Name of research institute or organization:

Test Centre, armasuisse S+T,
Federal Department of Defence, Civil Protection and Sport DDPS

Title of project:

Performance of Methanol Fuel Cells in Alpine Environments

Project leader and team:

Dr. Ronny Lorenzo, project leader
Markus Tanner,
Mario Clausen

Project description:

The long-term use of scientific measurement or monitoring equipment on remote alpine sites is often confined to the vicinity of permanent installations or to available mobile energy sources. While combinations of solar panels and rechargeable batteries are readily available, their power output is limited by the surface area of the solar panels (larger battery packs provide more energy but need a large array of solar panels to be recharged within a reasonable amount of time). Additionally, during prolonged periods of unfavourable weather, the solar panels may not be able to compensate the energy needs of the equipment resulting in prematurely drained batteries.

Methanol based fuel cells are not only small and safe to handle but also provide a fair amount of energy. Teaming fuel cells with solar panels and batteries, therefore, seems to be a sensible approach to a fail-safe power supply for unattended measuring campaigns in remote areas. However, available commercial fuel cells are not built for alpine environments where they have to cope with bad weather, temperatures below freezing, low atmospheric pressure and very dry air.

Figure 1. Methanol Fuel Cell in its weatherproof aluminium box with the attached auxiliary solar panel on the lower platform of the Sphinx observatory during the winter trials.

Two 5-day test runs with a military grade methanol-based fuel cell with a nominal power output of 130W in a weatherproofed aluminium box were carried out on the High Alpine

Research Station Jungfraujoch, in May and in December 2016. The fuel cell in its housing was placed on the lower platform of the Sphinx observatory. A 60W light bulb was used as electrical load to drain the battery and force the fuel cell to recharge. Every 15 minutes a set of 36 operational parameters from the fuel cell was logged.

During both campaigns the fuel cell performed according to specifications.

Due to the adverse weather conditions during the May campaign, the (new) solar panel mostly served as decoration only. This, of course, is not entirely true. Even with faint sunlight the panel, with a nominal power output of 85 W, was able to produce about as much power as the 20 year old one used in the 2015 trials did with considerably more sunshine.

To put the solar panel through its paces, additional performance tests during summertime on moderate altitudes (500 m.a.s.l.) were conducted. While the panel performed according to specifications during peak solar exposure, it surpassed the expectations in moderate and low light conditions. The weatherproofed box for the fuel cell on the other hand, had still issues with regulating inside temperatures. Consequently, further tweaks to the exhaust system were made.

The December campaign on the Jungfraujoch took place in perfect conditions: Five days of unspoiled sunshine with temperatures constantly below freezing. Interestingly, the fuel cell had to produce almost the same amount of energy (4100 Wh) as it did during the cloudy May campaign (4250 Wh). Although some of the energy is used by the fuel cell to prevent the stack from freezing, which is only necessary if the fuel cell is idle for prolonged periods of time, it still doesn't explain what happened to the additional energy produced by the solar panel due to perfect weather conditions. Preliminary analysis of the phenomenon hints towards a faulty charge controller, directing at least part of the energy from the solar panel towards the fuel cell instead of the batteries. Further laboratory experiments to pinpoint the culprit are scheduled for early 2017.

The campaigns at the High Alpine Research Station Jungfraujoch showed that commercially available fuel cells are capable of performing according to specifications even at high altitudes. The stand-alone solution which was the centre point of this year's tests proved to be perfectly suited for continuous unattended operation in alpine environments. With the addition of a solar panel operating time on one tank of methanol (10 ℓ) could almost be doubled.

For the follow-up campaigns in 2017 the internal design of the weatherproofed box will be finalised and the interplay of the components further optimised. Additionally, the problems with the charge controller will be fixed and the applied solutions verified.

Key words:

Methanol Fuel Cell

Collaborating partners/networks:

SFC Energy AG, Eugen-Sänger-Ring 7, D-85649 Brunnthal

Address:

armasuisse S+T
Test Centre
Feuerwerkerstrasse 39
CH-3602 Thun

Contacts:

Dr. Ronny Lorenzo
Tel.: +41 58 468 2753
e-mail: ronny.lorenzo@ar.admin.ch