Research in the Spotlight

Aiming at Non-Fossil-Fuel Railways: Development of Fuel Cell-Powered Trains

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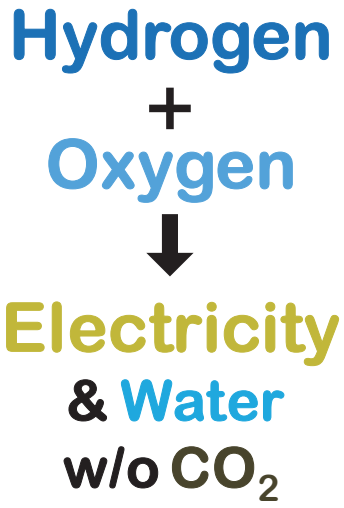
In our interview, Dr. Hitoshi Hasegawa, the head of the Hydrogen and Sustainable Energy Laboratory at RTRI and engaged in the development of railway vehicles powered by fuel cells, told us about the background of the development, the results achieved up to now, and the prospects for the future.

Why did you start the research on fuel cell-powered vehicles?

Non-electrified sections account for approximately 40% of the railway line extensions in Japan. On these lines and in many parts of the world, diesel-powered vehicle operations are common. Diesel vehicles use a fossil fuel of course and have a number of issues, primarily: carbon dioxide is emitted from the vehicles; vehicle vibration and noise are greater than those of electric trains; and maintenance takes a lot of labor and time. Moreover, in order to operate continuously between electrified and non-electrified sections, diesel vehicles are running even in the electrified sections. This current status quo can be improved by running electric trains even in the non-electrified sections. This would reduce global environmental burdens, diversify fuels, reduce vibration and noise, and enhance vehicle maintainability. As an option for the application of electric trains to non-electrified sections, battery-powered trains have already started practical commercial operation. However, we thought that the real target we should go after was the development of fuel cell-powered trains in order to extend the running distance compared to batteries. That was the reason why we started the development of the fuel cell-powered trains in 2000.

Demonstration run of fuel cell-powered train (in 2000)

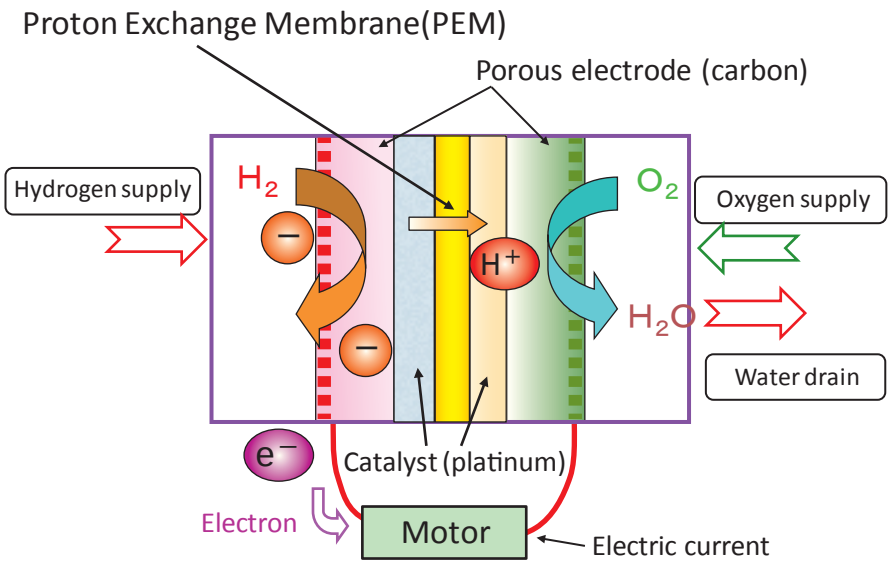


Please tell us the results that you have achieved up to now.

We conducted the world's first manned demonstration run of a train using a proton exchange membrane fuel cell on a garden railway. Then in 2006, we performed a running test and a bench test on a full-scale railway vehicle loaded with a proton exchange membrane fuel cell (produced by

Filling up the tank on the RTRI's full-scale prototype vehicle with hydrogen

Test run of full-scale prototype vehicle (in 2006)



How a fuel cell works

Prototype of liquefied hydrogen storage container (in 2012)

Nuvera, gross output 150 kW) and a carbon fiber reinforced plastic composite, high-pressure gas storage cylinder (produced by Dynetek Industries; 35 MPa, 210 m^3 at standard temperature and pressure, i.e. 0°C and 1.0 bar), prior to anyone else in the world. The test vehicle was then replaced by a prototype train with a fuel cell / lithium ion battery hybrid system, which was used for the measurement of energy consumption and operated for durability verification where degradation characteristics for as long as 10 years were documented. At WCRR 2016 in May 2016, one of our researchers reported the result of this durability test. Furthermore, in 2012 as a part of the study of a method for installing dense hydrogen, we produced an experimental liquefied hydrogen storage container and performed a test to measure the latent heat of vaporization at the fixed position, where the boil-off characteristics were determined.

Concerning the development of fuel cell-powered trains, could you tell us your prospects for the future?

In Japan, hydrogen fuel cell vehicles are available in the market, and hydrogen stations are under construction nationwide. Thus utilization of hydrogen energy to moving vehicles is making steady progress. Railways are not an exception and there are high expectations for the practical application of hydrogen fuel cells to provide power to trains. RTRI is planning to continuously advance the technical development towards practical use.