

JINHUA'S ROAD TO CLEAN ENERGY: SETTING THE STANDARDS FOR HYDROGEN FUEL CELL VEHICLES

¹Chen Wei Jun and ²Zhang Mei Fang

¹Jinhua Academy of Metrology and Quality Science, Jinhua, China

²Jinhua Technical Service Station of Zhejiang Society of Automotive Engineers, Jinhua, China

Abstract: *Hydrogen energy has emerged as a crucial player in addressing climate change and facilitating the transition to a decarbonized society. It stands as one of the primary future industries in many nations, attracting significant attention and innovation. With the global push for energy transformation and China's commitment to "carbon peak and carbon neutrality" goals, hydrogen energy has gained substantial traction in the pursuit of a sustainable future. Hydrogen fuel cell vehicles are a pivotal component of the new energy landscape and serve as a cornerstone for the entire hydrogen energy industry. Currently, the hydrogen fuel cell vehicle sector is in a stage of industrial cultivation, buoyed by policy support and regional initiatives driving its growth. As the industry evolves rapidly, the need for establishing and continually improving technical standards and evaluation criteria for hydrogen fuel cell vehicles and related technologies becomes increasingly urgent. In response to this imperative, the Jinhua Hydrogen fuel cell vehicle standard system has been meticulously developed. This system is grounded in an in-depth understanding of the Hydrogen fuel cell vehicle industry's unique attributes in Jinhua, aligning with domestic and global technology trends and industry development. It has been shaped by extensive demand research and is intended to serve as a guiding framework for fostering technological innovation, fueling hydrogen energy advancements, and ensuring the sustainable, scientific, and orderly growth of the industry.*

Keywords: *Hydrogen Energy, Fuel Cell Vehicles, Standardization, Technological Innovation, Sustainable Development*

Introduction

Hydrogen energy, as one of the six major future industries in the country, is active in technological innovation and a hot topic for global industrial development. With the continuous promotion of global energy transformation and the determination of China's "carbon peak and carbon neutrality" goals, hydrogen energy becomes an important path to address climate change and builds a decarbonization society.

The Hydrogen fuel cell vehicle is an important direction for the development of new energy and an important starting point for the development of the whole hydrogen energy industry chain. At present, Hydrogen fuel cell vehicles are in the period of industrial cultivation. With the policy driven, regions have increased their efforts to promote the layout of the Hydrogen fuel cell vehicle industry, the development of the industry is changing with each passing day. In order to standardize the development, it is urgent to promote the establishment and continuous

improvement of Hydrogen fuel cell vehicles and hydrogen related technical index system and testing and evaluation standards [1].

The Jinhua Hydrogen fuel cell vehicle standard system is prepared based on the research and of the development status and characteristics of the Hydrogen fuel cell vehicle industry in Jinhua, combined with the domestic and foreign technology development direction and industry development trend, and through extensive demand research. It aims to guide the technological innovation and creation of hydrogen energy and Hydrogen fuel cell vehicles and promote the sustainable, healthy, scientific and orderly development of the industry by building a standard system.

1. General requirements

The government should fully implement the national strategic decision on the development of the hydrogen energy and Hydrogen fuel cell vehicle industry, conscientiously implement the city's work deployment to promote the development of the hydrogen energy and Hydrogen fuel cell vehicle industry. The government should seize the important opportunity period for the development of the global Hydrogen fuel cell vehicle industry, serve technological innovation and industrial development, focus on Hydrogen fuel cell vehicle vehicles and key components, and build a standard system to meet the needs of technological innovation and industrial development. The government should give full play to the basic and guiding role of the standard system and standards, and provide important support for Jinhua to take the lead in building a hydrogen energy innovation chain and industrial chain, promote the high-quality development of the Hydrogen fuel cell vehicle industry, and support the transformation of Zhejiang's energy structure.

The standard system should reflect Jinhua's characteristics and do a good job in connecting and supporting. The standard system is based on the development foundation of Hydrogen fuel cell vehicle industry in Jinhua city, combines the direction of new technology innovation and the trend of new industry integration, highlights the characteristics of Jinhua, and highlights the foresight and leadership. The standard system should strengthen the connection with the national standard system of Hydrogen fuel cell vehicles and related industries to ensure that local standards are consistent with national standards and industrial standards.

Enterprises should adhere to innovation driven approach and focus on core technologies. Enterprises should closely follow the development direction of technology, rely on Jinhua's scientific and technological resources and strong industrial foundation. Enterprises should support the research and development of key parts and technologies of hydrogen Hydrogen fuel cell system such as stack, membrane electrode, bipolar plate, proton-exchange membrane, catalyst, carbon paper, air compressor, hydrogen circulation system and actively explore the construction of relevant standards.

The government should build a comprehensive system and highlight key content. Thoroughly analyzing the key issues facing the development of Hydrogen fuel cell vehicle industry, clarify the focus of standardization work, and achieve breakthroughs in key technical standards for key issues. The standard system covers all links of the whole industrial chain of Hydrogen fuel cell vehicles, focuses on key parts and commercial vehicles, and focuses on safety first, to establish and improve the safety supervision system and standard specifications.

The government should adhere to keep up with the times and dynamically adjust the system. The government should closely follow up the technology iteration and upgrading trends of Hydrogen fuel vehicles, analyze and evaluate the maturity of cutting-edge technologies, dynamically adjust the

standard system according to the actual industrial development and needs, timely supplement and improve, and ensure the progressiveness, applicability and effectiveness of the standard system.

The government should focus on the technological innovation and industrial development needs of Hydrogen fuel cell vehicles, and follow the idea of "innovation driven, industrial development, and standards first", focus on forward-looking, cross cutting, and blank areas, focus on safety, key parts, commercial vehicles and other aspects, Hydrogen fuel cell vehicle standard system is built to lead the technological innovation of hydrogen energy and the development of Hydrogen fuel cell vehicle industry. In 2022, we sort out the current standards of Hydrogen fuel cell vehicle related industries, investigate the current situation, trend and demand of technology and industry development, and build a Hydrogen fuel cell vehicle standard system. From 2022 to 2024, according to the actual development and demand of the Hydrogen fuel cell vehicle industry, we will develop and revise the standards of Hydrogen fuel cell vehicle related industries, supplement and improve the standard system. By 2025, a complete Hydrogen fuel cell vehicle standard system with progressiveness, applicability and effectiveness will be established to effectively guide the technological innovation and industrial development of Hydrogen fuel cell vehicles in the city [2].

2. Standard system

The government should be in accordance with the spirit of the Medium and Long Term Plan for the Development of the Hydrogen Energy Industry (2021-2035), the Development Plan of Jinhua Hydrogen fuel Cell Vehicle Industry (2020-2025), the Notice on Carrying out the Demonstration Application of Hydrogen fuel Cell Vehicles, the Notice on Starting the Demonstration Application of Hydrogen fuel Cell Vehicles, the Implementation Plan for Promoting the Construction of Jinhua's High Quality Development Standard System and other documents. We have established and improved the hydrogen energy safety supervision system and standard specifications, improve the safety management level of the whole process, ensure the safe and controllable utilization of hydrogen energy, promote the establishment and improvement of the relevant technical index system and testing and evaluation standards for Hydrogen fuel cell vehicles, and develop the Jinhua Hydrogen fuel cell vehicle standard system.

According to all links of the whole industrial chain of Hydrogen fuel cell vehicles, we sort out the current standards, with a total of 151 items. Firstly, the national standards related to the hydrogen energy industry, mainly the standards under the centralized management of the four standardization technical committees directly related to Hydrogen fuel cells (SAC/TC309, SAC/TC342, SAC/TC31 and SAC/TC114/SC27). Secondly, the national standards are related to industrial safety, mainly including gas cylinders, gas transportation pipelines, vehicle safety regulations, etc. Thirdly, the relevant standards for new energy vehicles, mainly including data platform management and on-board power batteries. Fourthly, the industry standards, local standards and group standards related to hydrogen energy, mainly including demonstration operation specifications, key component technical specifications and vehicle testing methods. General-purpose technology standards for vehicles, such as body, chassis, lighting, braking, steering, etc. are not included.

The research and application of hydrogen energy technology in Jinhua city is in a leading position nationwide, forming a first mover advantage. Firstly, it has strong technological research and development capabilities. The city has a certain number of universities and scientific research institutes, and has profound technology accumulation and output of achievements in basic research,

key materials and processes of hydrogen energy and Hydrogen fuel cells. Secondly, it has a solid foundation for industrial development. With the technological breakthrough, the city has formed a complete Hydrogen fuel cell vehicle industry chain with high-tech enterprises as the main body, covering the production, storage, transportation and processing of hydrogen, key parts of Hydrogen fuel cell system, manufacturing and application scenario demonstration of Hydrogen fuel cell vehicles, and nearly 100 related enterprises. Thirdly, some Hydrogen fuel cell vehicle technologies have a leading position in China. Multiple enterprises have made significant breakthroughs in key components and vehicles, and their technological level ranks among the top in China.

We build standard system framework and construction ideas. The standard system of Jinhua Hydrogen fuel vehicles is divided into five parts: safety and management, hydrogen foundation, hydrogen refueling, key parts, components and the whole vehicle, which are further divided and expanded according to the differences in content scope and technical characteristics of each part. They are reflecting innovation in the area of "security+management". In the construction of the standard system, we attach great importance to the overall safety of all links in the whole industrial chain of hydrogen energy and Hydrogen fuel cell vehicles, and build a three-dimensional safety system architecture of "total safety+sub safety". We set security and management as the primary directory, which is divided into three secondary directories: security, basic and management. They mainly cover common technical standards and regulatory standards related to safety in hydrogen energy applications, and corresponding safety sub directories are set up under other first level directories to cover the unique safety regulatory standards and requirements under this directory. At the same time, the management of hydrogen energy application is also an important consideration factor in the construction of the standard system.

The standard system considers the entire vehicle and components as center part. Comprehensively considering the demonstration application requirements and industrial development needs of Hydrogen fuel cell vehicles, the standard system is built with the whole vehicle and key parts as the core. The entire vehicle focuses on commercial vehicles and specialized vehicles, and passenger vehicles are temporarily not included. The Hydrogen fuel cell system and power cell are the power center of Hydrogen fuel cell vehicles, and the on-board hydrogen system is the energy supply center of Hydrogen fuel cell vehicles. The two are the decisive factors of vehicle operation power, economy and safety. Therefore, under the first level catalog of key parts and components, they are selected and subdivided to further accelerate the research and application of new technologies.

We research the technology which relates to the hydrogen energy industry. The standard system focuses on the construction of complete vehicles and parts. Although the basic hydrogen energy links, such as hydrogen preparation, storage, transportation and filling, are quite different from the vehicle standard system architecture and they belong to the energy system standard, considering that the demonstration application of Hydrogen fuel cell vehicles can effectively promote the development of the hydrogen energy industry, and hydrogen is also the basis for the development of the Hydrogen fuel cell vehicle industry. Therefore, in the construction of the standard system, consideration has been the technology related to the hydrogen energy industry can be considered.

Safety is an inherent requirement for the development of the hydrogen energy industry. It is necessary to establish a sound hydrogen energy safety regulatory system and standard specifications. The standard system should strengthen the prevention and control of major safety risks throughout the

entire industry chain, such as hydrogen production, storage, transportation, processing and use. The standard system should improve the level of safety management throughout the entire process. This section mainly covers the common safety standards and specifications of the hydrogen energy industry chain, and is divided into three parts: general requirements, hydrogen materials, and testing technology, focusing on hydrogen safety failure modes and controls.

Fundamentals and management include three parts: standard terminology, data management, and operational management. Standard terminology involves the definition and interpretation of basic standard terms for hydrogen energy systems. Data management aims to promote the integration and interoperability between the hydrogen energy industry and the new generation of information technology. The government should establish an intelligent operation platform, achieve digital collaborative management of the entire industrial chain of hydrogen energy production, storage, transportation, processing and utilization, and the government should ensure hydrogen security, mainly including data upload standards, terminal equipment configuration requirements, etc. Operation management mainly involves operational specification requirements, vehicle operation management, service requirements, and other contents.

The hydrogen foundation includes hydrogen preparation and quality, hydrogen storage and transportation. The relevant standards mainly cover technical specifications, manufacturing equipment, evaluation methods, safety requirements for hydrogen preparation, quality, testing, storage, transportation, and other aspects. It refers to relevantly national industry standards, combines with regional characteristics and industrial advantages, and focuses on supplementing renewable energy hydrogen production standards.

Hydrogenation infrastructure is a key link in the demonstration application, industrial development of hydrogen energy and Hydrogen fuel cell vehicles. There are two secondary directories of Hydrogen station and hydrogen refueling equipment under hydrogen refueling. Hydrogen station involves construction related contents, mainly including construction engineering technical specifications and safety technical requirements; The hydrogenation equipment mainly covers the technical requirements, safety specifications of key equipment and facilities in the Hydrogen station. The equipment and facilities mainly include compressors, fixed hydrogen storage devices, hydrogenation machines and control systems.

Key components mainly include important components closely related to the overall power performance, economic performance and safety performance of the vehicle. The Hydrogen fuel cell system is a completely power generation system with Hydrogen fuel cell stack as the basic unit. The Hydrogen fuel cell stack is mainly composed of membrane electrode (including Proton-exchange membrane, gas diffusion layer and catalyst) and bipolar plate, the auxiliary system includes air compressor and hydrogen circulation pump. In order to adapt to the complex and diverse application scenarios of road vehicles. Some key component technologies need to be continuously innovated and optimized. The standards of Hydrogen fuel cell system mainly cover performance, technical requirements, evaluation methods, equipment and safety requirements, etc. The standards of auxiliary systems include technical specifications, manufacturing equipment, evaluation methods, etc. of relevant components such as hydrogen supply system, air supply system, thermal management system, etc.

Lightweight, high pressure, high hydrogen storage mass ratio and long life are the development trends of on-board hydrogen storage cylinders for Hydrogen fuel cell vehicles. They are also the key to improve the range of Hydrogen fuel cell vehicles and reduce operating costs. Relevant standards for on-board hydrogen storage system of Hydrogen fuel cell vehicles mainly include technical specifications, manufacturing equipment, evaluation methods and safety requirements, etc. In addition, standards for relevant components of on-board hydrogen storage system are also included.

The power system of Hydrogen fuel cell vehicles adopts the "electric electric hybrid" Technology road map. Hydrogen fuel cells and power cells are used together. Hydrogen fuel cells provide output power under stable conditions, while power cells provide high power required for vehicle acceleration, deceleration and other unsteady conditions. This solution not only solves the problem of slow dynamic response speed of Hydrogen fuel cells, but also extends the life of Hydrogen fuel cells and provides strong power. The performance and safety of the power battery are focus to the standard system.

Relevant standards are specified in the standard system, such as Hydrogen fuel cell system, on-board hydrogen system, power battery mainly include motor, inverter, auxiliary power supply device, controller, etc. The relevant standards for the whole vehicle mainly include the relevant technical index system and test evaluation standards unique to Hydrogen fuel cell vehicles, including technical requirements, test specifications for power performance, crash safety, environmental protection performance and water safety. The technical requirements and testing specifications for conventional vehicles such as vehicle lighting, braking, which directly implemented in accordance with relevantly national standards, the standard system will not be repeated. It focuses on the relevant standards of Hydrogen fuel cell commercial vehicles and special purpose vehicles. Hydrogen fuel cell commercial vehicles are mainly buses and medium and heavy trucks, special purpose vehicles include Hydrogen fuel cell special purpose vehicles in key application fields such as sanitation, waste transportation, cold chain logistics and postal services. The special Hydrogen fuel cell vehicle focuses on the specification of especially technical requirements and testing methods for the professional operation part of the upper assembly.

3. Suggestions for implementing the standard system

The government should strengthen organizational leadership. The government should establish a standard linkage working mechanism for Hydrogen fuel cell vehicles, The government should strengthen organization, coordination and communication, dynamically maintain the standard system for Hydrogen fuel cell vehicles, and coordinate the work related to Hydrogen fuel cell vehicle standards. The government should drive the construction of group standards. We utilize the flexible and rapid response of the group standard mechanism to technological innovation and industrial development. The government should increase the effective supply of standards. Enterprises, social organizations are scientific research institutions are encouraged to carry out the construction of standards for Hydrogen fuel cell vehicles by reference to the Hydrogen fuel cell vehicle standard system. The government should actively explore regional collaborative cooperation. Based on the principles of resource sharing, complementary advantages, positive interaction and win-win development, actively promote the coordination of Hydrogen fuel cell vehicle standards in Jinhua.

The government should widely absorb social forces. The government should widely attract domestic leading enterprises, unicorn enterprises, medium-sized enterprises, scientific research institutions, colleges and universities to participate in standard formulation, The government should make full use

of think tanks, strengthen standard construction and improve the standard work level of Hydrogen fuel cell vehicles.

4. Conclusion

Jinhua Hydrogen fuel cell vehicle standard system can reduce the cost of Hydrogen fuel cell vehicle standard search and formulation, provide standard support for the administrative department to formulate policies, effectively prevent unqualified auto parts from entering the Hydrogen fuel cell vehicle industry chain. The government should ensure the quality of Hydrogen fuel cell vehicles, ensure the life safety of the people, and promote the healthy and sustainable development of Hydrogen fuel cell vehicle industry.

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