The development of fuel cell system for mass production vehicle

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1. Introduction

The use of electricity and hydrogen is regarded as a promising way of helping to resolve environmental and energy related issues. The topic of this article is new fuel cell system for actual production vehicle. In particular, this article describes the developmental approaches taken to reduce cost, which is one of the largest obstacles to the widespread acceptance of fuel cell technology.

2. Outline of Development

Figure 1 shows system components. The reasons that FC system is expensive are a special material and a complicated system.

We reduced the consumption of the special material by achieving the high performance of the FC units.

The conventional cell field structure in FC stacks generally use straight channels. This structure is susceptible to water accumulation underneath the flow field ribs that contact the electrode, which adversely affects oxygen diffusion and causes non-uniform power generation. To increase the current density and ensure voltage stability of new stack, an innovative three dimensional (3D) air flow was developed (Figure 2). In addition the innovation of electrode, we achieved the power density (3.1kW/L) double to this in the new FC Stack.

The high-pressure hydrogen tanks are composed of a resin liner at the innermost layer that functions to seal in hydrogen gas, surrounded by a strong carbon fiber reinforced plastic (CFRP) layer capable of withstanding high pressure. Focusing on the ineffective high-angle helical winding on the central region of the tank, a lamination method was developed that strengthen the boundary regions without the use of high-angle helical winding (Fig.3). As a result of these measures to reduce the usage amount of CFRP, the developed high-pressure hydrogen tanks achieved a storage performance of 5.7% (the hydrogen mass / tank mass), one of the highest in the world.

The FC system was simplified and reliability was enhanced. As shown in Fig.4, the most important change was to simplify the system by eliminating the external humidifier and integrating the functions of the valves. We adopted FC boost converter. This enabled the adoption of an HV traction motor and inverter already in mass production, thereby ensuring reliability while reducing the size and cost of motor system.

3. Summary

The mass production and commercialization of the FCV is result of a long and arduous journey. The launch of this FCV signals the start of lengthy struggle toward achieving widespread popularization. Toyota is continuing the development of FCVs as one of the most promising technologies for achieving sustainable mobility and energy diversification. At the same time, it will carry on activity working with government and related fields toward the realization of a hydrogen-based society, for the sake of the Earth and future generations.