



# SAFE AND EFFICIENT HOISTING

**A**ccording to the World Coal Association, global coal production reached a record level of 7.8 billion t in 2013, an increase of 0.4% on 2012. The top five hard coal producing countries were China, the US, India, Australia and South Africa. Among these top producers, ABB has delivered numerous mine hoisting systems to underground mines in China and South Africa, as well as to Poland.

Although there are two types of underground coal mines – shaft mines and drift mines (incline shafts), depending on the depth of the coal seam and the surrounding terrain – this article will concentrate on mine hoist applications in shaft coal mines that have vertical access to the coal seam: i.e. the mine hoists that carry

workers and equipment into the mine, as well as transport coal to the surface.

## Types of mine hoists

Mine hoists are divided into three categories: friction hoists, drum hoists and Blair multi-rope hoists. Both the friction hoists and drum hoists are used in coal mines; the selection is dependent on the mine's preference for technology and the mining conditions, as well as mining traditions in each country.

### Friction hoists

Friction hoists (Figure 1), also known as Koepe winders, can be used either for production or service purposes for the



## Oswald Deuchar and Wenqing Cui, ABB AB, Sweden, discuss mine hoist options for coal mines.

transportation of material, equipment and personnel. They are suitable at depths of 150–2000 m, although they are most suitable and economical at depths of 150–1800 m. Friction hoists can be tower mounted or ground mounted and they typically use between two to six ropes to carry the load. Hoist rope is not stored on friction hoist drums but only transported over it via a principle of friction.

### Drum hoists

Both single and double drum hoists serve as production or service hoists. A single drum hoist (Figure 2) requires a larger motor than the functionally equivalent friction or double drum hoist. There is no counterbalancing on the descending load, as there is with double drum hoist,

which generally limits the payload that single drum hoists can carry at depth. Single drum hoists are normally used as auxiliary hoists: for example, in emergencies, at loads of less than 4000 kg or as service hoists to depths of 1500 m.

A double hoist (Figure 3) is suitable at any depth up to the current maximum assumed hoist depth (due to the technical limitations of hoist rope) of 2000 m. Normally one drum raises a full load, while the other drum lowers an empty load. A double drum hoist normally costs more than the functionally equivalent friction hoist and requires a larger motor and stronger electrical network. Double drum hoists are traditionally ground mounted and each drum of a double drum hoist uses one rope to carry the load.

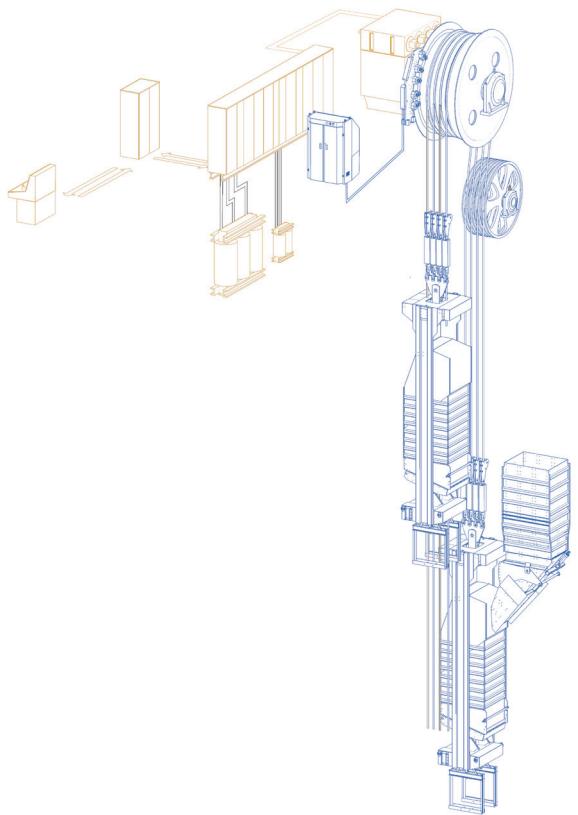


Figure 1. Illustration of a typical friction hoist.

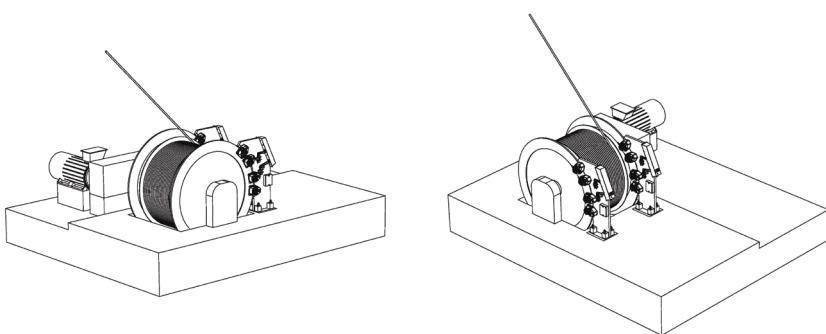


Figure 2. Illustration of a typical single drum hoist.

### Blair multi-rope hoists

Blair multi-rope hoists can be used as production or service hoists. Blair multi-rope hoists are also known as multi-rope drum hoists. They can use either one (single) or two drums. A multi-rope drum hoist is similar to a drum hoist – but each drum uses two ropes to handle the load which, in turn, adds certain complications. Two ropes carrying the load provide for a higher payload (but not double the payload). Blair hoists are preferred for depths above 2000 m and payloads above 13 000 kg. Since this type of hoist is an expensive hoisting solution and is only

suitable for very deep mines, they are not applicable for use in coal mines.

### Mine hoist case studies: China and South Africa

As mine hoists are significant capital investment, efficient, safe and reliable systems are of vital importance to coal mining companies. Since most coal mines are at depths of 600 – 1200 m, friction hoists are the first choice worldwide, except in the US and (to an extent) South Africa, where ABB has delivered a number of drum hoists to coal mines. Friction hoists are also less expensive than new drum hoists, while

the lead time for delivery may be shorter, as there are more suppliers. What is more, a friction hoist is smaller in diameter than a drum hoist for the same service, making it easier to ship and install than a drum hoist.

ABB has a large installed base of mine hoists and brake systems in China's coal mines. For example, it has delivered two hoisting systems to the Majalian coal mine, a subsidiary of Datong Coal Mine Group (Figure 4). The mine hoisting systems provided by ABB are China's largest and cover the main units, the motors, the control systems, the ACS 6000 MV drives, the break control systems and related technical service. The two systems have a 5.7 m dia., a payload of 45 t and an average payload per hour of 1520 t. They are now used in the main shaft of the Majaliang coal mine, significantly improving operational efficiency.

The new mine hoists also feature half-speed, full-load functionality – the first of its kind delivered to the Chinese coal mining industry. ABB's ACS 6000 MV drives, using two sets of independent systems, including rectifier units and inverter units, control the entire hoist. Under normal conditions, these two systems work separately and the hoist operates at full-load and full-speed. However, when one set of systems stops working, the entire hoisting system can be shifted to urgent mode by using the other system independently. Under these conditions, the hoist will operate at a full-load but at half-speed. Normally, without adopting ABB's technology, when experiencing a malfunction, the mine hoist has to stop working for examination and repair, compromising the safety and continuity of mine production.

ABB South Africa has been delivering hoisting systems to the coal mining industry since 1961. In recent years they have delivered friction hoists to all of the new Sasol mines, a total of 10 hoists since 2005.

In 2007, ABB received an order for two friction hoists from Anglo American for the Zibulo project. This project was a turnkey hoisting project and included delivery of the cages, sheaves and counterweights. The primary hoist is

friction hoist with six ropes and has a payload of 75 t, the largest payload for coal mines in South Africa. The service hoist was a two rope friction hoist used to transport men underground. The hoists were commissioned and handed over to the mine for permanent use in 2012.

### Key issues: energy efficiency and safety

Energy consumption and storage is set to become a key issue. Through technological development, ABB has developed a new peak-power compensation system for mine hoists. This offers a great number of advantages to customers operating mine hoists on weak networks. The system uses a flywheel connected directly to the hoist motor drive as an energy storage medium. This cost-effectively improves network quality by reducing peak power demand, power swing and power demand change rate. The flywheel can also reduce the CAPEX and OPEX needed for a local power plant or enable full utilisation of the hoist when the grid network is otherwise too weak.

The safety integrity level (SIL) is an increasingly important concern in the mining industry. As a complete mine hoist supplier, ABB follows IEC standards to build functional safety into mine hoist delivery, providing the assurance that the safety-related equipment will offer the necessary risk reduction required to achieve safety for the hoists.

The electrical control and drive systems for mine hoists from ABB have been accumulated with decades of experience. ABB – or ASEA, as it was then – launched the first electric drive for a mine hoist IM motor 1891. Since then, history has seen a lot of firsts in the development of ABB's mine hoists, such as the first Ward-Leonard drive with DC motor, the first digital hoist monitor in 1955, the first thyristor converter drive in 1962, the first cyclo-converter drive in 1987, the first MV VSI type ACS 6000 SD drive with synchronous motor, and so on. Now, with built-in SIL, ABB's advanced hoist monitors and reliable drive systems offer the company's mining customers

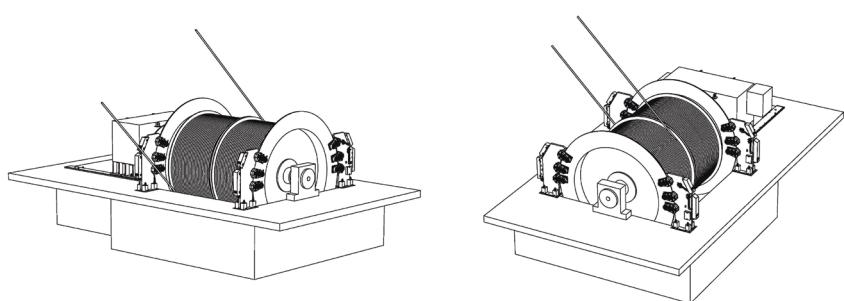


Figure 3. Illustration of a typical double drum hoist.



Figure 4. One of ABB's mine hoists at Datong Coal Mine Group's Majaliang coal mine, China.

maximum hoist availability, reliability and safety.

ABB's hydraulic brake system is used for emergency stops and holding during standstill. The system is split into separate and standardised products with a hydraulic power unit (HPU) and one or more hydraulic control units (HCU), making it modular and scalable to facilitate multi-channel configurations and hoist room layout. Both products are built with compactness and easy maintenance in mind and can be used in both friction and drum hoist applications. The hydraulic control principles are based on a high-performance safe servo-hydraulic solution for closed-loop regulated emergency braking, combined with a backup redundant constant brake force solution for unregulated, open-loop braking if needed. The hydraulic pipe configuration of the brake system enables full system circulation of the

hydraulic fluid and also creates dual return paths to minimise the duration of initial onset of the brakes at emergency stop. Combined with the ABB stand-alone SIL-certified brake-control system, the hoist brake system meets the requirements IEC standards.

ABB's in-house mechanical hoist design capability makes it possible to optimise hoist design between electrical and mechanical components in a most effective way. This mechanical capability makes ABB capable of designing every mechanical component for all types of mine hoists. With well proven design philosophy and advanced calculation tools, such as FEM, as well as strict manufacturing supervision and quality control, ABB has delivered a large number of tailor-made hoist systems or brake systems to coal mine customers in China, South Africa, Poland and India, among others. **W**