ECONOMICALLY USAGE OF HYDROGEN IN SOLID OXIDE FUEL CELLS

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Introduction

Hydrogen is acclaimed to be an energy carrier of the future. There are many processes for hydrogen production. Currently it is mainly produced from fossil fuels (petroleum, natural gas, coal) and renewable energy sources (solar, biomass, wind...). In addition, electrolysis and other methods for generating hydrogen from water. However; many methods of producing hydrogen, generate CO_2 and other emisions. One way to produce hydrogen with no emission is to electrolyze water but electrolysis has not been the preffered method because of high electricity costs.

In this study, the electricity required for the electrolysis process is produced by thermoelectric modules using heat of waste gases of solid oxide fuel cell (SOFC) unit. The goal is to point out the using of waste gases' heat and reducing the high hydrogen production costs.

Methods

SOFCs are promising candidates for future energy conversion systems because of their higher electrical energy conversion efficiency. SOFCs operate between temperatures of 700 and 1100^{o}C.

As it is known, SOFCs are electrochemically recombines hydrogen and oxygen delivering heat and electricity efficiently and clearly. Big amount of used hydrogen and oxygen exhausted from SOFC unit with high temperatures (~500 ^{o}C and higher). Results from experiments show that, heat of exhausted gases can be utilized.

Applying temperature gradient to the surface of thermoelectric module, module behaves like a DC power source. The occurred DC power source will provide needed electrical energy to operate the PEM electrolyser in this experimental setup.

The utilization of the waste gases' heat is obtained by using thermoelectric modules. Firstly, waste heat of the gases operates thermoelectric modules. Secondly, thermoelectric modules operates PEM electrolyser and water pump. So, the required hydrogen for SOFC unit is supplied from electrolyser using thermoelectric modules. Produced hydrogen is delivered to SOFC unit.

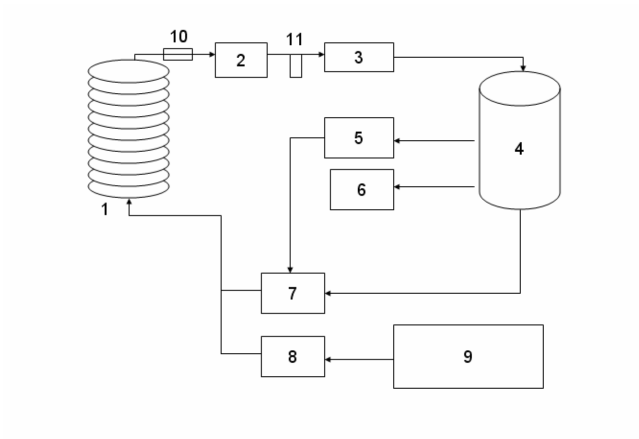

Fig. 1. Experimental setup:
1. SOFC;
2. Hydrogen cooling unit;
3. Peristaltic pump;
4. Waste hydrogen unit;
5. Pressure sensible, differential pressure gradient regulated electromechanic switch sensor;
6. Pressure pointer;
7. Switch off selenoid gas valve;
8. Switch on selenoid gas valve;
9. Hydrogen supplier/producer for SOFC;
10. Thermoelectric modules;
11. Trap.

Hydrogen is under pressure in hydrogen supplier **9,** pass through from switch on gas valve **8** when potential difference is not applied. The heated gas while passing through from SOFC, is reduced at acceptable temperature in hydrogen cooling unit **2**. Exhausted hydrogen from SOFC is reached to waste hydrogen unit **4**, usage of peristaltic pump **3**. Pressure increases because of switch on gas valve **7**. Hydrogen gas pressure obtained from waste hydrogen unit **4,** while tracking with pressure pointer **6,** it is also checked by pressure sensible, differential pressure gradient regulated electromechanic switch sensor **5**. Switch **5**, cuts hydrogen when it reached upper limit of differential pressure gradient and opens **7**, so pressured hydrogen accumulated in waste hydrogen unit is applied to SOFC unit.

When the value of hydrogen accumulated in waste hydrogen unit **4**, is reached lower limit of differential pressure gradient regulated electromechanic switch sensor **5,** sensor 5 switch off selenoid gas valve **7** and again switch on **8.** In this state, SOFC is supplied from hydrogen supplier **9** and also get tendency to refill hydrogen unit **4**.

Results and discussion

System keeps on its cycle automatically. The unstability of hydrogen pressure values in SOFC input because of switching on/off **7** and **8**, cause hysterisis difference on electromagnetic valves. To obtain unstability and reduce mistake to zero, electronic equipments and software included sensitive module can be used.

Conclusions

This method will provide more efficient production of hydrogen and economically reduce the production costs.

In addition, the produced hydrogen is delivered to the SOFC unit again; makes the system economically effective.

References

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