고분자 전해질 연료전지를 이용한 Laptop Computer용 전원 공급 장치

Fuel Cell for the Energy Supply of Laptop Computers

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1. Introduction

Electronic products in the low power range feature a two-digit growth rate and an enormous gain of new product classes, often called "smart appliances". Portable electronic products are dominated by cellular phones, computers, camcorders and cordless tools (4C-market).

Today these operating systems are powered by primary and rechargeable batteries. Primary batteries are available with a very high power density, but the costs per generated Wh are markedly high. Secondary batteries show often an insufficient cycles stability, small capacities, memory effects and self-discharge.

Due to high electrical efficiency and emission-free energy converting fuel cells are considered to be a future technology for power supply. The fuel cell as energy converter in combination with an independently dimensioned storage as energy source offers particular advantages, when relative low power demands are required for long time. Because of the separation of power converter and power source, flexible possibilities for system modulation and system integration are given.

Developed PEMFC system has a fuel cell stack, a DC-DC converter with control unit, hydrogen storage and all necessary accessories which are combined to one power pack, fitted in the battery housing of an existing lap-top model.

2. System characterization

After the completion of the fuel cell stack, tests were made to characterize the system. Tests of both stack alone and stack integrated in the lap-top system were performed.

2.1 Stack operation

The characteristics of the whole stack shows that a maximum power of over 50W is achievable. At single cell voltages of about 0.5V, the highest output is over twice the targeted value. This is not a suitable operating voltage, as the losses are very high. These losses turn into heat, and will over time dry out the membranes in the stack. A more fuel effective each cell voltage would be around 0.7V.

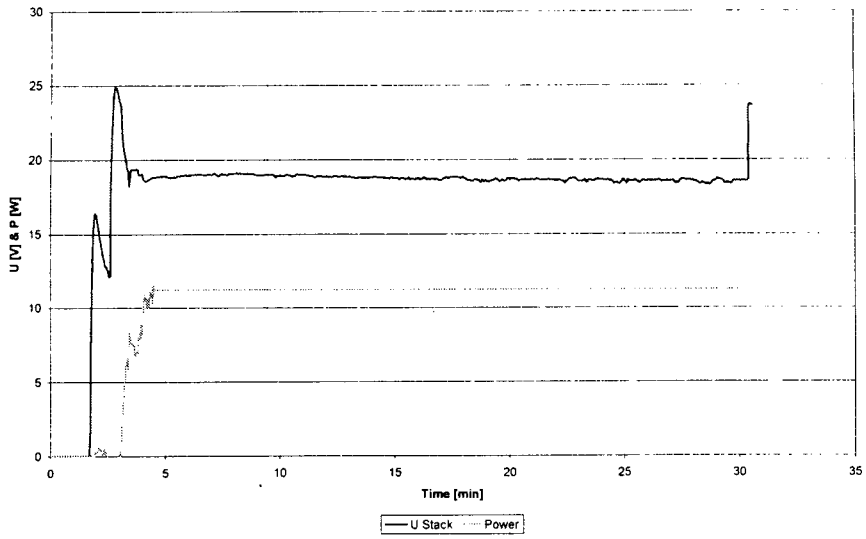

Fig 1. Stack operation at nominal power output

3.2 Heat transport

During the operation of the fuel cell system, a thermal camera was used to investigate the heat evolved from the stack. By this way the cooling principle with thermal contact between the hot stack and the cold metal hydride cartridges was made visible. The left photos show the system without cooling, and the right photos show the system with the cooling hydrogen cartridges connected.

By comparing the two photo series, it is obvious that the housing is being cooled by the metal hydride cartridges. The dark color on the right part of the housing shows that the temperature there is low. This is due to the endothermic mechanism of hydrogen release from the metal hydrides. During the first 15 minutes, the difference between the two systems are negligible. It is first on the photo after 20 minutes the cooling has an effect. The "hot area" is no longer expanding further, but is "blocked" after the last fan. From now on, it seems like that the housing doesn't get warmer. The temperature difference on the left end wall of the housing is not large. This wall is directly thermally connected to the stack, and gives a very good idea on the cell temperature. A sufficient cooling system is not yet implemented, but it is shown that some of the heat evolved can be removed or re-directed. A better connection or arrangement of the stack and hydrogen cartridges can exploit the potential in the cooling principle better.

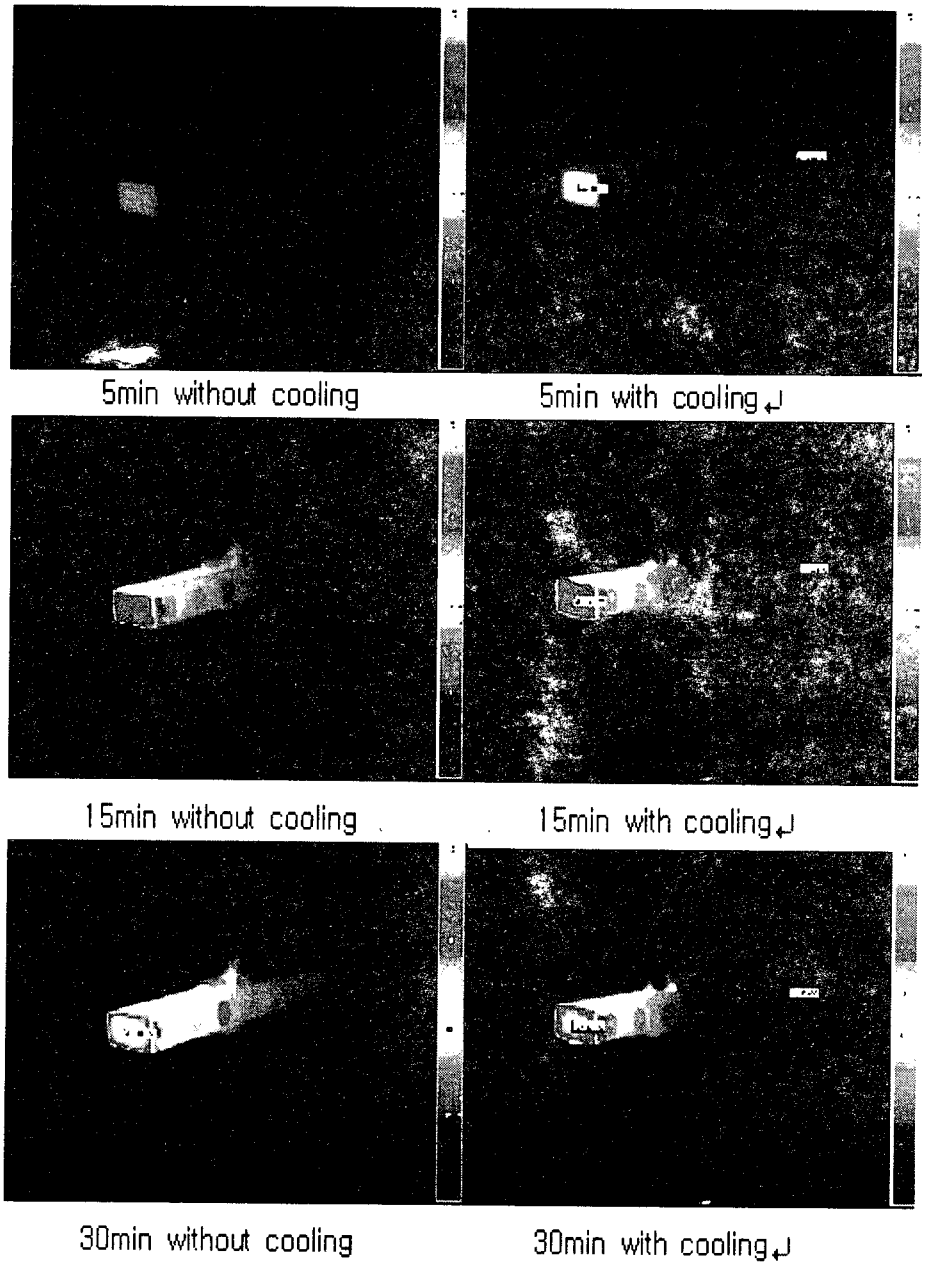

Fig 2. Heat transport principle without cooling and with cooling.

2.3 Laptop operation

It was also performed tests with the fuel cell system operating the lap-top. Temperature and stack voltage is shown in figure 3 during start up and standby mode of the lap-top. The stack runs very stable at around 19 V. As expected, the temperature rises, but it stabilizes below 50°C.

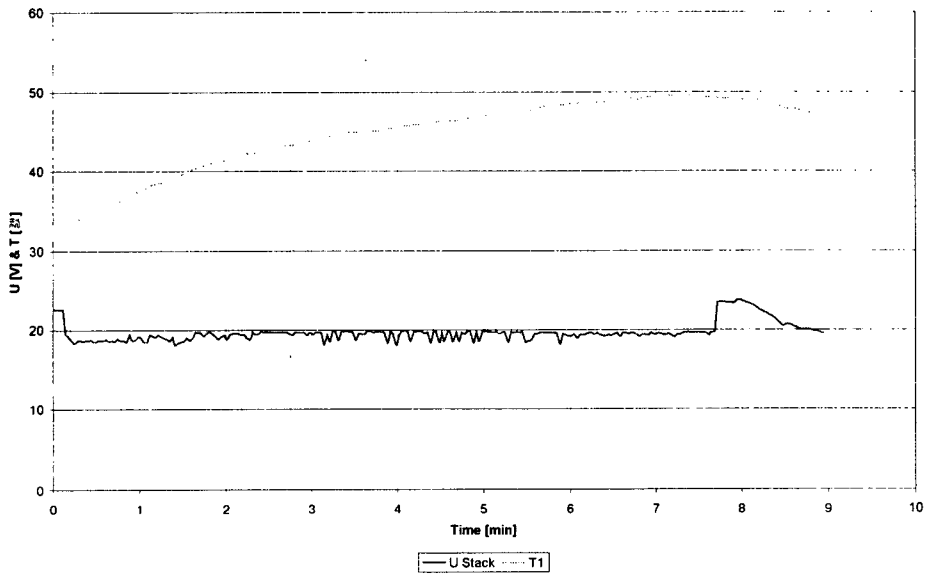

Fig 3. Laptop operation

3. Summary

The lap-top with a integrated fuel cell system presented here proves that these solutions have a great potential. Though, there are things that have to be improved before they are introduced to the marked. In this system, heat and water management as well as dead end operation are critical issues which must be directly addressed in further research. Both modified stack design and other new cooling techniques are possible ways to continue the work.