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Structural features and drive options for scraper conveyors in agricultural industry

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Abstract. *The article examines the structural features of chain scraper conveyors used in the agricultural sector, particularly the types of drive stations and their characteristics. The current state of domestic production is assessed, key advantages and challenges are identified. Emphasis is placed on the importance of improving the reliability and technological efficiency of the equipment.*
Keywords: *technological efficiency, equipment.*

The chain scraper conveyor is a continuous-action transport machine designed for horizontal or inclined movement of bulk and small-lump materials. The main working element of the conveyor is a chain with scrapers enclosed within a housing, which moves the material along the bottom of the transport trough. Due to this design, chain scraper conveyors provide minimal dust generation and high operational safety, which is especially important for the agricultural industry.

According to expert estimates, as of 2023–2024, Ukrainian manufacturers account for about 65–70% of the total supply of chain scraper conveyors to the domestic market. This situation is driven by both economic factors (availability of raw materials, reduced logistics costs, support for local manufacturers) and technical ones – modern domestic enterprises demonstrate a high level of standardization, reliability, and adaptation of products to the requirements of Ukrainian grain elevators and storage facilities. However, Ukrainian manufacturers in this market must compete not only with foreign companies but also consider increasingly likely risks associated with disrupted logistics (reduced range of components, longer delivery times, and higher logistics costs), shortages of qualified personnel, and power outages.

Therefore, under current conditions, to ensure efficient and stable production, reduce costs, and guarantee high-quality agricultural products, manufacturers must constantly seek ways to enhance the reliability and technological advancement of chain scraper conveyors.

An analysis of current scientific developments shows that a significant number of studies are devoted to the analysis of chain scraper conveyor designs, improvement of their energy efficiency, wear resistance, reliability, and adaptation to operating conditions in the agro-industrial sector.

For example, the authors of [1] offer a detailed analysis of conveyor design development and classification. The structural aspects and application areas of mechanical conveyor systems are examined. The characteristics are evaluated, and the advantages contributing to increased efficiency, productivity, and sustainability of industrial processes are highlighted. Work [2] presents a comprehensive analysis of the development and classification of mechanical conveyor systems. It emphasizes the importance of optimizing these systems to improve performance and reduce environmental impact in industrial processes. Study [10] examines the operation mechanism of chain conveyors with a trough and analyzes material movement support in such systems. The importance of proper chain design is demonstrated to ensure energy efficiency and optimal operation of bulk material transportation systems.

Drive stations play an essential role in the overall operability of conveyors. The drive station ensures chain movement via a gear motor, which transmits torque to the drive sprocket. The drive is selected depending on required capacity, route length, loading conditions, installation location, and more.

Currently, the most common types of drive stations, depending on the type of gear motor, are:
- Bevel-helical gear motor with hollow shaft;
- Parallel shaft helical gear motor with hollow shaft;
- Gear motor with output shaft and flexible coupling;
- Gear motor with V-belt transmission.

The **bevel-helical gear motor** is one of the most common drive types for conveyors due to its high reliability and compactness. Its design provides an efficiency (η) of up to 96%. The hollow output shaft allows direct mounting onto the drive shaft via key or clamping sleeve, simplifying installation and maintenance. Thanks to its compact size, this type is currently in the highest demand.

The **parallel shaft helical gear motor with hollow shaft** also provides up to 96% efficiency. However, when mounted on the drive shaft, it significantly increases the dimensions of the drive station, which negatively affects its applicability in confined spaces, such as under or above silo galleries. Nonetheless, their cost is 5–15% lower compared to bevel-helical units.

Flexible elastic couplings are used to connect the gear motor to the conveyor's drive shaft to compensate for misalignments, dampen vibrations, and protect drive components from shock loads. This connection scheme ensures longer drive life and high maintainability, especially in powerful and long conveyors. However, this type of drive station has the largest dimensions.

Gear motors with V-belt transmission are not widely used, though they offer smooth operation and reduced vibration. They are easy to adjust in terms of gear ratio and provide motor overload protection. Nevertheless, the need for constant tension control and belt condition monitoring is a significant disadvantage, especially under increased costs for automation of the material handling process.

References

1. Deka, R., Borthakur, P. P., Baruah, E., Sarmah, P., & Saikia, M. A comprehensive review on mechanical conveyor systems: evolution, types, and applications. International Journal of Natural and Engineering Sciences. 2024. Vol. 18, № 3. P. 164–183.

2. Zhang, S., & Xia, X. Optimal control of operation efficiency of belt conveyor systems. Applied Energy, 2010. № 87(6). P. 1929–1937. https://doi.org/10.1016/j.apenergy.2010.01.00.

3. Katterfeld, A. Calculation of motion resistances in trough chain conveyors by method. Whitepaper. 2021. Otto-von-Guericke University, Chair of Material Handling, Institute of Logistics and Material Handling Systems. https://doi.org/10.13140/RG.2.2.18282.85444/1.