DIRECT METHANOL SOLID OXIDE FUEL CELL

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Introduction

In this study, performance of membrane electrode assembly (MEA) was studied with hydrogen and methanol/water vapor fed directly to the anode. MEA was prepared by using scandia-stablized zirconia (SSZ) electrolyte and NiO-SSZ and Sr-doped lanthanum ferrite (LSF) as anode and cathode material. A three dimensional model of solid oxide fuel cell (SOFC) has been developed and is used to predict the temperature, fuel concentration distribution across the cell. On the other hand we designed special experimental set up for testing MEA performance. The influence of different operation parameters (temperature, fuel concentration, fuel-air flow rate...) to the MEA performance was examined. The results show the maximum power generation from MEA when fed with methanol and hydrogen. The maximum power output of 1.6 W/cm² was obtained at 750°C with pure hydrogen. When methanol was directly used as fuel the maximum power output was 1.2 W/cm² at same temperature.

Results and discussion

The performances of membrane electrode assemblies (MEA) developed at Niğde University were tested by Vestel Co. For these tests a system was designed and built up. The system is shown below (Fig 1). Performance of membrane electrode assembly (MEA) was studied with hydrogen, to have a reference later to compare and methanol/water vapor fed directly to the anode. For MEA performance tests, in the experimental setup influence of different operation parameters (temperature, fuel concentration, fuel-air flow rate...) were examined.

Power density versus current density changes at different temperatures and constant fuel (m_{fuel}=1000ml/min) and air (m_{air}=1500ml/min) flow rate is presented in fig2. Increasing the operation temperature positively affected the performance of MEA if H_2 was used as fuel.

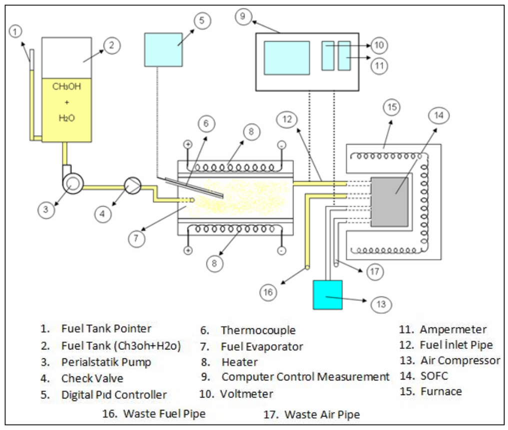

Fig.1. Direct methanol solid oxide fuel cell experimental setup.

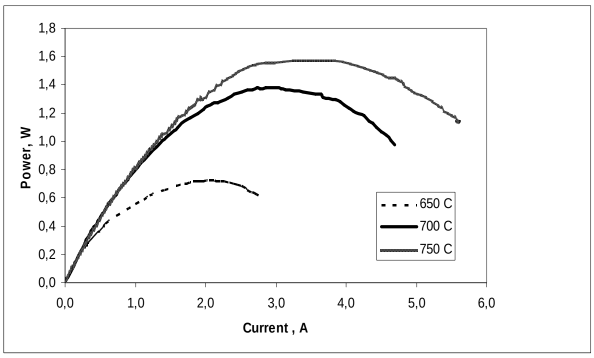

Fig 2. Effect of temperature on performance of MEA (fuel is hyrogen).

The same single cell SOFC was tested with methanol/water (1:1 methanol-water ratio) at different temperature and constant methanol/water (2ml/min) – air (1500ml/min) flow rate. Fig.3 gives the performance of SOFC changes.

Fig.3 shows that SOFC performance is better when temperature is increased. This situation is based on electrochemical reaction rate and kinetics increasing with temperature. However at same test condition, maximum power density output of 1.6 W/cm² was obtained at 750°C with pure hydrogen and 1.2 W/cm² was obtained with direct methanol fed in.

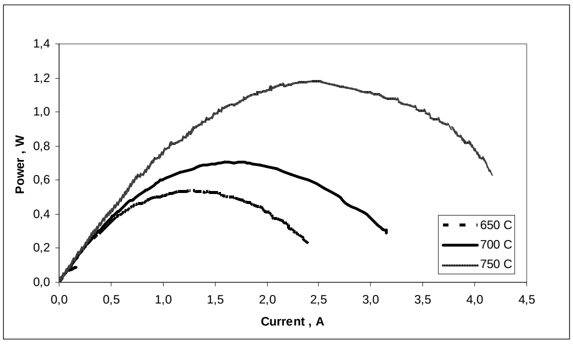

Fig.3. Effect of temperature on performance of MEA (1:1 methanol/water ratio) power density-current density (m_{fuel}=2ml/min, m_{air}=1500ml/min).

Methanol concentration is another parameter which effects SOFC performance. During the tests, it was observed that performance is not affected too much by changing the molarities of methanol. However the performance with methanol was less when compared with tests done by pure hydrogen. The best performance was achieved when 50% methanol-50% water is used. It can be stated that the decrease in performance is due to the fact that the crossover passage of methanol from anode to cathode and the carbon deposition on MEA surface. Deposition of carbon prevents the contact between fuel and the surface so that electrochemical reaction can not occur as expected.

Conclusions

We can conclude that:

1.Increasing the operation temperature has affected the performance of MEA positively either H_2 or methanol was used fuel.

2.At 750^{o}C and the same test conditions, maximum power density output of 1.6 W/cm² was obtained with pure hydrogen and 1.2 W/cm² was obtained when direct methanol was used as fuel.

3.During the tests, it was observed that performance is not affected too much by changing the molarities of methanol.

4.The performance with methanol was less when compared with tests done by pure hydrogen.

References

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