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REVIEW OF ELECTRIC DRIVE OPTIONS FOR BELT CONVEYORS

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Belt conveyors play a pivotal role in mineral extraction processes, serving as an indispensable technological component in all relevant industrial facilities. Special attention is directed towards research in the field of electric drives for belt conveyors, given that their efficiency significantly impacts the productivity of mining operations. Currently, active efforts are being made to optimize control methods, aiming to make the process more efficient and economically viable. Emphasis is placed on the development of drive mechanisms with enhanced mechanical reliability.

Since the early 1990s, the predominant and leading type of motor used in belt conveyor drives has been the squirrel cage induction motor. Due to its simple design, high reliability, and cost-effectiveness, this motor type has displaced the use of direct current motors. In drive systems without regulation, a fluid coupling was employed for smooth starting; however, this component has several drawbacks [1]. Figure 1[1] depicts a schematic of a disassembled squirrel cage induction motor.

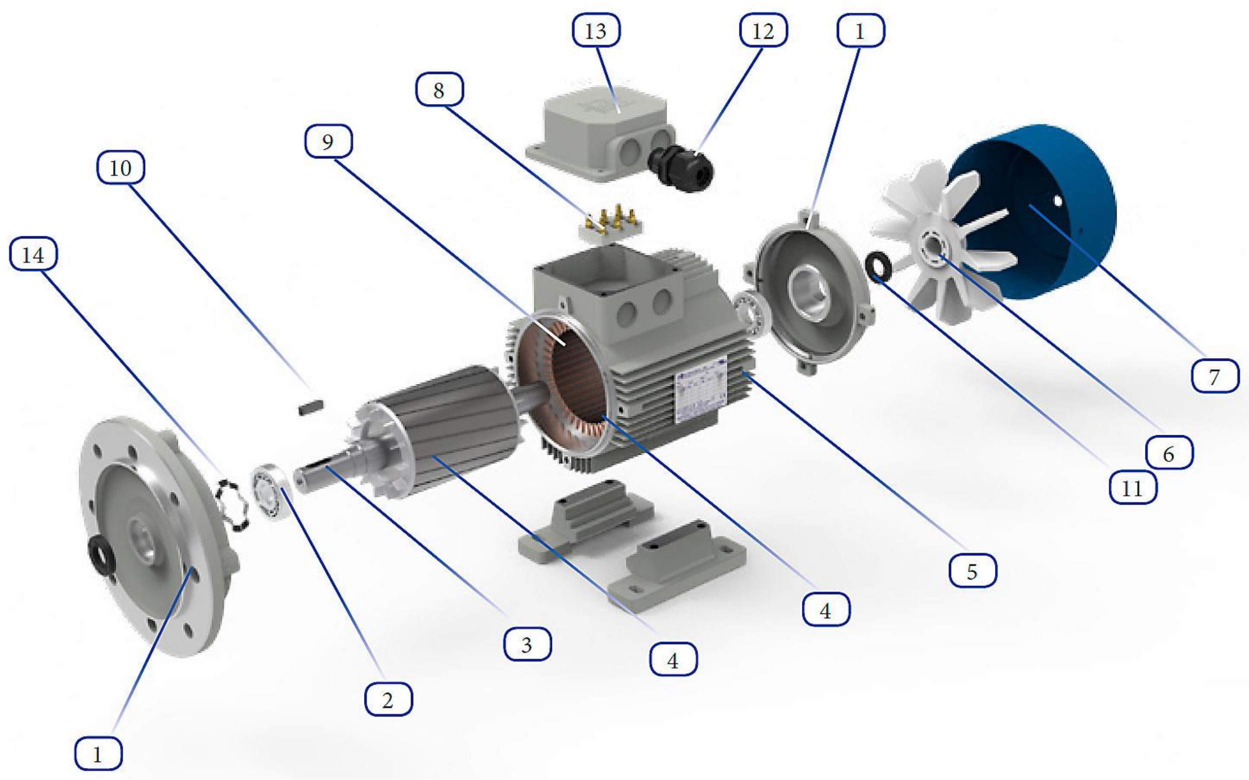

Figure 1 – Asynchronous motor with squirrel-cage rotor

With the advancement of microprocessor and semiconductor technologies, uncontrolled electric drives have been replaced by adjustable ones. The combination of a frequency converter and an induction motor has enabled a reduction in energy consumption and an increase in the energy efficiency of technological devices.

Despite all the advantages of the asynchronous drive, there are notable drawbacks to highlight. Significant dimensional sizes compared to synchronous motors equipped with permanent magnets, as well as the use of a gearbox, hinder space savings and the creation of a compact drive. Additionally, the asynchronous motor has limited overload capacity, amounting to only 2.5 times the nominal value.

At the end of the previous century, neodymium magnets (Nd2Fe14B) [2] emerged, capturing the attention of motor manufacturers due to their high induction. China is the primary supplier of neodymium magnets, accounting for approximately 96% of the global production volume of rare earth elements [3].

Magnets of this type have gained widespread use and found application in the production of Permanent Magnet Synchronous Motors (PMSM). These innovative magnets have become an integral part of technological advancement in the field of electrical engineering, particularly in the development of modern electric motors.

In Permanent Magnet Synchronous Motors (PMSM), the magnetic field is generated using permanent magnets instead of a traditional excitation winding. This design improvement has led to several advantages, including increased efficiency and reliability by eliminating the brush assembly in the motor. Such (PMSM) motors require minimal maintenance throughout their operational lifespan [4].

Main Advantages of PMSM-Based Electric Drive [5, 6]:

1. Enhanced device reliability (elimination of the brush assembly in motors).
2. Increased overload capacity in terms of torque.
3. Low inertia, resulting in improved dynamic response.
4. Elevated energy efficiency, with minimal variations under varying loads.
5. Minimal size and weight characteristics.
6. Extended service life due to simple design and strength margin.
7. Capability for high-speed operation.

Figure 2 illustrates various PMSM constructions.

Thus, this type of motor finds extensive application in various industries in our daily lives. Permanent Magnet Synchronous Motors (PMSM) play a crucial role in the drives of mining equipment, including control systems for belt conveyors. The use of PMSM in such systems allows for the creation of drives without additional mechanical components, such as gearboxes or couplings, owing to the high torque values. This attests to the mechanical strength and reliability of these drives.

The main drawback of implementing an electric drive using synchronous motors with permanent magnets is the increased cost compared to drives based on asynchronous motors. The primary factor influencing the price is associated with the use of rare earth magnets in the construction of the electric motor.

Depending on the control method, there is a need to equip the motor with a rotor position sensor.

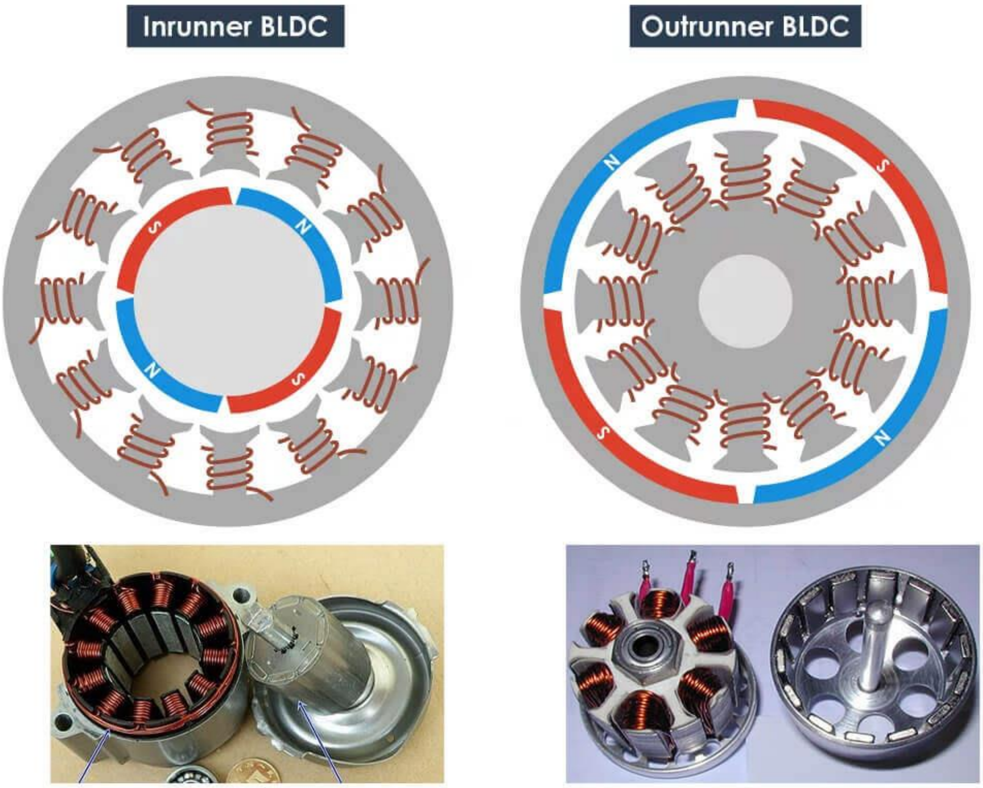

Figure 2 – Types of design of a synchronous motor with permanent magnets

The position sensor provides:

1. Sensor feedback, allowing the controller to accurately determine the rotor's position at any given time, crucial for proper stator current control and ensuring efficient motor rotation.
2. Phase synchronization, enabling the correct control of stator currents and ensuring effective torque production.
3. Start-up position, indicating the initial position for motor rotation.
4. Efficiency and precision in control, thereby enhancing its overall efficiency and performance.
5. Loss prevention.

Today, the control of a permanent magnet synchronous motor (PMSM) can be categorized into two main types:

1. Sensor-based feedback control using position sensors.
2. Sensorless control.

This study has examined progress in the field of electric drive systems for belt conveyors. Currently, synchronous motors with permanent magnets are considered the most promising option for use in conveyor electric drives. Despite the high construction cost, which impacts the overall expense, such an electric drive system provides a significant reserve of mechanical strength and resilience to failures, which is crucial for economic considerations. The energy efficiency of these motors should also be taken into account, ultimately contributing positively to production efficiency. Additionally, it is worth noting that such a drive system does not require frequent maintenance throughout its operational lifespan.

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