Activities of the Japan Gas Association in the National Projects for Fuel Cell and Hydrogen Society

By
Yasuharu Kawabata, Hideyuki Kishi, Tatsuro Yasumatsu, Kazuhiro Matsumoto, Kouzou Kurahashi and Ryoichi Nishida

Fuel Cell and Hydrogen Project Group, R&D Department, the Japan Gas Association

1. Introduction

Stationary fuel cell cogeneration systems provide an effective means for promoting energy conservation and reducing CO_2 emissions. Therefore, expectations have grown concerning the market penetration of these systems in recent years. With such expectations in the background, fuel cells have begun to penetrate the market steadily: the first commercial units of polymer electrolyte fuel cell (PEFC) system were installed at the new official residence of the prime minister in April of 2005. And around the same time, a large-scale demonstration test project started for stationary fuel cell systems. Expectations are also growing concerning the future market release of solid oxide fuel cell (SOFC) systems, with the first residential testing in Japan of such a system conducted in November 2005.

Under the contract to the New Energy and Industrial Technology Development Organization (NEDO), the Japan Gas Association (JGA), together with the Japan Gas Appliances Inspection Association (JIA) and the Japan Electrical Manufacturers' Association (JEMA), is conducting a five-year national project that began in 2005. In this project, known as the "Project for the Development of a Hydrogen-based Society: Research and Development for the Re-examination and Standardization of Regulations concerning Stationary Fuel Cell Systems," we are re-examining the regulations and standardization of test methods, to prepare the conditions necessary for the successful introduction and penetration into the market of stationary fuel cell systems, including the next generation of fuel cells, such as SOFC systems.

In addition, the "Project for Safety Research on the Hydrogen Supply Systems" is being conducted by Japan's Ministry of Economy, Trade and Industry (METI) for the three years up to fiscal 2007. This national project is conducting research that contributes to the development of technical standards concerning the safety of hydrogen supply systems for the hydrogen-energy-based society of the future. JGA

carried out the project on behalf of METI in fiscal 2005 and has been actively involved in investigations concerning a hydrogen-based society.

This paper provides general descriptions of these two projects undertaken by JGA in an effort toward the substantial market penetration of stationary fuel cell systems and the realization of a hydrogen-based society of the future. It also reports on the work conducted so far and their associated outcomes and describes plans for the future.

2. Project for the Development of a Hydrogen-based Society: General Description

While focusing on small stationary fuel cell systems, including the stationary-type small PEFC systems with the electrical output power of less than 10kW covered by the Millennium Project and other projects in the past, as well as the next generation fuel cells such as the stationary-type small SOFC systems and the stationary-type pure-hydrogen-driven fuel cells (pure hydrogen PEFC systems), this particular project pursues the following: the establishment of evaluation methods for testing safety, reliability and so on; the simplification of systems and the removal of surplus safety devices for reducing the cost; and the collection of data pertaining to the standardization by domestic and international standards such as JIS and IEC.

3. Project for the Development of a Hydrogen-based Society: Outcomes of Past Activities and Plan for the Future

3.1 Small Stationary PEFC Systems

To reduce the cost of PEFC systems – our major concern – we have been collecting data that can be used for the further deregulations. More specifically, our concern relates to the safety of appliances after we remove the overpressure prevention device and/or the flammable gas detection device currently required by the regulations. In this connection we have been studying test methods and collecting data, as activities useful for the re-examination of regulations.

Figure 1 shows an example of data we collected in fiscal 2005 concerning the safety of appliances with the overpressure prevention device removed. The data concerns small stationary PEFC systems, and show the fuel-gas-line pressure in the system and the temperature in the reformer, measured when a control system error occurred while the system was operating at the rated electric output. It is thought that the rated operation condition brings the highest pressure in the gas line of the system.

In this example, an error of a control system that occurred when the system was operating at the rated electrical output caused the maximum fuel-gas-line pressure in the system outlet valve to close, temporarily raising the pressure within the closed gas line. When this happened the maximum pressure still remained below 0.1MPa, achieving compliance with the current regulation. With such a system, the level of safety required by the current regulation can be maintained without installing the overpressure prevention device, which means these kinds of systems can remove the device and reduce the cost.

As a result of such test data and outcomes from the project having been referred to extensively in reviews conducted by an official committee for the re-examination of regulations, it is expected that small stationary PEFC systems will be allowed without the overpressure prevention device, provided that the system meets a certain set of requirements. The tasks we plan to carry out in the future include the following: investigations concerning the possibility of removing the flammable gas detection device (adoption of an alternative method for the detection of flammable gas); investigations concerning the standard test methods for evaluating the durability of systems and of the cold-resistance of the models designed for cold climate region; and investigations concerning the issues associated with grid interconnection.

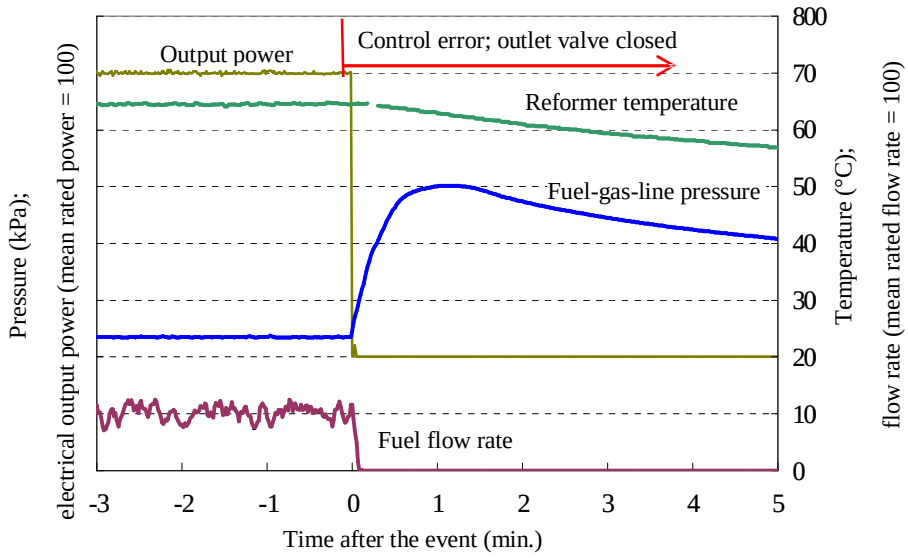

Figure 1 Verification of the safety of a system without the overpressure prevention device (example of test data)

3.2 Next-generation Fuel Cell Systems

(1) Small Stationary SOFC systems

As a result of JGA's activities, a regulation concerning the need for constant monitoring is expected to be revised as early as the first half of fiscal 2006 for the stationary SOFC systems with an operating pressure of less than 0.1MPa. However, as the case of previous small stationary PEFC systems, the small stationary SOFC systems with an output in the range of less than 10kW are still subject to strict regulations that are applied to larger fuel cell systems with the output over 10kW. This regulations prevent easy installation of smaller systems to the residential & small commercial use.

This project therefore aims to deregulate the small SOFC systems to the level already accepted in the case of small PEFC systems, in preparation of their market release and successful penetration. More specifically, to contribute to the discussions about the following five revisions concerning the Electricity Utility Industry Law and the Fire Services Act, we are collecting safety verification data, the examination and standardization of the test methods for safety evaluation and the standardization of:

a) To regard simple-installable generator (Electrical Utilities Industry Act)
b) Omission of inert gas purging (Electrical Utilities Industry Act)
c) To deregulate the requirement of installation report to the local fire department (Fire Services Act)
d) To deregulate installation distance requirement (Fire Services Act)
e) To deregulate the requirement to furnish a backfire prevention device (Fire Services Act)

At official committee meetings held in fiscal 2005, issues concerning the safety of SOFC systems were summarized with a view to the differences between these and PEFC systems. This process brought focus on the following two issues, about which the safety verification data from our project was required:

A. Since the temperature of the cell stack can be as high as 700 to 1000°C, the temperature inside the system, the temperature on the package surface, and the exhaust temperature can be quite high.

B. Since the reforming is done internally and CO removal is not necessary, the exhaust may potentially contain CO emission.

In order to adequately address these issues, the project involved the collection of data pertaining to the safety of SOFC systems, so that it will be used in discussions at official committee meetings. As an example of such data, Figure 2 shows the safety verification data that can be used in the discussions concerning the possible revision of the minimum distance to the wall as an installation requirement, together with a photograph showing how we collected such data. This data is particularly useful for the verification of safety concerning the first of the two issues mentioned above (i.e., issue A). There are several kinds of difference in SOFC and PEFC systems concerning temperature. In SOFC systems, high temperature part is the cell stack. On the other hand, that kind of part in the system is the burner unit of the fuel reformer in PEFC systems. The methods and characteristics of excess heat utilization and removal are also different. In spite of these differences, as shown in the figure, it is clear that there is little difference between two systems in terms of the package surface temperature and the exhaust temperature because the cell stack is usually covered by a heat insulating material and the excess heat from the cell stack is effectively utilized for reforming and heating.

These test results indicate that PEFC and SOFC do not differ substantially in terms of the temperatures of the package surface, flammable objects nearby, and exhaust gas, concerning the risk lies for injury caused by burns and for nearby objects catching fire. We plan to continue collecting various data about SOFC systems to contribute to the re-examination of regulations and the standardization of test methods.

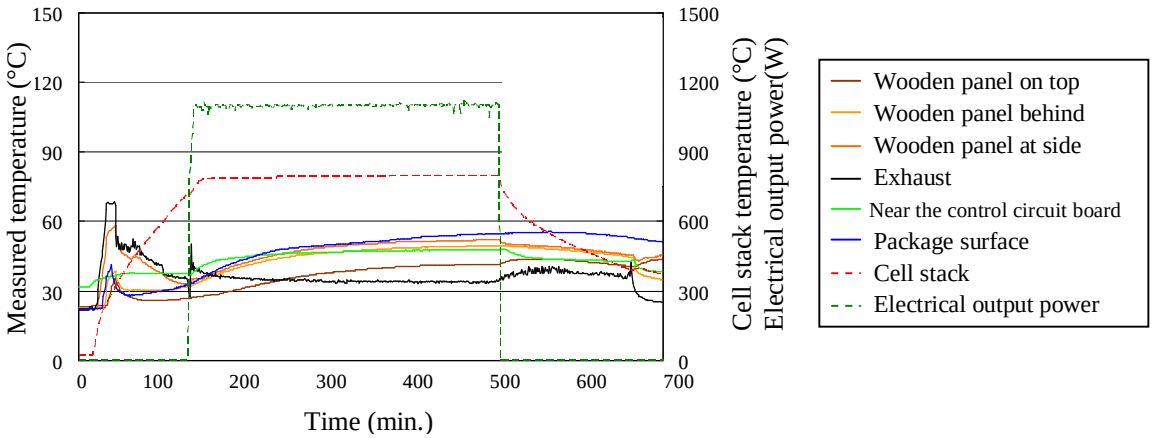

Figure 2 Verification of the safety of a small stationary SOFC system (with 10mm distances to the surrounding wooden panels)

(2) Pure hydrogen PEFC systems

With the Millennium Stationary Fuel Cell Project, we already achieved the revision of the related regulations in the Electrical Utilities Industry Act concerning the pure hydrogen PEFC systems. However, the regulations by the Fire Services Act (on account of the points ③, ④ and ⑤ mentioned above) still remain. To facilitate the re-examination of these regulations by the Fire Services Act, we plan to clarify the safety requirements for the pure hydrogen PEFC systems in the context of fire prevention and collect data pertaining to their safety.

3.3 Project for Researches on the Safety of Hydrogen Supply Systems

In fiscal 2005, we studied scenarios concerning the introduction of hydrogen supply systems in order to identify pipelines for technical survey. In addition, as part of investigations into the possible specifications of newly-constructed hydrogen pipelines, we conducted evaluation tests for identifying the possibility of hydrogen affecting the mechanical properties of metal piping materials, performed field surveys, and researched technical papers, standards, and criteria of hydrogen pipelines used in the US and Europe.

4. Conclusion

Stationary Fuel cell systems have arrived at the stage of being introduced to the market, thus marking the first step toward a hydrogen-based society. JGA aspires to further contribute toward early popularization of fuel cell systems through the undertaking of national projects and in other ways.

Source: “City Gas Symposium” handouts