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:

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Project description:

The long-term use of scientific measurement or monitoring equipment at 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 new weatherproof aluminium box on the lower platform of the Sphinx observatory during the winter trials.

At the High Alpine Research Station Jungfraujoch, two 5-day test runs with a military grade methanol-based fuel cell in a redesigned weatherproofed aluminium box were taking place, one in May and one in December 2014. The fuel cell in its new housing was placed on the lower platform of the Sphinx observatory. The improved fuel cell used is now capable of a continuous power output of 125W at altitudes below 1500 m.a.s.l. (previous model: 90W). 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.

The May campaign was the maiden voyage of the completely redesigned weatherproof aluminium box. In fact, hardly had the box been finished when it was shipped to the research station. Admittedly, the complete absence of basic testing prior to the experiments backfired slightly. The thermal management was greatly improved with the new box and the fuel cell was operating within normal parameters, no matter how the meteorological conditions were. However, concerning handling characteristics, the new box had to be considered a step backwards. Filling the stack's methanol reservoir required the fuel cell to be removed from the box. Even though this only has to be done for the initial start of the system, this is only an option if the weather is favourable. In heavy snowfall this would not be an advisable thing to do.

Operating the fuel cell system at moderate altitudes (500 m.a.s.l.) during summertime revealed another design flaw. Weatherproofing the aluminium box was paramount for the project. Therefore cutting holes in the top part of the box is bad advice. As a matter of fact, hot air was trapped inside the top part of the box, resulting in overheating the fuel cell at outside temperatures of +25°C and above.

To improve the handling characteristics, the components of the system were rearranged inside the aluminium box prior to the December campaign. In addition, the vents were enlarged and a second fan was installed to enhance the air circulation inside the box. The changes made proved to be beneficial to the overall performance and handling of the system.

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 has been the centre point of this year's tests proved to be perfectly suited for continuous unattended operation in alpine environments.

For the follow-up campaigns in 2015 the weatherproofed box used will be adapted to allow operation in moderate climates as well as in high alpine environments. Additionally, the integration of solar panels into the system will be realised.

Key words:

Methanol Fuel Cell

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