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Development Status and Standardization Research of Container Reach Stacker

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Abstract. With the sustained growth of global trade, the advancement of multimodal transport, and the comprehensive implementation of China's dual carbon goals, as a core piece of equipment in the logistics equipment system, the container reach stacker is showing a development trend of steady growth coupled with structural upgrading. Its technology is accelerating its transformation towards green, low-carbon, and intelligent directions.. This paper systematically reviews the current state of technology and industrial development of container reach stackers both domestically and internationally, with a focus on discussing the practical application progress and interim achievements of clean energy drive technologies such as pure electric and hydrogen fuel cells in the reach stacker field. It provides an in-depth analysis of the current status of relevant domestic technical standards, identifies China's strengths and weaknesses in standard development, and on this basis, offers a forward-looking perspective on future technology development trends and key directions for standardization work in the reach stacker industry. The aim is to provide useful references and decision-making support for achieving high-quality and sustainable development of China's reach stacker industry, and for further enhancing its overall international competitiveness and influence.

Keywords: container reach stacker, technological development, green and low-carbon, intelligence, standards

1. Introduction

Container transportation serves as a vital pillar of the modern logistics system. In 2025, China's ports handled a total container throughput of 350 million TEUs, representing a year-on-year increase of 6.8%. Shanghai Port maintained its position as the world's leading port for the sixteenth consecutive year with 55.06 million TEUs, while Ningbo-Zhoushan Port surpassed 40 million TEUs for the first time [1]. Container reach stackers (hereinafter referred to as 'reach stackers') are flexible and highly adaptable to various sites. They are widely used in ports, railway yards, container transfer stations, logistics parks, and other scenarios, making them one of the core pieces of equipment for container handling operations.

In recent years, with the sustained advancement of China's multimodal transport strategy, the demand for inland container depots has been continuously increasing, and the market size of reach stackers has been rising accordingly, making industrial upgrading increasingly urgent. The

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dualcarbon goals have imposed stricter requirements on energy conservation and emission reduction in the port machinery sector, exacerbating the high energy consumption and high emissions of traditional dieselpowered reach stackers. Consequently, promoting the deep integration of clean energy and intelligent technologies into reach stacker products has become an inevitable trend in the industry's development. On the other hand, against the backdrop of China's accelerating internationalization of construction machinery, the export scale of reach stackers continues to expand, and the completeness of the standardization system directly affects the international competitiveness of Chinese products. Therefore, reviewing the existing standard system and clarifying the future direction of standardization are of great practical significance for promoting the highquality development of the industry.

2. Current development status of container reach stackers

2.1. Current development status abroad

The development of reach stackers can be traced back to the late 1960s. In 1969, Italy's Belotti company invented the first reach stacker, the B75, establishing a standard configuration comprising a wheeled chassis, a frame structure, a two-stage telescopic boom, and extendable lifting attachments [2]. During the 1980s, Sweden's Kalmar produced the world's first commercial reach stacker; its ContChamp model later became a cornerstone of the global logistics industry. By the mid-1990s, Kalmar held a 45% share of the global reach stacker market [3].

Currently, leading international manufacturers of advanced reach stackers include Sweden's Kalmar, Finland's Konecranes, and Germany's Linde and Liebherr. Kalmar has 30 years of experience in manufacturing reach stackers. Its RT240 is the world's only off-road reach stacker, with a lifting capacity of 29.5 tons, capable of operating in extreme environments such as deserts and the Arctic. Its DRG1300-92ZX is the largest reach stacker to date, with a lifting capacity of 130 tons [4]. Liebherr's LRS545 and LRS645 reach stackers feature full hydraulic transmission, a maximum lifting capacity of 45 tons, and stacking heights of 5 and 6 layers of containers, respectively.

2.2. Current development status domestically

The development of reach stackers in China began in the 1980s. In 1985, China Waterborne Transport Research lnstitute (hereinafter referred to as the Water Transport Institute) collaborated with Guangzhou Port Machinery Manufacturing Plant to develop China's first reach stacker, the JD4; subsequently, they jointly developed the ST400 and JD24 models. During the 1990s, the Water Transport Institute partnered with Shenzhen Zhaoshang Machinery and other entities to create the CRS450 reach stacker, which had a maximum lifting capacity of 45 tons and achieved technology on par with international advanced levels [5].

In the 21st century, Chinese-made reach stackers have developed rapidly. In 2005, Sany Heavy Industry launched the first reach stacker with independent intellectual property rights, the RSC45-5M, which held multiple patents. In 2009, Sany independently developed the RSC45C2-P reach stacker, with a maximum lifting capacity of 55 tons, making it the world's largest reach stacker at the time [6]. In 2012, ZPMC initiated the development of reach stackers. Its second-generation products were equipped with onboard terminals and 360° panoramic cameras, while the third-generation products featured patented technologies such as variable wheelbase, achieving approximately 70% lower fuel consumption than standard models.

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According to public reports, Sany Marine's reach stackers and empty container handlers hold a domestic market share of approximately 60%–70% and a global market share of about 35%–39%, ranking first in the industry. In early 2026, the cumulative global deliveries of Sany Marine's reach stackers exceeded 10,000 units. In the future, the market size of China's reach stacker industry will maintain a steady growth trend.

From the development history at home and abroad, it can be seen that traditional diesel-driven reach stackers have become increasingly mature in terms of technical performance and industrial scale. However, with the acceleration of the global energy transition and the deepening implementation of China's "dual carbon" strategy, the limitations of reach stackers driven solely by internal combustion engines in terms of carbon emissions and energy consumption are becoming increasingly prominent. Against this background, clean energy drive technology has emerged as a new direction for industry development.

2.3. Development of clean energy reach stackers

2.3.1. Pure electric reach stacker

The pure electric reach stacker is currently the most widely adopted technical route for clean energy applications. In 2016, XCMG rolled out the globes initial pure electric reach stacker, the XCS45. In 2020, it presented the subsequent-generation XCS4531E3, outfitted with a 423 kWh traction battery pack and 300 kW dual-gun fast charging technology. This stacker can be fully charged within 1.5 hours and offer 10 hours of continuous operation. It saves 250,000 RMB annually in operating costs when compared to diesel-powered models.In 2022, Sany Heavy Industry rolled out its third-gen pure electric reach stacker, the SRSC45E3. It is equipped with a large-capacity 507 kWh lithium iron phosphate battery pack. It supports high-power dual-gun charging, which only takes 1 hour to fully charge and allows for 10 hours of continuous operation.This model employs a single-motor direct drive along with a self-developed energy recovery system. It attains a comprehensive range that is over 10% greater than that of models having the same battery capacity.It is additionally outfitted with a low-temperature safeguarding system, enabling operation in extremely frigid environments as cold as -40°C.

In 2021, Kalmar launched three types of all-electric equipment, among which the pure electric reach stacker series includes eight models, with a maximum lifting capacity of 45 tons, capable of stacking up to six tiers high. It uses lithium-ion batteries and offers four battery capacity options, with the maximum capacity reaching 587 kWh.

The practical application of pure electric reach stackers has achieved remarkable results. Dalian Container Terminal Co., Ltd. has been implementing a new energy mobile equipment replacement plan since 2021, promoting the electrification of terminal equipment and the application of clean energy. The newly deployed electric reach stackers, compared with traditional fuel-powered equipment, have achieved a reduction in operating cost of RMB 4 per TEU, saving approximately RMB 180,000 in energy costs per unit per year, and reducing carbon dioxide emissions by about 50 tons, delivering significant economic and environmental benefits. Since August 2025, Longkou Port, Yantai Port, Shandong, has accelerated its green and low-carbon transformation, vigorously introducing electric and hybrid new energy equipment to replace old units. This has not only achieved zero emissions during operation but also reduced operating costs per thousand tons of cargo by up to 35%.

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2.3.2. Hydrogen fuel cell reach stacker

Hydrogen fuel cell reach stackers demonstrate unique advantages in specific operating conditions that require high power, high intensity, and high refueling efficiency. In China, Hangcha Group has launched various products including hydrogen-powered reach stackers and hydrogen-powered forklifts, equipped with fuel cell systems that feature zero emissions, high efficiency, long endurance, and fast hydrogen refueling. In 2025, the Port of Valencia in Spain completed the H2PORTS project, achieving routine operation of hydrogen fuel cell reach stackers at the container terminal. These stackers are equipped with four high-pressure hydrogen storage tanks, require only 10–15 minutes for a single refueling, and can operate continuously for one to two shifts, enabling emission-free operation.

In March 2026, the Ministry of Industry and Information Technology, along with two other departments, jointly issued the Notice on Carrying Out Pilot Work for Comprehensive Application of Hydrogen Energy, which clearly specifies that industrial vehicles such as forklifts will be included in hydrogen innovation application scenarios and subsidy coverage. This will directly accelerate the commercialization of hydrogen-powered industrial vehicles.

In summary, pure electric and hydrogen fuel cell technologies represent the two mainstream directions for clean energy reach stackers. Pure electric technology is relatively mature, has achieved large-scale application, and delivers significant economic and environmental benefits in scenarios such as ports and yards. Hydrogen fuel cell reach stackers offer unique advantages in special working conditions that require high power, high intensity, and fast refueling efficiency. Generally speaking, pure electric reach stackers are more suitable for scenarios with relatively stable operating intensity and well-established charging infrastructure, whereas hydrogen fuel cell reach stackers are more competitive in heavy-load, continuous operation scenarios where refueling time is critical. With the improvement of battery performance, the expansion of hydrogen refueling infrastructure, and stronger policy support, the two technologies will complement each other and develop in parallel, jointly driving the rapid green and low-carbon transformation of the reach stacker industry.

3. Current status of standardization development for reach stackers

China's standardization of reach stackers is transitioning from meeting basic technical requirements to supporting a high-quality development stage characterized by green and intelligent development. Current standards cover the entire product lifecycle, including design, manufacturing, testing, and safety aspects.

GB/T 26474—2026 *Container reach stacker* as a product standard specifies the types, basic parameters, technical requirements, inspection rules, signs, packaging, transport and storage of the container reach stacker, and describes the corresponding test methods. This standard has been comprehensively revised from the 2011 edition to meet the rapid development needs of global green, low-carbon, and intelligent technologies and equipment. Compared to the previous version of the standard, it not only expands the scope of application by adding specifications for product types and basic parameters, energy recovery technologies for power transmission and steering, key components of new energy vehicles such as lithium batteries and hydrogen fuel cells, as well as requirements for driver cabins and coating treatments, but also significantly strengthens safety protection requirements while refining testing methods, inspection rules, and transportation and storage requirements for new energy products. Furthermore, in order to effectively enhance China's technical voice and market recognition in the field of port and logistics equipment in international

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trade, promote smoother access of related products to the Belt and Road Initiative partner countries and global markets, and reduce trade barriers arising from differences in standards, this standard has been simultaneously developed in an English version.

GB/T 17992–2008 *Safety code for the container reach stacker* specifies the safety technical requirements for the design, manufacturing, installation, use and maintenance, inspection and repair of reach stackers with a lifting capacity of not less than 24,000 kg.

GB/T 16905–1997 *Test method for the crane of container front-handling mobile* provides the test methods for reach stackers handling 20 ft and larger containers. These include no-load tests, rated load tests, static load tests, stability tests, as well as the determination of technical performance parameters such as the machine's working speed, working range, insulation of electrical components, and pressure values of hydraulic components.

In addition, other relevant foundational standards such as GB/T 3811—2008 *Design rules for cranes* and GB 6067.1—2010 *Safety rules for lifting appliances - Part 1: General* provide unified specifications for the general requirements of reach stackers, including design and safety protection, thereby serving as a fundamental technical basis for product development and manufacturing of reach stackers.

Overall, China's reach stacker standards already cover the main technical requirements for both traditional fuel-powered and new energy products, which well aligns with the actual needs of technological transformation and market development in the industry. These standards not only provide clear technical guidelines for the R&D planning, manufacturing, and quality inspection of domestic reach stacker products, but also, through the simultaneous development of foreign-language versions, export China's technical solutions abroad, offering standardization support for Chinese reach stacker products to compete in the international market.

4. Conclusion and prospects

This study systematically reviews the development process and technological evolution of container reach stackers, with a focus on analyzing the current state of domestic and international industrial development, the trend of clean energy transition, and the progress of standardization. In the future, as battery performance continues to improve and hydrogen refueling infrastructure is gradually perfected, cleanenergydriven reach stackers will move from the demonstration stage to largescale promotion and application. During this period, intelligent technologies such as automatic guidance, remote operation, AIbased obstacle recognition, 5G communication, and IoTbased fleet coordination will drive reach stackers towards unmanned and autonomous operation. Standardization efforts need to continuously track the latest developments of ISO and IEC in the fields of hydrogen energy and intelligence, update domestic standards in a timely manner, and promote harmonization and mutual recognition between domestic and international standards, thereby providing solid support for the "going global" strategy of Chinesemade reach stackers.

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