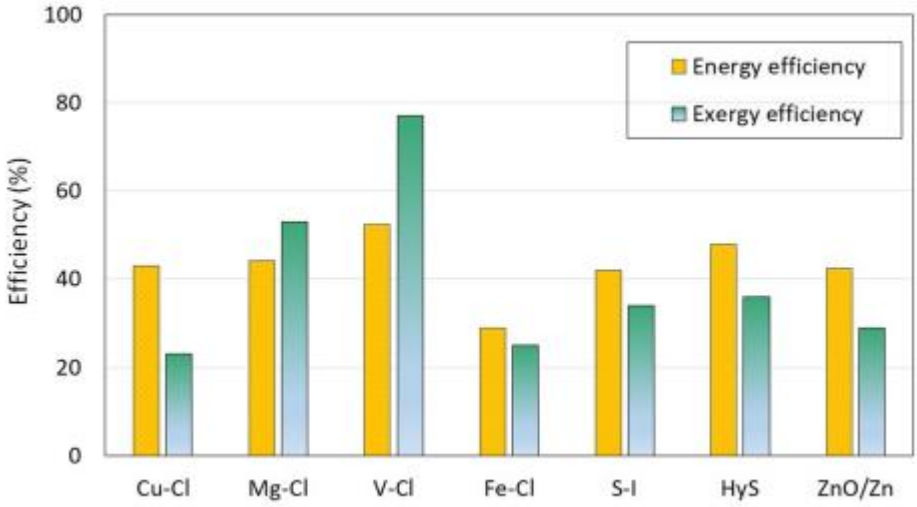

Figure 6: efficiency comparison [6]

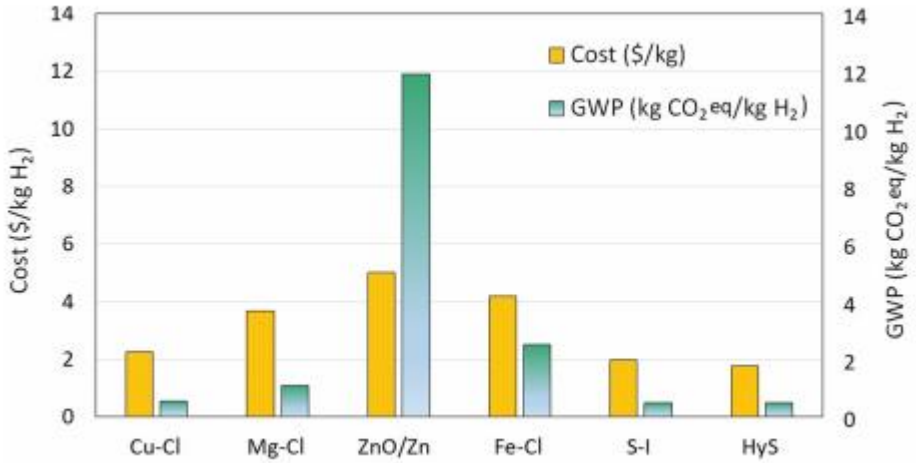

Figure 7: cost comparison[7]

Figure 6 shows the comparative evaluation of shown thermochemical cycles in terms of their efficiency. It can be seen that the V-Cl cycle has the higher exergy efficiency and e-Cl has the lowest. Figure 7 Shows the comparative evaluation of hydrogen production cost where ZnO/Zn cycle has the high hydrogen production cost of 12$ kg and the sulfurine based cycles have the lowest cost of 2$/kg H2.

5 Conclusions

The production of hydrogen is increasing slowly and it will reach its peak in time and it is expected that when that happens our reliability on the fossil fuel will decrease. Researchers around the world are investigating the thermochemical cycles and developing them. The efficiency of the thermochemical are being improved through efforts and the pilot scale testing of many cycles have been demonstrated. It has been seen that the V-Cl cycle has the high efficiency but hindered with some technical issues. Cu-Cl and Mg-Cl cycles are the promising in the field in terms of cost and efficiency.

References

[1] "IEA webstore. Key World Energy Statistics 2018." [Online]. Available: https://webstore.iea.org/key-world-energy-statistics-2018. [Accessed: 15-Feb-2020].