Analyses of Characteristics and Efficiency of Fuel Cell

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Abstract – **The basic principles of operation of a proton exchange membrane fuel cell (PEMFC) are presented. Practical experiments with PEMFC are made. Current – voltage characteristicin electrolyses, voltage, current and power characteristics of PEMFC are given. The efficiencies at different operating modes are determined and presented. Final conclusion about characteristics and efficiency of PEMFC are derived.**

Keywords– **Fuel Cell, Proton Exchange Membrane.**

I. INTRODUCTION

Renewable energy is one of the most important and prominentsourcesfor energy generation. Hydrogen fuel cells (FC) are a new and interesting concept of an alternative energy source [1]. Different types fuel cells are used for energy generation. In the last few years the Proton Exchange Membrane (PEM) fuel cells are one of the leadersin the field of fuel cells. In this paper the analysis of characteristics of the PEM fuel cell ispresented. The main characteristics are [2]:

- The electrolyze characteristic;
- The current, voltage and power characteristics on FC;
- The characteristics in different load modes.

PEM fuel cells are efficient in transportation, communication and general power supplies. Fuel cellsrun on hydrogen and oxygen and produce water as a byproduct of the energy conversion. They are simpleand have no moving parts; can be used in stack installation to increase power load of the wholesystem.

II. ANALYSES AND CHARACTERISTICS OF PEM FUEL CELL

Theanalyses and characteristics are made usingProton Exchange Membrane Fuel Cell of Horizon Company. The active area of fuel cell is 10 cm^2 [3].

A. The electrolyser

The first analysis is to determine the current and voltage relationship in electrolyses mode as well as the minimum voltage of the electrolyses of water [4]. The experimental data is given in Table 1. The current - voltage characteristic is shown on fig 1.

TABLE I
EXPERIMENTAL DATA DURING ELECTROLYSIS

V [V]	I [A]
1,4	0,025
1,5	0,03
1,6	0,075
1,7	0,12
1,8	0,15
1,9	0,19
2	0,22
2,1	0,26
2,2	0,29
2,3	0,33
2,4	0,38
2,5	0,42
2,6	0,47
2,7	0,52
2,8	0,57
2,9	0,61
3	0,65

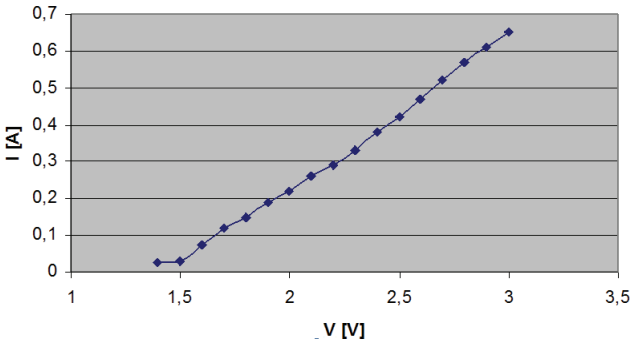

Fig.1. Current - voltage characteristicin electrolyzes

The minimum voltage of the electrolyses of water is 1,4 V.

B. The characteristics curves of the hydrogen PEM fuel cell

The secondanalysis is to determine the current, voltage and powercharacteristics of the hydrogen fuel cell. The experimental data are given in Table 2.

TABLE II
EXPERIMENTAL DATA OF VOLTAGE AND POWER

R [ohm]	V [V]	I [A]	P [W]
200	1,2	0,02	0,024
150	1,05	0,03	0,0315
100	1,0	0,04	0,04
50	0,95	0,05	0,0475
20	0,9	0,06	0,054
10	0,85	0,07	0,0595
5	0,8	0,1	0,08
2	0,75	0,25	0,175
1	0,7	0,35	0,245
0,5	0,65	0,40	0,280

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The voltage - current characteristic is shown on fig 2.

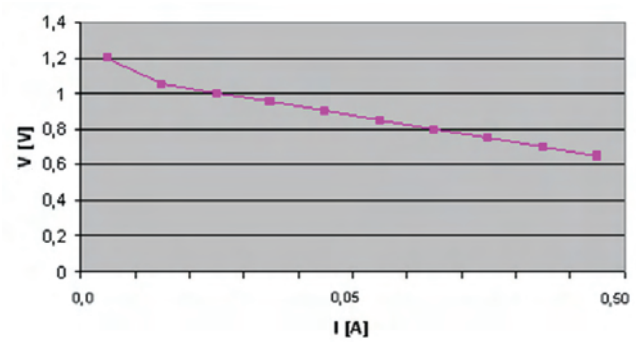

Fig.2. Voltage - current characteristic

The working voltage is around 0.9 V. The working current is up to 400 mA.

The power characteristic is shown on fig 3.

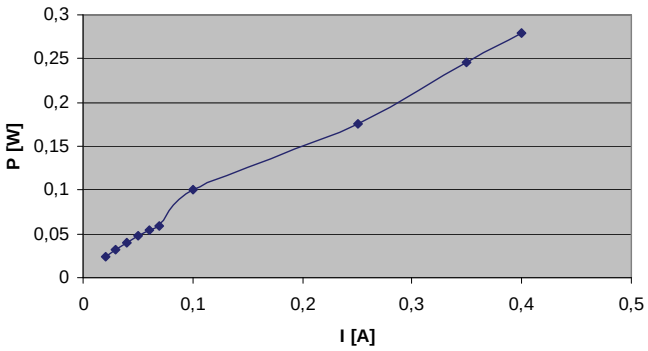

Fig.3. Power– current characteristic

The working power is around 0.25 W.

C. The load characteristics

The loadanalysis determines the operation time of the Horizon hydrogen fuel cell car [3] in different loads. The hydrogen fuel cell is electrolyzing for 30 seconds. The experiments are made in four different load modes on the car. The experimental data is given in Table 3.

TABLE III
EXPERIMENTAL DATA OF VOLTAGE AND POWER

Load [kg]	Time [s]	Curve
0,220	125	1
0,440	65	2
0,880	40	3

The load characteristics are shown on fig 4.

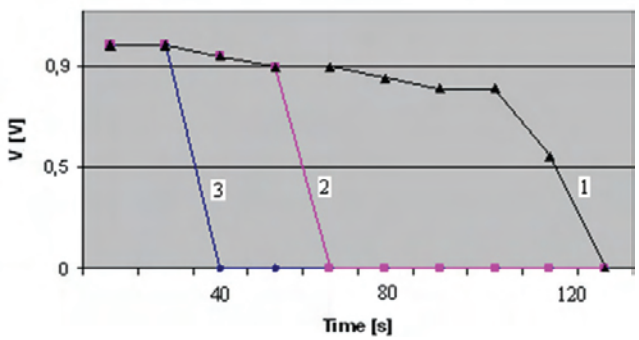

Fig.4.The load characteristics

Increasing onthe load causesthe operation time to decreasein progression.

III. CONCLUSION

The paper shows the main features and important characteristics of a Proton Exchange Membrane Fuel Cell. This study illustrates a big potential of one small fuel cell for energy generation.The minimum voltage of the electrolyses of water is obtained. The working voltages, current and power are shown. The load analyses of hydrogen fuel cell car are presented. The working time in different load modes is given. We concluded that the fuel cell system is effective for driving car and can be alternative of battery power supply. In the future work, we purposed,using stack fuel cells to increased power factor of the system.

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