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Review and analysis of reach stacker models for handling operations in industry

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ABSTRACT

The use main advantages and disadvantages of reach stackers for container overload in port facilities and overloading complexes are defined in the paper. The review and analysis of reach stacker models of leading manufacturers was carried out. Based on this analysis, the reach stacker model to 45 tons carrying capacity was adopted as an analog for further design development.

Keywords: reach stacker, handling operations, container, tier, carrying capacity.

1. INTRODUCTION

Reach stackers are widely used in terminals and ports for handling operations with containers and are designed in such a way that this work type is performed as rather. Work with containers was carried out by gantry and portal cranes and forklifts before the appearance of reach stackers. However, due to their design features, as well as due to the increase in the container flow, they cannot perform the required amount of work efficiently and quickly [1–3].

The appearance of reach stackers allows you to significantly speed up the work with containers. Reach stackers remain popular, due to their cost-effectiveness and relative maintenance ease, since the world's most cargo is transported in containers.

2. REVIEW AND ANALYSIS OF REACH STACKER

The reach stacker is a special type of forklift (Fig. 1) that has some external features of the hydraulic truck crane by the telescopic boom presence, at its end fixed the device for gripping containers (the spreader). The main parameters of the reach stacker are the lift capacity, the container tier numbers into which they are stacked, the wheelbase of the tractor and the working weight [4, 5]. Additional characteristics include the ability to work with different spreader types, engine power, transmission type, and running equipment features.

Figure 1. Use of reach stackers for handling operations with containers in cargo terminals and ports

The reach stacker design of different producers is the same type, although some models have certain design features, which consist of changing the relative placement of the cabin and the boom, as well as the boom shape. This allows them to be used for loading containers into the holds of watercraft, working with containers placed on railway platforms or special trailers.

The reach stacker contains the long-base wheeled machine usually, on its frame the boom with the spreader and the cabin are placed in the longitudinal axis plane. The cabin can be moved to the machine front in some models. The spreader boom and mechanisms control are carried out by the hydraulic system. The container gripe by the spreader is carried out by rotary locks that are fixed in the container fittings.

The production of reach stackers is well established in European and Asian countries, and the USA. The most famous producers are Ferrari (Italy), Liebherr (Germany), Kalmar (Sweden), Terex (USA) and other models (Table 1).

Table 1: Technical characteristics of some reach stackers

Parameter	Reach stacker model					
	CVS Ferrari F-500 RS8	Hyster RS46-29 CH	Liebherr LRS 545	Konecranes SMV 4531	Kalmar DRF 450	Terex TFC45LC
Carrying capacity, t	45	46	45	45	45	45
Engine power, kW	257	239	230	265	182	239
Container type	20′–40′	20′–40′	20′–40′	20′–40′	20′–40′	20′–40′
Tiers number	5	5	5	5	5	5
Operating weight. t	87	78	69	71.8	76	75.4

For example, all CVS Ferrari models are equipped with Kessler drive axles with oil bath multi-disc brakes. Almost all models of the main series have a rotary spreader (rotation to the left – 95°, to the right – 185°) with an upper grip for working with 20- and 40-foot containers. The equipment includes the CANBUS control system, the 3B6 overload and overturning protection system, the rollback blocking system when the boom is lowered, and the complete set for operating the equipment in low-temperature conditions.

Reach stackers of Linde Heavy Truck Division, Ltd., produced at the plant in Wales, work in many terminals and ports of companies around the world. The spreaders are adapted to work with 20- and 40-foot containers, while the turning radius of the reach stackers with the boom raised is 13.05 m. All models have the same overall spreader length, wing width and wheelbase. The cabin meets the requirements of the ISO 6682 standard in terms of all parameters of ergonomics. The fully

adjustable steering column allows you to adjust the controls to the height and build of the machine operator.

The Hyster company, which has its production facilities in Europe, the USA, Japan, Australia, Brazil, Mexico and the Philippines, announced a new line of reach stackers after successful tests. The automatic displacement of the cabin by 2.6 m is standard for models of the IH type. This is especially convenient when working at a low height when it is necessary to see the base of the load and the distance to the ground. The cab in the SN models is manually moved up to 2.6 m to provide access to the engine and subframe components.

The Liebherr LRS 545 reach stacker of the West German concern is designed for overloading containers to 45 tons carrying capacity. It has the possibility of lifting them to a height of up to the 5th tier in the 1st container row. The main problem in the operation of the hydraulic boom drive is the occurrence of asymmetric loads due to malfunctions of the hydraulic cylinder locks and overloads under the influence of lateral forces. The boom telescoping of the box section is carried out by two hydraulic cylinders located inside the housing wrapped around (that is, coaxial with each other). The first hydraulic cylinder is mounted at the boom base, the second hydraulic cylinder is mounted in the upper telescopic section near the boom head.

The main difference between the SMV Konecranes models and the reach stackers of other companies, in addition to the use of axial-piston pumps, is the chassis frame made of the welded box profile with reinforced upper and lower walls. It is interesting that for all the years of the production, the company has never received complaints about cracks in this design.

Kalmar Industries factories are located in Sweden, Finland, the Netherlands and the USA, the equipment is operated in more than 140 countries of the world. For handling loaded containers in the 2nd and 3rd rows, Kalmar offers «heavier» models equipped with support jacks. It is advisable to use them for the overloading of car trailers or containers from railway platforms, which stand on the second road.

Terex company offers several models for overloading containers to 45 tons carrying capacity (Fig. 2): TFC45, TFC45R and TFC45RS with 6 000 mm wheelbase, as well as machines with an extended base TFC45L, TFC45LS and TFC45LSX (as evidenced by the letter L in the index) with 7 000 mm distance between the axles of wheels.

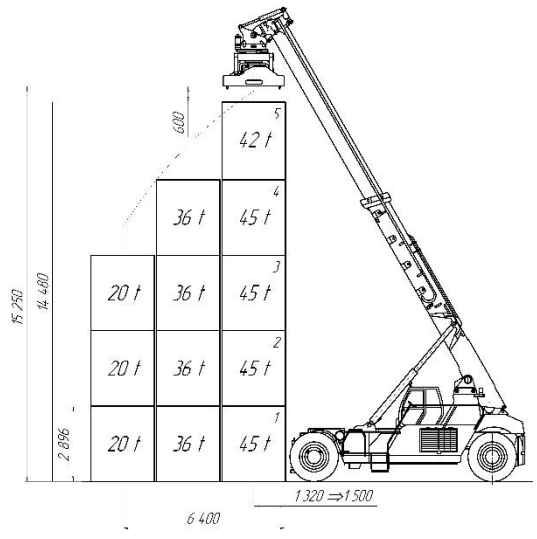

Figure 2. Scheme of stacking containers by reach stacker

The required number of container stacking tiers from the listed machine models is provided by the TFC45L and TFC45LS models. We will take this as an analog for further research and design development, using the design procedure of reach stacker control system [6]. The TFC 45 model range is produced in two versions: reach stackers are equipped with 290-horsepower Cummins M11 turbodiesels for the French and English markets and models with 320-horsepower Cummins QSM11 engines for other EU countries and the USA are provided. All machines of the TFC series are equipped with Clark 15.5 HR (Dana 36432) reversible four-range automatic transmission, which provides 25 km/h speed in the highest gear.

3. CONCLUSIONS

The review and analysis of river stacker models for handling operations in port facilities and overloading complexes showed that only international companies produce such machines. The reach stackers model range is presented with both an electromechanical drive for the load-grabbing mechanism control and a hydraulic one. This drive increases the resources of the equipment, allows you to optimize the operation of the engine, units and aggregates, and reduces the probability of emergencies.

References

[1] Vikovych I. A. Transportni navantazhuvalno-rozvantazhuvalni zasoby [Transport handling means]. Lviv, 2018. 678.

[2] Loveikin V. S., Palamarchyk D. A., Romasevych Yu. O., Balaka M. M. Analysis of starting in horse head system at optimal jerking mode of movement. *Machinery & Energetics.* 2021. No. 12(1). P. 67–73. URL: http://dx.doi.org/10.31548/machenergy2021.01.067.

[3] Balaka M., Gorbatyuk Ie., Mishchuk D., Prystailo M. Characteristic properties of support surfaces for self-propelled scrapers motion. *Fundamental and applied research in the modern world:* Abstracts of the 6th International scientific and practical conference (January 20–22, 2021). 2021. Boston, USA. P. 53–58.

[4] Izteleuova M. S., Hrytsuk I. V., Arimbekova P. M., Tarandushka L. A. Orhanizatsiia ta lohistyka perevezen [Organization and logistics of transportation]. Kherson: Oldi Plus, 2021. 264.

[5] Teteriatnyk O., Balaka M. Analiz shliakhiv zabezpechennia enerhonezalezhnosti budivelnoi tekhniky z vykorystanniam vidnovliuvalnykh dzherel enerhii [Analysis of ways to ensure the energy independence of construction equipment using renewable energy sources]. *Girnychi, budivelni, dorozhni ta melioratyvni mashyny*. 2021. No. 97. P. 24–35. URL: https://doi.org/10.32347/gbdmm2021.97.0301 .

[6] Lysak S., Balaka M., Machyshyn H., Diachenko O., Shcherbyna T. Design procedure of reach stacker control system. *Girnychi, budivelni, dorozhni ta melioratyvni mashyny.* 2024. No. 103. P. 25-32.

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