

Analysis of the standard system of China for hydrogen energy and fuel cell vehicle related fields

Caizhi Zhang^{1* #}, Yuqi Zhang^{1 #}, Min Fan², Yanyi Zhang³, Dong Hao^{3* #}

¹ School of Automotive Engineering; The State Key Laboratory of Mechanical Transmissions; Chongqing Automotive Collaborative Innovation Centre; Chongqing University, Chongqing, 400044, China

² Propulsion Research Institute of Chongqing Changan New Energy Vehicle Technology Co., Ltd., Chongqing, 400000, China

³ China Automotive Technology and Research Center Co., Ltd., Tianjin, 300300, China

(#, Equal contribution; *, Corresponding authors: czzhang@cqu.edu.cn (C.Z Zhang), haodong@catarc.ac.cn (D. Hao)

ABSTRACT

The innovation of hydrogen energy and fuel cell technology promotes the development and application of fuel cell vehicle, which also requires the real-time follow-up of relevant standards. This paper summarizes the domestic and foreign existing conditions of FCV related standard system at beginning, which contributes to a comprehensive comparative analysis. Subsequently, the potential gaps of existing standard system are summarized, and the possible reasons are analyzed. Finally, the development of fuel cell standards in China is presented. In the future, it is important to strengthen the construction of related standard system, so as to promote the high-quality and high-level development of fuel cell vehicle industry.

Keywords : hydrogen energy, fuel cell vehicles, standard system

1. INTRODUCTION

In the context of global environmental and energy deterioration, which has led to a shift in the attention of the world's major automakers and related companies from traditional cars to new energy vehicles^[1]. So that new energy vehicles have been rapid development^[2]. On the macro perspective, fuel cell has the same strategic position as pure electric. Firstly, they can get rid of the dependence of fossil energy^[3]. Besides, as a new technology industry, it can stimulate the advancement of economic environment. Third, it can effectively mitigate exhaust pollution^[4]. From the micro level, fuel cell vehicles has a direct analogy with traditional vehicles in energy conversion^[5].

Over the years, many countries have expedited

the formulation and perfection of relevant standards in the field of fuel cell vehicles based on the original relatively perfect standards in the field of traditional vehicles and pure electric vehicles, so as to guarantee the high-quality development of fuel cell vehicles. On the one hand, standardization is beneficial to maintaining market order and improving the scientific and efficient management of Research and Development market. On the other hand, standardization puts forward relatively comprehensive requirements for research and development of products, which to some extent ensures the technical, quality, environmental protection and safety of products, and is of great significance to the promotion of the fuel cell vehicle industry and the sustainable development of the industry^[6].

Thus, this paper focuses on standards in hydrogen and fuel cell related fields and analyzes the contributions China has already made in this field. Of course, based on the support of national policies, China's hydrogen fuel cell industry has been vigorously developed, but the technology in related fields is still being constantly updated, and the enactment of standards needs to keep up with the development.

2. CURRENT STATUS OF RELEVANT STANDARD SYSTEM FOR FUEL CELL VEHICLES ABROAD

Toyota MIRAI, Hyundai NEXO, Honda Clarity and other hydrogen fuel cell models have been successfully developed, setting off a new wave for hydrogen fuel cell development^[7]. For that, various countries have issued relevant policies to support the accelerated development of fuel cell. At present, there are two relatively complete fuel cell standardization organizations have been formed

internationally to standardize and lead the development of the industry: International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC). Among them, ISO focuses on the vehicle and battery, including performance indicators, test method standards. However, IEC focuses on the standards of electrical components^[8]. ISO and IEC work closely together to establish a joint working group to contribute to the improvement of the fuel cell standard system^[9, 10].

The basically three aspects, performance, safety and reliability, which have been covered in the international fuel cell standard system^[8]. China participated in the formulation of GTR 13, which stipulates the technical requirements and test methods of fuel cell vehicle safety and on-board hydrogen storage system safety^[11], including vehicle collision safety requirements, component requirements and system safety standards. Besides, international regulations and standards stipulate that the safety requirements of

electric vehicles are applicable to fuel cell electric vehicle.

3. CURRENT STATUS OF RELEVANT STANDARD SYSTEM FOR DOMESTIC FUEL CELL VEHICLES

3.1 China's hydrogen fuel cell standards system and standards committee

In 1985, the first hydrogen energy standard system document in China, GB 4962-1985《Technical Safety Regulation for Gaseous Hydrogen Use》 was officially released^[12], marking the start of hydrogen energy standardization in China. So far, a relatively complete standard system has been established in the field of hydrogen energy and fuel cell in China. The framework of relevant technical standard system is shown in Figure 1 and Figure 2.

Throughout the long chain of fuel cell industry, the standard committee directly related to fuel cell in China's existing standardization technical committee is shown in Table1.

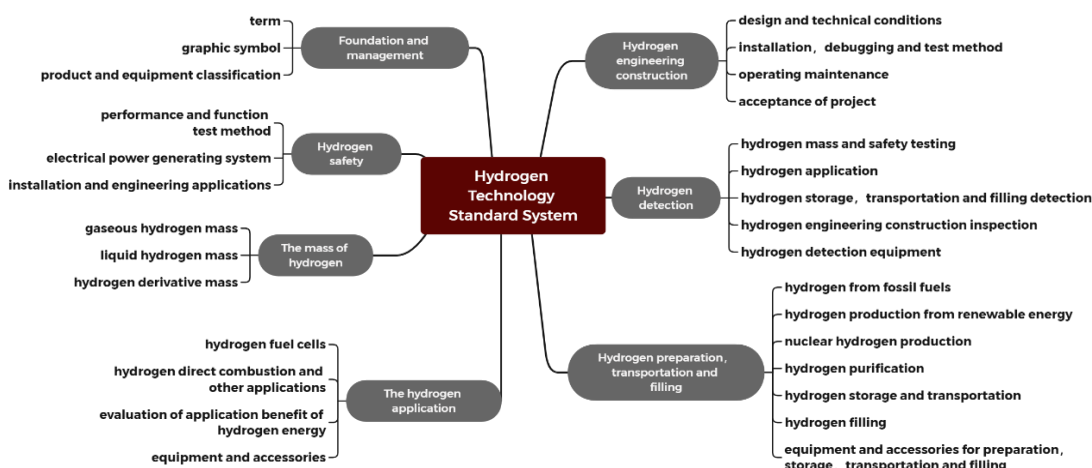


Fig.1 Technical standard system of Hydrogen energy in China

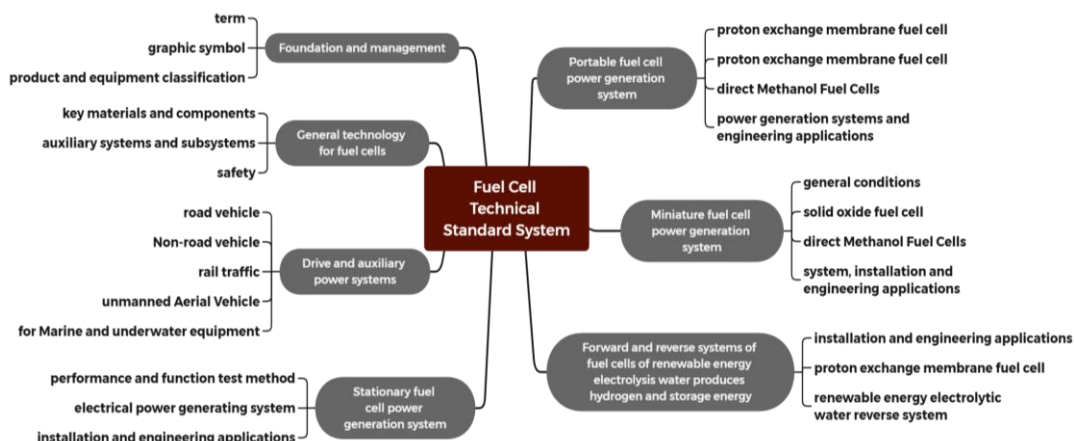


Fig.2 Technical standard system of Fuel cell in China

Table.1 Fuel Cell Standard Committees

Name of standard council	Serial number	secretariat	Counterpart	Responsibility	Representative
Sub-technical Committee on Electric Vehicles of National Technical Committee of Auto Standardization	SAC/TC 114 /SC 27	China Automotive Technology and Research Center	Sub-Technical Committee on Automobiles of ISO (ISO/TC 22/SC 37)	Automotive fuel cell standard, currently fuel cell vehicle related strong inspection standards are in this committee	GB/T 24554-2009 《Performance test methods for fuel cell engines》
National Technical Committee on Fuel Cell and Flow Redox Cell of Standardization Administration	SAC/TC 342	Machinery Industry Beijing Electrotechnical Institute of Economics Research	Technical Committee on Fuel Cells of Standardization of IEC (IEC/TC 105)	Fuel cell standards, other than those for vehicles, are led by Academician Ebron, and one of the current subsidy tests is for this committee	GB/T 33979-2017 《Test methods for proton exchange membrane fuel cell power system at subzero environment》
National Standardization Technical Committee for Hydrogen Energy	SAC/TC 309	China Institute of Standardization	ISO Technical Committee on Hydrogen Energy (ISO/TC 197)	The emphasis is on the standard formulation of hydrogen energy, including hydrogen production, hydrogen transport, hydrogenation stations, etc.	GB/T 34583-2017 《Safety technical requirements for hydrogen storage devices used in hydrogen fueling station》
Sub-technical Committee on High Pressure Fuel Cylinders for Vehicles of National Technical Committee on Gas Cylinders Standardization	SAC/TC 31 /SC 8	Zhejiang University Chemical Machinery Jindun Pressure Vessel Co., LTD	/	The emphasis is on developing standards for the cylinders themselves, currently there is only one standard output	GB/T 35544-2017 《Fully-wrapped carbon fiber reinforced cylinders with an aluminum liner for the on-board storage of compressed hydrogen as a fuel for land vehicle》

3.2 Current status of hydrogen energy standards in China

Since the 14th Five-Year Plan, in order to speed up the research of hydrogen energy technology, China has continuously launched working guidelines for the hydrogen energy industry. By April 2021, China's hydrogen energy technical standard system is divided into 8 categories with 95 standards^[13].

Hydrogen engineering construction is also one of the key elements of the progress of hydrogen fuel cell industry, which standard system has been formed yet, but some standards in other fields have been referred and formulated^[12], such as GB/T 50016-2014 《Standard for design of timber structures》^[14], ISO/TR 15916 《Basic considerations for the safety of hydrogen systems》^[15] and GB/T 20801-2020 《Pressure piping code-Industrial piping》^[16] etc..

4. COMPARATIVE ANALYSIS OF FUEL CELL STANDARDS BETWEEN HOME AND ABROAD

4.1 Comparison with U.S. hydrogen fuel cell standards

The U.S. government strongly encourages and supports the development of hydrogen fuel cell industry, and the relevant standard setting institutions jointly develop and study the standard system with a number of domestic and foreign technical institutions and scores of domestic automobile enterprises. At the same time, the United States has respectively set up six special working groups on "emission and energy consumption, interface, performance, safety, recycling, terminology".

The standard system of the new energy vehicle industry in the United States covers from performance to emission and then to recycling. It

covers a wide range of contents and are highly complementary to each other. The standard system in U.S. is at the leading level in the world. In China, the formulation of standards for hydrogen fuel cell vehicles exists potential gaps in some respects. Each domestic competent authorities are specifically responsible for one or several types of standards in the field related to hydrogen fuel cells, so the overall standard system is relatively complete. In addition, in order to further improve the standard system in China in the field related to hydrogen fuel cell vehicles, the communication between various institutions should be increased to promote the effective connection according to the demand of standards^[17].

4.2 Comparison with European Union hydrogen fuel cell standards

In order to control the risk of hydrogen storage bottles, several EU regulations such as GTR 13, ECE R134 and EU 406/200 have put forward numerous requirements on the safety performance of hydrogen storage bottles^[18], the essence of which is that hydrogen storage bottles are obliged to pass stringent tests and verifications.

In recent years, China has a certain advantage in the number of fuel cell related standards. The standards of fuel system, infrastructure and general foundation are covered. At present, European Union member states represented by Germany have realized the whole hydrogen energy industry chain of hydrogen production, transportation, storage and fuel cell application, and fuel cell technology has been applied to many fields such as automobiles, ships and power stations. Compared to that, the focus of hydrogen energy development in China is still limited to hydrogen fuel cell vehicles, while the exploration of other broader fields is lesser.

4.3 Comparison with Japan hydrogen fuel cell standards

In Japan's hydrogen fuel cell vehicle standard system, among which the phosphoric acid fuel cell standard is relatively comprehensive^[17]. In Japan, phosphoric acid fuel cell has become the fastest developing and most mature hydrogen fuel cell. Comparatively, the development and standard formulation in China is still very insufficient.

Although China has issued some standards related to hydrogen fuel cells, the norms on safety performance and stack life are still insufficient. Besides, most of them are general and need to be more summarized compared with Japan. In addition, Japan's standards for hydrogenation technology and

hydrogenation facilities are relatively complete and strict, which is also the part that should be strengthened in the process of perfecting the standard system by the relevant technical personnel responsible for the formulation of hydrogen fuel cell vehicle standards in China.

5. POTENTIAL GAPS OF CURRENT FUEL CELL STANDARD SYSTEM IN INDUSTRY

As mentioned above, relevant standards have been issued and implemented at present in China. Nevertheless, most of the standards are inadaptability and have blank fields, which restrict the development of related industries. Mainly reflected in the following aspects.

5.1 Inadaptability

One of the basic challenges in the establishment of hydrogen fuel cell vehicle standard system in China is that the more practice is demanded. In the process of reference to some international standards, there have been mismatches and inadaptations in our country. Beyond that, the some of the earlier standards are a little lag and need more accurate industry development predictability, thus showing the inadaptability between actual product evaluation needs after industry development. In addition, the market maturity of China's fuel cell field is lower than that of technology, and the construction of application standards before and after market entry needs to be strengthened^[17].

5.2 Blank fields

The nature of standard formulation and revision will lag behind the development of technology and industry, and hydrogen fuel cell technology itself is a new technology^[19]. As the prosperity of fuel cell related technologies, there are some areas that have not been covered yet by the original standards, which are mainly reflected in the less involvement of partial technical standards such as key components, functional subsystems, requirements and parameters of specific equipment, energy and equipment recovery etc.

In addition, China's fuel cell technical standards are mainly developed in the field of vehicle use, and their standard systems cannot be completely applied for reference in marine and mechanical industries, where are still in a blank field^[10, 20]. Such as 《Guidelines for Ships Using Alternative Fuels》 (2017) promulgated by the China Classification Society (CCS), which has stipulated the design and inspection requirements of fuel cell ships. However,

due to the special nature of the ship environment, its requirements related to marine fuel cell as the

6. DEVELOPMENT OF HYDROGEN ENERGY AND FUEL CELL STANDARD SYSTEM IN CHINA

China's national standards in fuel cell related fields are gradually being improved. For the past few years, the standard committee has drafted and approved some new fuel cell standards, and has been revising the existing standards to promote the development of fuel cells and meet the requirements of industry reform with the times.

The standards of the whole vehicle are mainly divided into safety, dynamic, economy and emissions. Among them, the acceleration performance and climbing performance are added on the basis of the original GB/T 26991-2011 for dynamic standards. In terms of economy, GB/T 18386.1-2021 will be promulgated, which adds Chinese driving conditions, defines the test method of energy consumption driving range, and makes a clear relationship with relevant standards to avoid overlapping projects.

Key components mainly include on-board hydrogen system, engine (system), stack, gas cylinder, etc. For example, gas cylinder with 70MPa is added into GB/T 26990-2011 and GB/T 24554-2009. Besides, standards for stack including performance tests and environmental tests are being drafted.

Interface and communication are important standards related to interchangeability, which play a significant role in promoting the development of the industry and reducing the research and development cost of enterprises, mainly including the preparation of hydrogenation port, hydrogenation gun, communication protocol and other related standards^[22]. For example, the latest national standard GB/T 26779-2021 has been officially released, replacing (GB/T-2011) the old national standard. The national standard increases the size of 70 MPa hydrogenation port and a number of technical items such as ozone aging resistance, salt spray corrosion resistance, temperature cycling resistance and compatibility test etc.

Under the national "double carbon" policy, China has formed several hundred core enterprises in the industry chain around the key technology of fuel cell vehicles. The industry is in urgent need of a more perfect fuel cell standard system, such as strengthening the construction of group standards and local standards, and encouraging enterprises to contribute to the basic research of some standard systems according to their needs, so as to support

main power source and marine equipment certification are not yet clear^[21].

the healthy and orderly development of the industry. In addition, based on these standard systems, China has also established more than 30 testing organizations from vehicle, system and BOP to stack and material level, including 17 automotive fuel cell testing organizations certified by CNAS, which is sufficient to reflect China's determination to vigorously develop hydrogen fuel cells and the numerous contributions made to this end.

The National Energy Administration has proposed that the huge potential of hydrogen energy in China's energy transformation should be fully recognized, the technical standards, testing and certification, and regulatory system related to hydrogen fuel cells should be comprehensively improved during the 14th Five-Year Plan period. In addition, China should actively carry out international cooperation in the field of hydrogen energy and participate in the international standardization of hydrogen fuel cells, jointly promote the role of hydrogen energy in the construction of a clean and low-carbon security system, improve the infrastructure of fuel cell technology and its supporting equipment, and accelerate its broad industrialization process.

7. SUMMARY

As a new energy vehicle, fuel cell electric vehicle will play a vital role in the development of the future automotive industry. In China, fuel cell electric vehicle has a huge market potential, but there is a certain gap compared with other developed countries. In the process of the "double carbon" era, China has made a lot of contributions in the field of hydrogen fuel cells and has deployed corresponding work in the long chain of the industry. The standardization system of fuel cell electric vehicle in China is still at a development stage and need to be strengthened from the top-level design and comprehensive planning in order to make the standards keep up with the pace of industrial development and the development speed of fuel cell electric vehicle as soon as possible. The international standard committee, national standardization department, multi-industry associations and multi-departments need more cooperate with standardization work. In addition, attention must be paid to constantly updating and supplementing the standard content in the future. It is important to improve and refine the standard system, to create good conditions for the steady development of fuel cell industry in China and in the

world.

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