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Demonstration of a Fuel Cell Powered Boat

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A 1.2 kW fuel cell power system (Nexa by Ballard) was used to power a small boat equipped with a 600 W electric outboard motor (M26 E-Drive by Yamaha). A DC/DC converter/voltage regulator was used to match the voltage of the motor (12 V). Two 12 V 65 Ah batteries were incorporated in the system in parallel in order to provide 24 V required for the Nexa system start-up, but they also provided additional energy. Hydrogen was stored in 3 metal hydride bottles; each 2.6 liter bottle contained up to 600 standard liters of hydrogen at 10-14 bars. Figure 1 shows the configuration of the boat propulsion system.

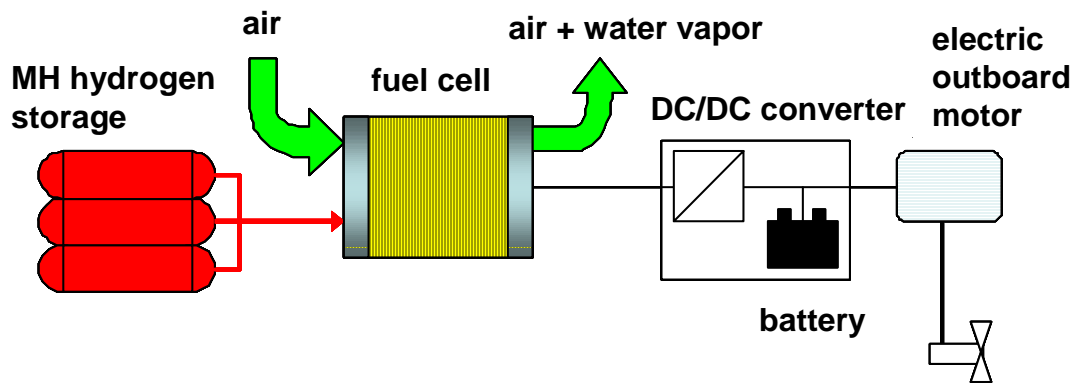


Figure 1: Configuration of the boat propulsion system.

This configuration was able to run the boat at the speed of 4 knots for more than 5 hours (3 hours of running time coming from stored hydrogen and 2 hours from the batteries). Figure 2 shows the boat with installed equipment under the prow compartment. The advantages of electric propulsion are reliable, clean and quiet operation, and excellent maneuvering capabilities at very low speeds. Fuel cell adds additional operability of the system essentially as a range extender. By separating power from energy it would be easy to further extend the range of the boat by simply adding additional bottles.

During operation the temperature of the metal hydride bottles dropped significantly below the ambient temperature, reducing the immediate availability of hydrogen. Additional tests were performed in the laboratory in order to quantify this phenomenon and to provide inputs for more optimized system design. The results of both the field test and the laboratory tests will be presented.



Figure 2: Completed fuel cell powered boat.

Small boats may be an interesting niche market for the fuel cell systems. Clean and quiet operation has its price some may be willing to pay. This is particularly appealing for use in national parks, but also in every isolated tourist destination as quietness and clean air are a part of the vacation purpose. In addition, hydrogen can easily be produced locally from water electrolysis, which may be additional selling point for use in remote areas where fuel supply is not always easy.

This project is a part of a wider initiative called the Hydrogen Islands Initiative, launched by the UNIDO-International Centre for Hydrogen Energy Technologies. Islands are ideal polygons for demonstration of hydrogen energy technologies and entire hydrogen economy at a manageable scale. Because of their remoteness and isolation, energy solutions for the islands differ from those on the mainland. The choice of conventional energies on the islands is often limited and their cost may be several times higher than on the mainland. At the same time, most islands do not have energy intense activities, have historically learned how to conserve energy, and most importantly have plenty of clean renewable energy available, such as solar, wind, geothermal, waves, tides, ocean current, and ocean thermal gradient. These sources may be used to generate electricity and hydrogen, which then can satisfy all the energy needs of the islands communities. There are hundreds of islands where hydrogen inclusive economy would be not only technically but also economically feasible, even today.

The Hydrogen Islands Initiative strives to establish clean hydrogen energy systems on the world islands in order to solve the existing energy problems and at the same time preserve

their pristine environment, and in such manner provide energy basis for sustainable development. With hydrogen energy systems based on renewable energy sources, the worldwide islands will become energy self sufficient, and serve as the showcase for development of the global hydrogen energy system. This initiative practically creates an early market for hydrogen technologies (technologies for hydrogen production, storage and use) and their demonstration in real-life applications.