

Technological features of reach stacker operation when stacking containers

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ABSTRACT

The technological features of the reach stacker operation in container terminal conditions are considered in the paper. The container stacking schemes and the machine movement path are analyzed, which made it possible to determine the patterns of carrying capacity reduction depending on the stack height and spatial limitations of maneuvering. The calculated dependencies of the reach stacker performance and stability, and recommendations for the operation rational organization are presented.

Keywords: reach stacker, container, stacking, carrying capacity, performance, stability, maneuverability.

1. INTRODUCTION

The modern development of transport and logistics infrastructure is accompanied by the increase of container transportation and requires optimization of their processing technologies. Highly mobile handling machines play an important role in this, ensuring the flexibility and efficiency of cargo terminals and ports. The leading place among them is occupied by the reach stacker, which combines versatility and high performance. The reach stacker design allows stacking containers up to 5–6 tiers high, requiring minimal maneuverability space, which is especially important for cargo terminals with limited space [1–4].

The reach stacker efficiency depends on the site configuration, the base bearing capacity, the permissible loads on the coating and the organization of container flows. Compliance with safety requirements is of additional importance, especially under conditions of intensive round-the-clock operation.

Therefore, reach stackers remain a key element of logistics systems, and increasing their efficiency requires the integrated approach that combines the technical, organizational and technological solutions.

2. REACH STACKER OPERATION TECHNOLOGY

Analysis of the technological scheme for stacking containers by reach stacker (Fig. 1) shows that its carrying capacity directly depends on the lifting height. On the lower tier, the possibility of stacking containers weighing up to 45 tons is provided, on the middle levels – up to 36 tons, while on the upper tier, the permissible weight decreases to 20–42 tons. This is explained by the increase in the loading moment and the change in the force arm when the container gravity center is removed from the base of the machine [4, 5].

The stacking process must be carried out taking into account the permissible limits of operational characteristics. Failure to comply with these parameters creates the loss risk of the reach stacker stability, which can lead to emergency situations and damage to containers. Thus, the rational organization of stacking involves not only compliance with technical restrictions, but also the application of engineering calculations and control procedures that guarantee the safety of operations and increase the efficiency of container terminals.

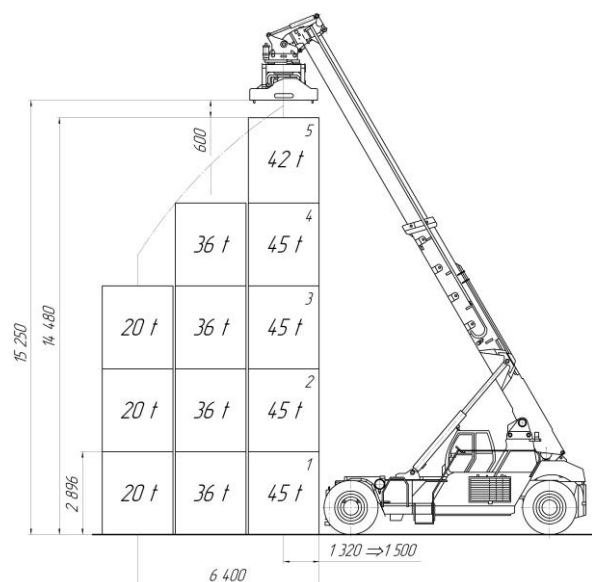


Figure 1. Technological scheme of stacking containers by reach stacker (side view)

The reach stacker operates in the limited space between stacks of containers when maneuvers (Fig. 2), which requires precise control and consideration of spatial parameters. The radius of the container path is approximately R_1 , while the turning radius of the reach stacker chassis is R_2 [1, 6].

The minimum width of the working corridor (distance between rows) is required not less than 12 m to ensure safe and efficient movement.

These parameters have the direct impact on the layout of the container site. In cases where the aisles between the rows are too narrow, the reach stacker is unable to perform the maneuver in one movement, requiring additional corrective actions by the operator. In turn, this leads to an increase in the work cycle duration, increased fuel consumption and the decrease in the overall performance of the handling operations [7].

Thus, the correct design of work areas in compliance with the regulatory parameters of the corridor is a key condition for increasing the reach stacker use efficiency in conditions of intensive container transportation. Rational organization of space ensures safe maneuvering of the machine, reduces the risk of downtime and emergencies.

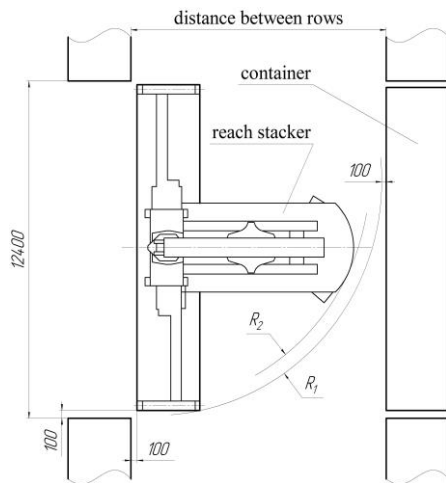


Figure 2. Scheme of reach stacker movement when stacking containers (top view)

We determine the reach stacker performance by an equation

$$Q = \frac{60 \cdot m}{t},$$

where m – mass of the container; t – time of one work cycle.

Thus, performance will increase in the case of the decrease in cycle time, which confirms the dependence of the reach stacker efficiency on the organization of the production process. In particular, on the optimization of movement path, reduction of idle runs, and rational planning of the work site.

The reach stacker stability is assessed under the condition of moment equilibrium

$$M_l \leq M_{st},$$

where M_l – moment from the container, $M_l = 9.81 \cdot m \cdot a$; a – force action arm from the container; M_{st} – moment from the machine mass with counterweight, $M_{st} = 9.81 \cdot m_r \cdot b$; m_r – reach stacker mass with counterweight; b – distance from the reach stacker mass center to the reference point.

The arm size increases as the boom reach increases, which reduces the permissible container weight. This limitation should be taken into account when stacking on upper tiers to ensure safety and prevent the machine from tipping over.

The reach stacker operation is associated with increased demands on the operator concentration and accuracy, especially when stacking containers on the upper tiers [6]. The human factor in this case has the direct impact on the performance and safety of the work process.

Key conditions for the reach stacker safe operation include:

- evenness and sufficient strength of the site for the reach stacker movement;
- compliance with speed limits during loading and unloading;
- automatic systems use for monitoring the loading moment and preventing critical deviations;
- work passages formation of appropriate width to avoid dangerous maneuvers and reduce the collisions risk.

The implementation of these measures increases safety and improves the operator work ergonomics, reduces physical and psycho-emotional stress, which contributes to the stability of performance and reduce the likelihood of accidents.

Reach stackers are advisable to use when flexible handling of containers various types is required, in the absence of large-sized portal cranes or the terminals with high cargo flow intensity and limited areas for maneuverability [1, 4].

The effectiveness of their use is determined by the balance between performance and stability: reduce the work cycle time increases throughput, and compliance with stability conditions, regulatory loads and site parameters prevents accidents and preserves the equipment durability.

3. CONCLUSIONS

The rational operation of the reach stacker requires the comprehensive approach that combines organizational measures (such as careful site planning, optimized traffic flow logistics, and scheduling of handling operations) with advanced technical solutions (automated load moment control systems). Such integration ensures not only safety, efficiency, and high performance of container handling operations, but also reduces downtime and prolongs the service life of the machine.

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