

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 on remote alpine sites is often limited 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 small and safe to handle and 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 on the lower platform of the Sphinx observatory during the spring trials.

In 2013 two 5 day test runs with two methanol-based fuel cells each were taking place at the High Alpine Research Station Jungfrauoch, one in May and one in December. A military

grade fuel cell without weatherproofing was placed in the cavern behind the research station and an industrial grade fuel cell in a stand-alone weatherproofed aluminium box was placed on the lower platform of the Sphinx observatory. Both fuel cell systems are fitted with the same stack and provide a permanent power output of 90W at altitudes below 1500 m.a.s.l. A 60W light bulb was used as electrical load on each system to drain the batteries and force the fuel cells to recharge. Every 15 minutes a set of 36 operational parameters from each fuel cell was logged.

During both campaigns the fuel cell in the cavern behind the research station performed according to specifications, the one at the Sphinx observatory not quite.

In the May campaign outside temperatures varied between -10°C during the night and +15°C around noon. The weather stayed fine during the whole campaign but the fuel cell at the Sphinx was covered by 30 cm of snow within the first 12 h of operation, which helped keeping temperatures within the box low. Nevertheless, stack temperatures stayed close to and above the shut down temperature of 55°C. Operating the fuel cell close to the threshold causes the stack to dry up, resulting in a complete shut down of the system and in the need for manually filling methanol directly into the stack's reservoir.

In the December campaign outside temperatures stayed between -20°C and -5°C, the skies stayed clear and the air was very dry (<10% RH). Nevertheless, the fuel cell at the Sphinx observatory constantly overheated and ran dry. Continuous operation was only possible with the lid of the box wide open. Since the box needed to be closed during the night for safety reasons, the light bulb was disconnected for the night and the fuel cell automatically switched into the freeze protection mode.

The campaigns at the High Alpine Research Station Jungfrauoch showed, that commercially available fuel cells are capable of performing according to specifications even at high altitudes. Available stand-alone solutions, however, still cannot be used for continuous unattended operation in alpine environments. According to the data collected during the campaigns, this is due to the poor thermal management of the weatherproofed cases, which were designed for operation at sea level and which cannot cope with the thin and dry air at high altitudes.

For the follow-up campaigns in 2014 the weatherproofed box used will be completely redesigned and fitted with an improved version of the military grade fuel cell (capable of providing a continuous power output of 120 W).

Key words:

Methanol Fuel Cell

Collaborating partners/networks:

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