



# Research of Standard System on Fuel Cell Systems for Vehicles

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**Abstract.** China attaches great importance to the development of hydrogen energy and fuel cell industry, and a series of industrial policies and relevant national departments have repeatedly mentioned the direction of industrial development. This paper comprehensively sorts out and analyzes the relevant domestic and foreign standards focusing on fuel cell system for vehicle use, suggest that the standard system construction of them should center on key components and performance indicators, and establishes a four-level system from performance indicators to components. On several key performance indicators that restrict the large-scale industrialization of fuel cell vehicles, the entire industry should strengthen research.

**Keywords:** Hydrogen energy · Fuel cell · Standards

## 1 Introduction

Hydrogen energy and hydrogen fuel cell are an important way to realize clean energy utilization and optimize the energy consumption structure in China. Hydrogen energy has characteristics and advantages such as diverse sources, large-scale stable storage, transportation and utilization, rapid replenishment, etc. It can be widely used in many fields, such as transportation, industrial production, domestic life and aerospace, etc. The development of hydrogen energy technology is an important way to realize the clean energy utilization.

As an important application scenario of it in transportation, hydrogen fuel cell vehicles are an important direction for transforming and upgrading the electric power system of vehicles worldwide. Hydrogen fuel cell vehicles have the advantages of “zero emission” during the use phase, efficient energy utilization, long driving range and short refueling time, etc. If renewable energy is used to produce hydrogen, fuel cell vehicles can even achieve zero emissions throughout their life cycle.

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In 2020, the Chinese Society of Automotive Engineers published Technology Roadmap for Energy Saving and New Energy Vehicles 2.0, which covers the hydrogen energy system supply chain and the key system technology chain of the vehicle for hydrogen fuel cell vehicles [1].

Based on the classification of this roadmap, this paper focuses on the standard system of fuel cell systems for vehicles. Section 2 of this paper presents the guiding measures of national and local policies on the standard system of fuel cell system. Section 3 presents the paper's hierarchical classification of current standards for automotive fuel cell systems. Section 4 presents statistical information and a brief analysis of the current national, local, group and international standards on automotive fuel cell systems. Section 5 gives the conclusion and outlook for the future.

## **2 National and Local Policy Guidance on Fuel Cell System Standards**

### **2.1 Purpose and Importance of Investigating Fuel Cell System Standards**

In the past, the lack of an industry standard system was considered to be one of the obstacles to the rapid development of the hydrogen energy and fuel cell industry. China attaches great importance to the development of them, and a series of industrial policies as well as many mentions by relevant state departments have clearly defined the direction of industrial development. In 2019, hydrogen energy was included in the State Council's "Government Work Report" for the first time. In the same year, Ministry of Industry and Information Technology summarized work essentials of new energy vehicle standardization of 2019 which clearly included five key research areas, such as fuel cell electric vehicles [2].

With the introduction of a large deal of industrial standards in recent years, the domestic industrial standardization system is being rapidly established, but there are still a large number of sub-discipline areas with standard vacancies. At this stage, the requirements of national standards are becoming stricter and stricter, mainly applied to basic safety and major project support, while local and industry are encouraged to actively participate in the subdivision standard clauses.

Standardization is the feedback of science and technology and the accumulation of experience, and the process of "development-implementation-revision" of a standard is the process of "innovation-application-re-innovation" of science and technology. If a country wants to promote technological progress and the rapid and standardized development of a certain industry, it will certainly actively promote the development of relevant standards to guide society to rationally allocate the resources invested in this industry. If enterprises hope to win, they must use technical standards as a means to enhance the ability of enterprises to compete in the industrial market.

### **2.2 National Policy Guidelines for Fuel Cell System Standards**

The National Development and Reform Commission pointed out in the mid-term and long-term plan for the development of the hydrogen energy industry (2021–2035): "A

perfect standard system for the hydrogen energy industry should be established. Leading enterprises are encouraged to actively participate in the development of various standards, and conditional social groups are supported to develop and publish relevant standards” [3]. In 2020, the Ministry of Finance, together with other four ministries, issued a notice on demonstration and application of fuel cell vehicles. In this notice, they proposed that, given the current situation of industrial development, incentives will be given to eligible city clusters to carry out the industrialization of fuel cell vehicle key core technologies and demonstration applications, forming a new model of fuel cell vehicle development with reasonable layout, focus and synergy. The notice emphasized that in the demonstration content to promote the establishment and perfection of hydrogen fuel cell vehicle-related technical indicator system and testing and evaluation standards, and continuously improve the technical level of the industrial chain and product safety and reliability [4].

### **3 Local Government Planning for Fuel Cell System Standards**

#### **Guangdong Province’s planning for fuel cell system standards**

Guangdong Province has been a key region in China’s hydrogen energy industry, and in September 2021, the Ministry of Finance, with other four ministries, officially approved Guangdong fuel cell vehicle demonstration city cluster as the first demonstration city cluster [5].

In August 2022, Guangdong Provincial Development and Reform Commission issued an action plan accelerating construction of fuel cell vehicle demonstration city cluster for next four years. In this plan, it specified that they would support quality metrology supervision and testing institutions and relevant testing enterprises to establish professional standard research platforms for fuel cell vehicles. They would support leading enterprises, universities and research institutes to jointly develop technical standards for inspection and testing of key components of fuel cell vehicles and improve professional testing capabilities [6].

As early as September 2020, Guangdong Provincial Development and Reform Commission and other four institutions released Guangdong Provincial Hydrogen Fuel Cell Vehicle Standard System and Planning Roadmap (2020–2024). This is the first clearly proposed and comprehensive provincial-level hydrogen fuel cell vehicle standard and technology system plan in China. The roadmap comprehensively summarizes the existing standards related to hydrogen fuel cells at home and abroad, compiles the framework of the hydrogen fuel cell industry standard system, and puts forward the recommendations for the creation and revision of key standards and the standardization roadmap for the hydrogen fuel cell industry [7].

This standard system framework sorts and classifies national, industry, local, and group standards at all levels, and collects 127 national standards, 11 industry standards, 2 local standards, 3 group standards, and 94 standards to be developed for hydrogen fuel cell vehicles. As for the current standard system, the standards for storage and transportation, fuel cell system and vehicle application are relatively perfect, while the

standards for foundation and management, preparation and refilling are relatively lacking. However, there are not many standards for automotive fuel cell systems and their subdivisions.

### **Beijing's Planning for Fuel Cell System Standards**

In August 2021, the Ministry of Finance and other four ministries jointly approved the Beijing-Tianjin-Hebei hydrogen fuel cell vehicle demonstration city cluster under the leadership of Beijing [8]. In November 2022, Beijing Municipal Bureau of Economy and Information Technology and the Bureau of Market Regulation released Beijing Fuel Cell Vehicle Standard System, in which the existing standards were sorted out according to the whole industrial chain and various links of fuel cell vehicles, a total of 151 items.

The standard system considers the requirements of fuel cell vehicle demonstration application and the needs of industrial development, and builds the standard system with the whole vehicle and key components as the core. Considering that the fuel cell system is the power center of fuel cell vehicles, the standard system chooses to subdivide under the first-level catalog of key components to further accelerate the research and application of new technologies.

Compared with the hydrogen fuel cell system standard system developed in Guangdong Province, this standard system clearly states that the standards related to the three main auxiliary systems of the fuel cell system, namely the hydrogen supply system, the air supply system and the thermal management system, should also be included in the construction of the standard system [9]. However, this standard system does not continue to subdivide the automotive fuel cell system downward according to the system-auxiliary system hierarchy.

### **3.1 A Four-Level Classification of Fuel Cell System Standards in This Paper**

The above information shows that both national and local policies clearly point out that the construction of a standard system of automotive fuel cell system is a necessary element for the establishment of fuel cell vehicle industrialization. The standard system of automotive fuel cell system should land on key components and performance indicators. On this basis, the classification of the standard level of fuel cell system should be clarified. Only then can the outline of the standard system be verified, the gaps be filled, and the required standards be prepared or revised in a targeted manner.

In the development process, the industry usually classifies fuel cells according to the three-level structure of system, auxiliary system and components, and carries out the corresponding design development work. Therefore, the three major auxiliary systems of fuel cell systems should not be neglected in the development of standards. After research, there are indeed relevant standards for all three layers.

Meanwhile, the national industrial policy has set clear performance indicator requirements for both the fuel cell system and its major components. Although performance indicators can be further subdivided as a separate classification dimension, such as environmental adaptability, safety, and durability. However, these performance indicators are too abstract, and in practice they are realized through different levels of the fuel cell system, and it is not conducive to establishing a connection with key components if the performance indicators are singled out as the main level. Therefore, in this paper,

standards for automotive fuel cell systems are divided into four levels: performance indicators, systems, subsystems, and components.

In terms of standard types, standards for fuel cell systems can generally be divided into two categories: technical conditions and test methods. In the past, when some standards were prepared, some products with simpler principles and structures or more mature industrial development were prepared by combining technical conditions and test methods. However, the fuel cell system industry is still in the cultivation stage, and the technical routes of various products have not yet been completed. Therefore, this paper still divides the types of standards for automotive fuel cell systems into these two categories.

## 4 Domestic and Foreign Related Standards Statistics and Brief Analysis

### 4.1 Relevant National Standards Statistics and brief Analysis

The search yielded a total of fourteen existing national standards related to automotive fuel cell systems, as shown in Fig. 1 and eight of them are in the type of technical conditions, and six are in the type of test methods. There are nine standards at the system level, no standards at the subsystem or component level, and five standards related to performance indicators. There are also some standards under preparation, see Fig. 2.

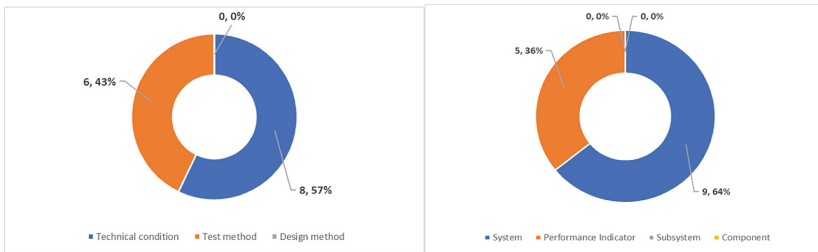


Fig. 1. Current national standards of fuel cell systems for vehicles

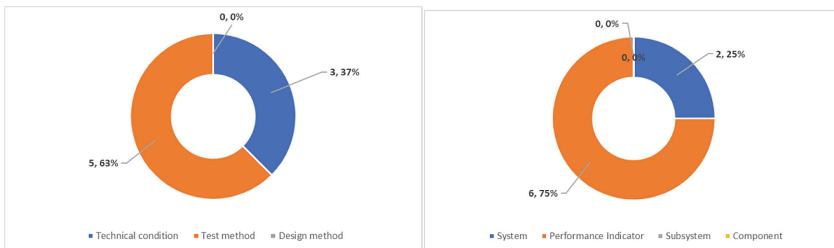


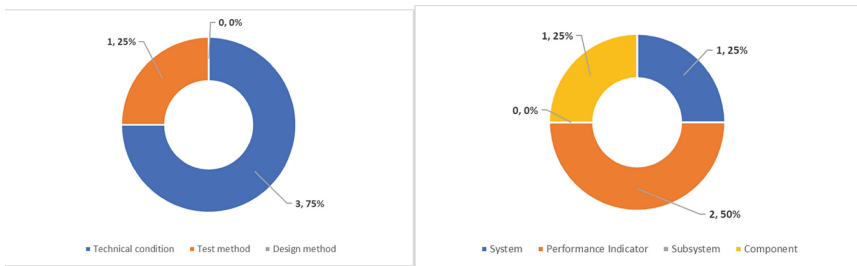
Fig. 2. National standards in preparation of fuel cell systems for vehicles

From the above information, the national standard mainly focuses on system-level standards and does not include key components. In terms of performance indicators,

the national standard is mainly concerned with environmental adaptability, safety, and durability.

**4.2 Relevant Local Standards Statistics and Brief Analysis**

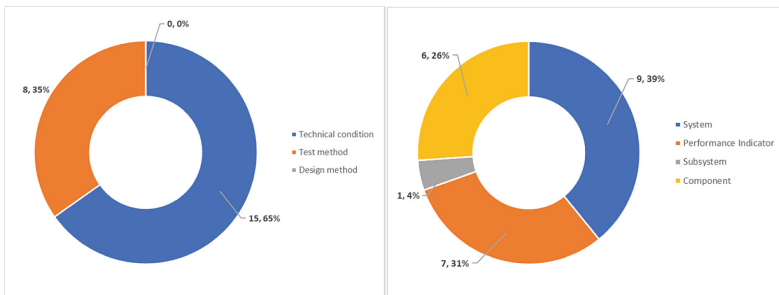
Among the existing local standards, there are four standards related to automotive fuel cell systems, as shown in Fig. 3. Three of them are in the technical condition type and one is in the test method type. There is one system-level standard, one component-level standard, and two standards related to performance indicators. Local standards are also mainly concerned with safety and durability two performance indicators, and local standards have a strong access nature, so more attention to the technical conditions of the standards.



**Fig. 3.** Current local standards of fuel cell systems for vehicles

**4.3 Relevant Group Standards Statistics and Brief Analysis**

There are twenty-three group standards related to automotive fuel cell systems, as shown in the figure below. Among them, there are fifteen standards of technical conditions and eight standards of test methods. There are nine standards of system level, one standard of subsystem level, six standards of component level and seven standards of performance indicators (Fig. 4).

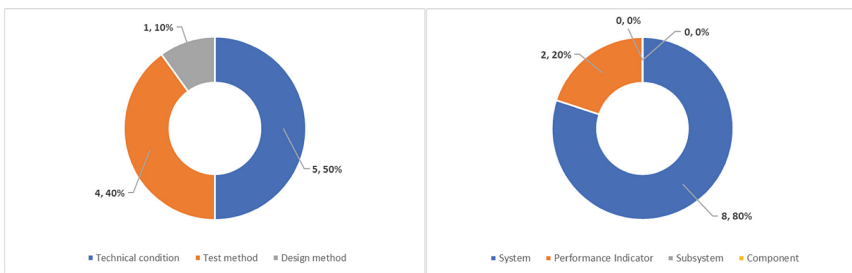


**Fig. 4.** Current group standards of fuel cell systems for vehicles

#### 4.4 Relevant International Standards Statistics and Brief Analysis

The search yielded ten international standards related to automotive fuel cell systems, as shown in Fig. 5. Five of them are technical conditions, four are test methods and one is a design development method. There are eight standards at the system level and two standards at the performance indicator level.

The American Society of Automotive Engineers (SAE) has developed a relatively comprehensive set of international standards for fuel cell vehicles, mainly based on test methods. However, some of the standards were published relatively early and their contents may have lagged the development level of the industry. In addition, since SAE standards are not developed by international standards organizations, China rarely adopts SAE standards when developing relevant standards. Therefore, SAE standards have some significance for the development of national standards, but they need to be carefully selected in the process of specific transformation [10].



**Fig. 5.** Current international standards of fuel cell systems for vehicles

The International Electrotechnical Commission (IEC) has also published a few standards for automotive fuel cell systems, and the publication time is more recent, and the types of standards are mostly technical conditions, so these standards have more reference value for the preparation of national standards.

## 5 Conclusion and Outlook

The standard system of automotive fuel cell system should focus on key components and performance indicators. Whether it is an international standard, or a national standard, local standard or group standard, all have the role of guiding industrial development, so the concentration point should be on technical conditions and test methods from the type of standard. In the process of construction, it should be clearly established from the performance indicators, systems, auxiliary systems to parts of the four-tier system. In terms of level, national and international standards are more concerned with the system level, while group standards are more focused on the component level.

Although there are fewer standards dealing with the subsystem level, there are also relevant groups that have been established. Although the fuel cell subsystem cannot be a separate product at present, with the gradual development and growth of the fuel cell

industry, it is foreseeable that strong component suppliers in the industry will form strong alliance to provide separate fuel cell subsystem products and solutions to fuel cell system suppliers and even OEMs. Standards related to fuel cell subsystems will also gradually increase in the future. From the point of view of performance indicators, whether it is the national standard or the industry standard or the local standard, the most important performance indicators are mainly environmental adaptability, safety and durability, which are also the neck indicators that limit the large-scale industrialization of fuel cell vehicles. The whole industry should strengthen research and breakthrough in these performance indicators.

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