



ABB drives in cement
Medium voltage drives for reduced
energy consumption and optimized
process control



Increasing cement quality and reducing operating costs

With product quality demands and production costs rising, yet cement prices falling, the cement industry needs to use the most efficient technologies to safeguard its future.

To be profitable, cement producers need to:

- Reduce energy consumption per ton of produced cement
- Increase availability of equipment and reduce shutdown period
- Reduce maintenance costs

Achieving high levels of efficiency and availability will increase production output, improve product quality, lower energy costs and CO₂ emissions.

Energy-efficient processes in harsh conditions demand efficient and reliable process equipment

Equipment in most cement industry processes are exposed to extreme working conditions such as dust and high temperature variations.

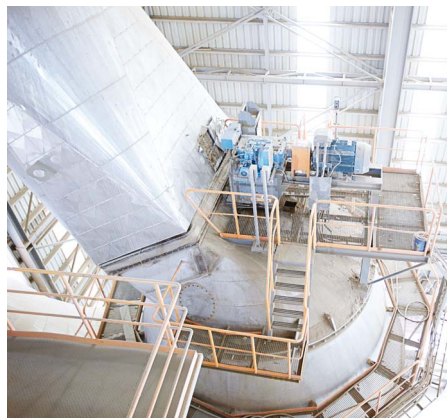
Such conditions put a high demand on the process equipment. To ensure consistent high quality cement, the process equipment has to operate reliably under these conditions.

Furthermore, cement production is very energy intensive. Much of the energy used is consumed by electric motors. Still today, many of these motors are constantly running at full speed regardless of actual output requirements, wasting a tremendous amount of energy. In many applications, energy use can be cut by up to 30 percent by controlling motors with variable speed drives (VSDs).

Variable speed drives

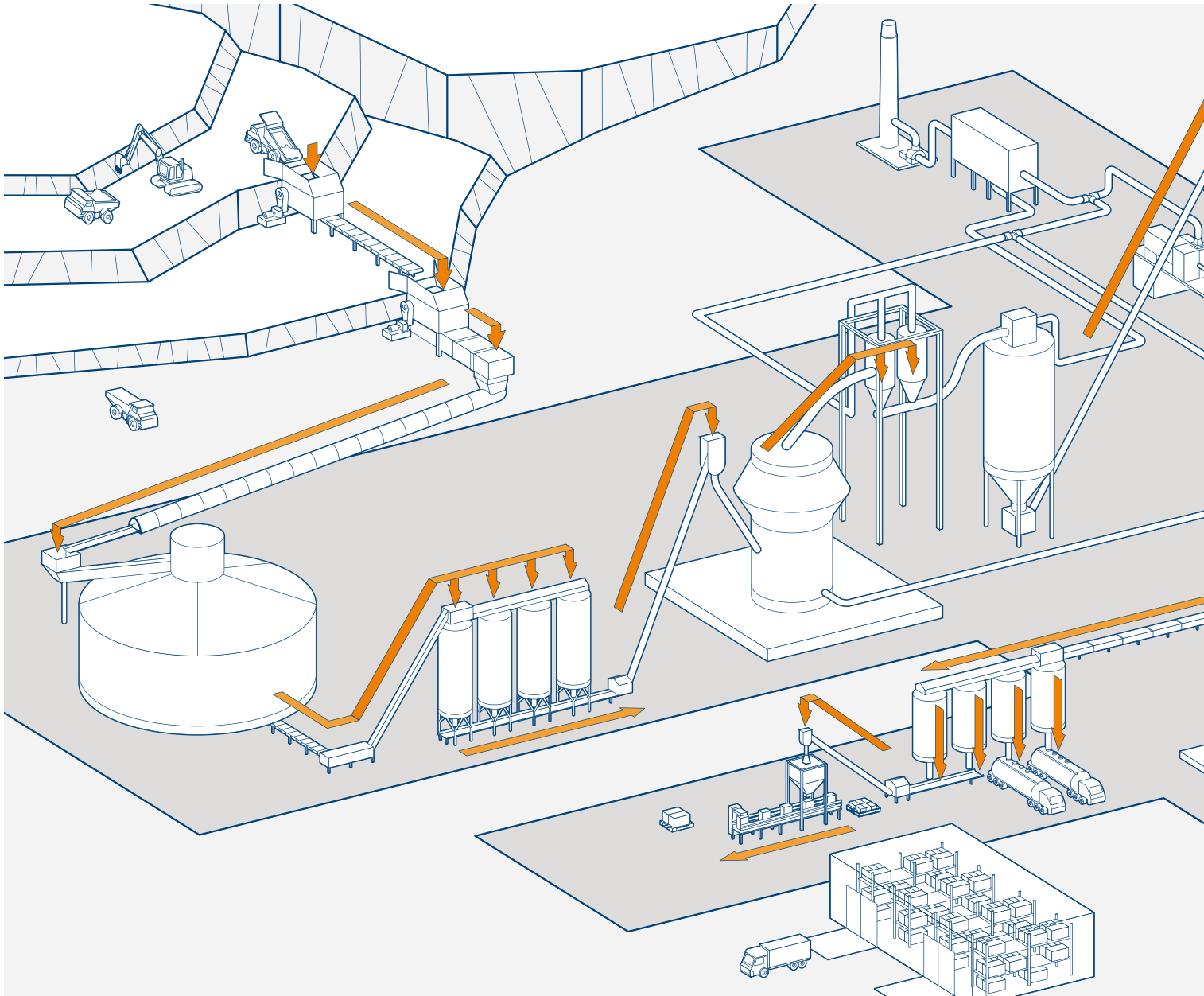
VSDs provide optimized process control and save energy. ABB has been supplying variable speed drives for over 30 years. Today, VSDs are used in a wide range of applications in the cement industry, such as:

- Induced draft (ID) / forced draft (FD) fans
- Baghouse fans
- Preheater tower fans
- Kiln gas fans
- Clinker cooler exhaust fans
- Separator fans
- Raw mills
- Cement mills
- Conveyors
- Rotary kilns
- Coal mills



Variable speed drives for cement applications

Various processes and applications benefit from using variable speed drives.

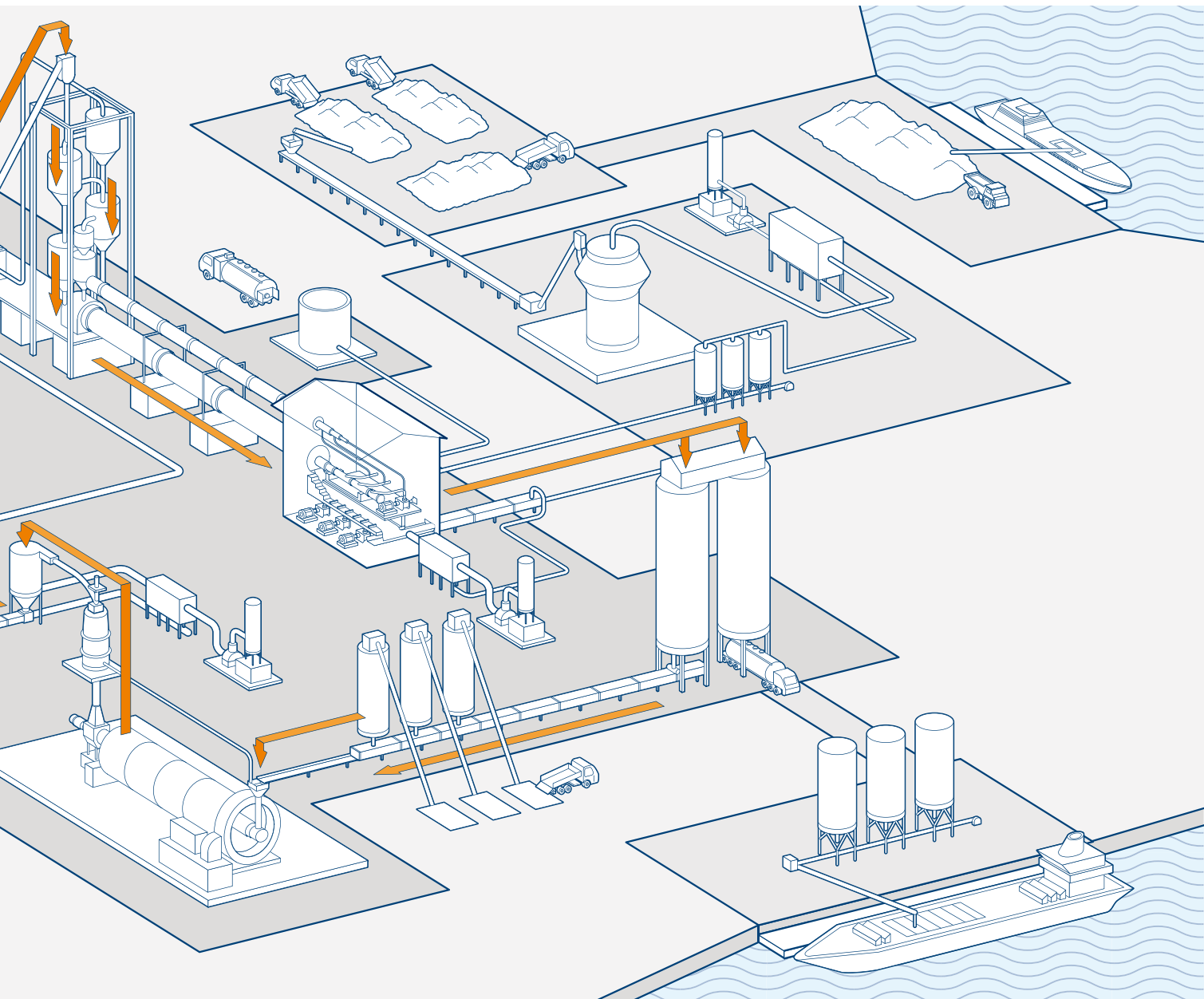


Quarry and conveying

- Conveyors
- Crushers

Raw mill and separation

- Fans
- Filters
- Mills



Kiln and clinker cooling

- Rotary kiln
- Fans
- Conveyors
- Filters

Fuel handling

- Mills
- Conveyors
- Fans
- Filters

Cement grinding

- Roller presses
- Mills
- Filters

Benefits of variable speed drives

Controlling processes with variable speed drives has a direct impact on a company's operating costs.

Fixed versus variable speed control

The most common flow control method is by means of a fixed speed motor where the flow is adjusted by a mechanical device. This method can be compared to adjusting the speed of a car by braking while keeping the foot on the gas pedal. This technique does not only waste a tremendous amount of energy, it also wears out the equipment.

With electric variable speed drives, changing the flow is simply achieved by adjusting the speed and/or torque of the motor, which can be compared to reducing the speed by taking the foot off the gas pedal. The equipment is operated at the BEP (Best Efficiency Point) under all operating conditions. Electric variable speed drives are the most efficient control method – saving energy, decreasing CO₂ emissions and minimizing total operating costs.

Variable speed drives replace mechanical control devices such as hydraulic couplings, valves, fan inlet vanes and dampers which are often used throughout the cement making process.

Benefits of variable speed drives

- Lower energy consumption and CO₂ emissions
- Minimized mechanical wear of equipment
- Higher process quality and efficiency
- Increased productivity and throughput
- Less investment in electrical network compensation devices, such as filters

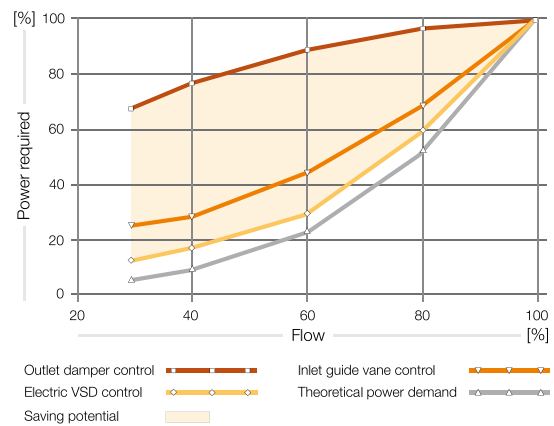


Fig. 1: Power consumption for various fan control methods



Energy savings and reduced emissions

The energy consumption of most motor-driven applications can be reduced with variable speed drives. Fans, for example, typically run at partial load. Huge energy savings can be achieved by controlling their speed with VSDs. The power required to run a fan is roughly proportional to the cube of the speed, ie a small reduction in speed can make a big reduction in the energy consumption. A fan running at half speed consumes as little as one eighth of the energy compared to one running at full speed. By employing VSDs on fans instead of dampers and vanes, the energy bill can be reduced by as much as 60 percent. Consequently, electric variable speed drives also help to reduce CO₂ emissions.

Reduced maintenance costs and longer lifetime of equipment

VSDs also act as soft starters, reducing the stress on network, motors and process equipment. During the starting process, the VSD progressively increases the motor speed and smoothly accelerates the load to its required speed.

Soft starting eliminates high starting currents and voltage dips which can cause process trips. By soft starting, maintenance costs will be reduced and the lifetime of the equipment extended.

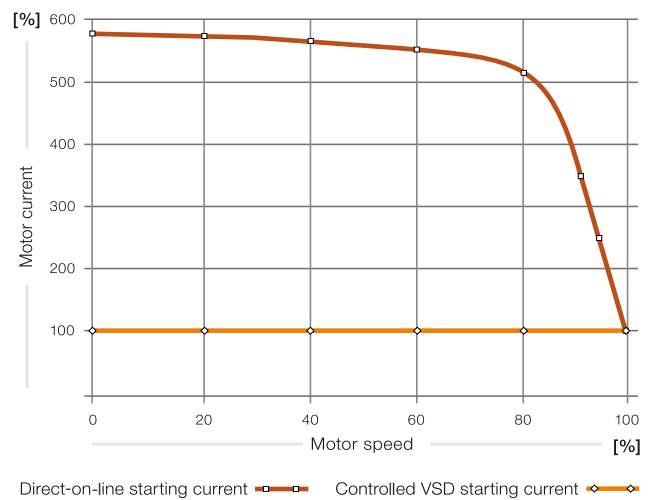


Fig. 2: Motor current for various starting methods



Applications

Fans

Energy savings and improved process control

The performance of centrifugal fans is controlled by a set of rules known as the affinity laws, which state that:

1. Flow is proportional to speed
2. Pressure is proportional to the square of the speed
3. Power is proportional to the cube of the speed.

The diagram shows a typical fan characteristic which is a function of volume flow and pressure. Also shown is a typical system characteristic. The operating point of the system is at the intersection of these two curves. If the required volume of air is deviating from this point, the fan or system characteristic needs to be changed.

Traditionally, the most common way of changing the operating point is by using a damper which alters the system characteristic (operating point moves from position 1 to 2, see Fig. 3) increasing the system losses. However, increasing or decreasing the fan speed with a variable speed drive will change the fan characteristic itself (point of operation moves from position 1 to 3, see Fig. 3) without adding additional losses. The energy consumption can be reduced significantly because lower pressure is needed for the same air flow.

Drives in action

Jura Cement, Switzerland's second largest cement producer, replaced a 25-year old cascade converter with a VSD from ABB. The ACS 2000 drive system, rated at 550 kW, controls the clinker cooler exhaust fan of Jura Cement's cement plant in Wildeg, Switzerland.

The clinker cooler exhaust fan plays a critical role in the cement making process. Raw mix enters the kiln and is heated to 1,450 degrees Celsius where it is transformed to clinker. Upon exiting the kiln, the clinker is cooled to 100 degrees Celsius by the clinker cooler fans which blow cooling air through the clinker. By controlling the clinker cooler exhaust fan, the drive keeps the pressure in the kiln hood constant. It does this by regulating the fan speed that draws cold air through the clinker cooler in relation to the hot air that is being drawn through the kiln.

Accurate energy input is critical to the quality of cement – insufficient heat will result in poorly burned low quality clinker whereas excess heat might damage the kiln shell.

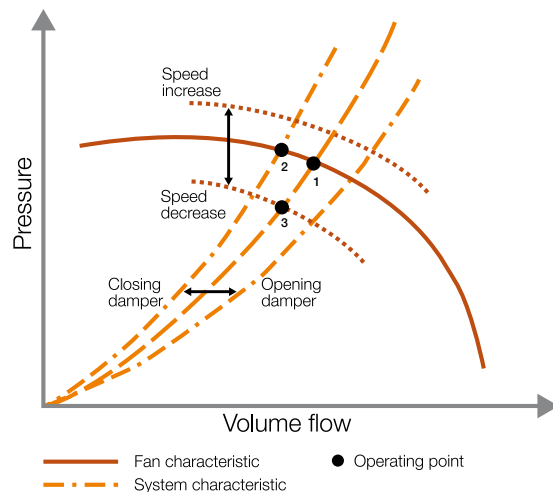
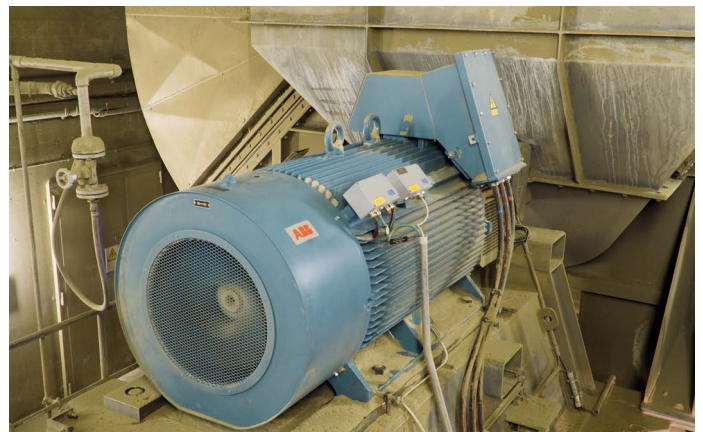


Fig. 3: Typical fan characteristic showing operating point

The replacement resulted in the following benefits:

- Higher availability
- Reduced maintenance costs
- Some 20 percent lower energy consumption
- Wide range of speed control from 0 to 1,000 rpm



Clinker cooler exhaust fan motor at Jura Cement

Applications

Mills

In cement production, mills are process critical. Reliable and precise control has a high impact on production throughput and operating costs. Controlling them with variable speed drives results in the following benefits.

Optimized plant production

By controlling a mill with a VSD, the speed of the mill is tuned for optimal grinding and maximum throughput, resulting in a more efficient use of the grinding power. If up and downstream processes require a lower grinding throughput, the mill can be operated at partial load without having to stop the process. VSDs can adjust the speed according to charge volume.

Less wear and higher reliability

Grinding raw material and clinker causes considerable wear to the grinding mill. Starting the mill direct-on-line stresses the mill and the gearbox, increasing the risk of gearbox failure and shortens the lifetime of mechanical equipment. VSDs help optimize the mill speed to match the material flow, thus minimizing the wear of the grinding mill.

Energy savings

Grinding mills can consume more than 60 percent of the plant's total electrical energy. Controlling them with VSDs results in significant energy savings.

Smooth ramp up

Torque pulsations and peak torques, generated by mills during the starting phase, creates high stresses on network and mechanical equipment. VSDs provide a smooth ramp up of the mill. They deliver high starting torque for the current drawn from the power plant system and have a programmed upper limit to reduce peak current during the start of the mill. The low starting currents and high starting torque enable a smooth start-up of the mill, even when fully loaded.



Applications

Conveyors

Extended lifetime and increased availability

Conveyors are found in almost every cement plant. The environment is demanding and there is always a risk of damaging the belt by overstretching, slipping or breaking. To reduce operational costs, it is important to extend the belt lifetime and availability.

Variable speed drives provide accurate torque and speed control of conveyors. This reduces the stress on mechanical equipment such as gearboxes, pulley and belts, especially during start-up and stopping, but also during operation and maintenance.

With the use of VSDs it is possible to control the speed of the conveyors to match the production capacity and as such reduce wear and save energy. For maintenance inspection, belt changes or repairs or avoidance of ice build-up it is possible to run the conveyor belt at slow speed.

Accurate and fast load sharing

ABB medium voltage drives provide an accurate and fast load sharing between several drives. This is useful for conveyor applications, where two or more motors operate on the same conveyor belt, making sure all motors are loaded as needed. The converter control provides a window speed limitation to prevent belt slippage.

Power factor compensation

With ABB medium voltage drives the power factor is greater than 0.95. There is no need for additional power factor compensation and there are less losses on the electrical network. Also, the electrical network is not exposed to high inrush currents when the conveyors are started.

Regenerative braking of downhill conveyors saves energy

To avoid unnecessary conveyor wear, downhill conveyors require continuous braking, which varies depending on the raw material transported. VSDs provide precise speed and torque control which is required for the continuous braking need demanded by downhill conveyors.

With VSDs, the braking energy can be fed back into the plant's electrical network, thereby generating energy.



Applications

Kilns

Variable speed drives are used to control the rotational speed of cement kilns. As the speed of material flow through the kiln is proportional to rotation speed, a VSD is required to control it. In addition to speed, VSDs provide controlled torque.

Special requirements of kiln drives

- High reliability. As cement making is a continuous process the kiln needs to operate 24 hours a day. As each kiln stop can cost several thousand dollars per hour, maximizing uptime is paramount.
- A wide range of speed control. During normal operation the rotary kiln is to be driven with the most suitable speed. This is decided by the condition of the material combinations and the combustion even if a load variation occurred.
- High control accuracy is required for an accurate load sharing if more than one motor is used.
- High starting torque. For the nominal starting period the rotary kiln must be driven with low speed until the temperature becomes sufficiently high.

High starting torque

A special design requirement is the starting torque. It is typically 250 percent of full load torque for the first three to five seconds before dropping to around 200 percent and gradually reducing further during the next 15 to 20 seconds at the end of which period the full speed is attained. This can be seen in figure 4. The physical size of the kiln and the weight of its contents mean that its inertia is fairly large. The eccentricity of the loaded material inside the kiln also substantially adds to the required starting torque.

Accurate and fast load sharing

To avoid oscillations in kilns with dual motors, high performance torque accuracy is required. This is achieved with the accurate and fast load sharing function of ABB's medium voltage drives.

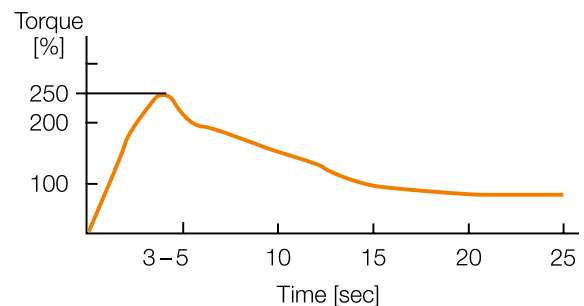


Fig. 4: Typical starting characteristic for a kiln



ABB medium voltage drives

The heart of a medium voltage drive system is the frequency converter. ABB offers the entire range of frequency converters for medium voltage applications in the power range from 250 kW to more than 100 MW.

ACS 1000 (315 kW – 5 MW, up to 4.16 kV)

The ACS 1000 is suitable for retrofit applications and new standard induction motors. Due to its unique output sine filter, bearing currents and voltage reflections at the motor are eliminated. The ACS 1000i is a fully integrated drive including input transformer and input contactor.

ACS 2000 (250 kW – 1.6 MW, 4.0 – 6.9 kV)

The ACS 2000 is suitable for retrofit applications and new standard induction motors. It can be used without an input isolation transformer, thereby allowing a direct connection to the line supply (direct-to-line), with an integrated transformer, or for connection to an external input isolation transformer. The ACS 2000 is also available for four-quadrant operation for energy regeneration and reactive power compensation.

ACS 5000 (2 – 32 MW, 6.0 – 6.9 kV)

The ACS 5000 can be applied to standard industrial motors (induction and synchronous). It is ideal for applications in the higher power range such as induced and forced draft fans, feed-water and cooling water pumps. The air-cooled ACS 5000 is also available with integrated transformer.

ACS 6000 (3 – 27 MW, up to 3.3 kV)

ABB's ACS 6000 is a modular drive designed for single or multi-motor applications for synchronous and induction motors. It can be equipped with an Active Front End which enables four-quadrant operation for energy regeneration and reactive power compensation.

MEGADRIVE-LCI (2 – 100 MW)

ABB's MEGADRIVE-LCI is an optimal solution for high voltage and high power applications. Standard designs are available for ratings up to 72 MW; engineered designs for more than 100 MW. The MEGADRIVE-LCI is available as variable speed drive or soft starter.



Technology highlights

Reliability is the main guiding principle of the research and development activities for medium voltage drives.



Direct Torque Control (DTC)

The ACS drive control platform is based on ABB's award-winning Direct Torque Control (DTC), resulting in the highest torque and speed performance, as well as lowest losses ever achieved in medium voltage drives. Control of the drive is immediate and smooth under all conditions.

Power loss ride through

Due to its power loss ride through function, the drive system is able to withstand disturbances of the power supply. The drive will continue to operate in an active but non-torque producing mode if the incoming supply voltage is cut off. The drive is active as long as the motor rotates and generates energy to the drive. It will resume normal operation immediately upon return of power supply.

Low parts count

The fewer the parts the higher the reliability. ABB uses high power semiconductor switching devices and a topology that minimizes the parts count.

Fuseless design

ABB medium voltage drives are designed to operate safely without fuses which are known to be unreliable, costly and subject to aging. The fuseless design results in less spare parts and fast re-starting.

Remote monitoring and diagnostics

DriveMonitor™ allows secure real-time access to the drive. It supports monitoring and diagnostics of ABB drives independent of the implemented control method, thus enabling the connection of existing installations.

The optional tool consists of a hardware module, as well as a software layer that automatically collects and analyzes selected drive signals and parameters.

Long-term monitoring functions deliver important information on equipment status, tasks needed and possible performance improvements. Diagnostic procedures and trending can cover not only the converter itself but other parts of the shaft train as well.



Motors and transformers

A variable speed drive system includes a medium voltage converter, motor and transformer.

ABB offers the complete variable speed drive system or assists in selecting components that match the process requirements. ABB's equipment is known for its state-of-the-art technology, high efficiency, reliability and worldwide support.

Converter motors

ABB's converter motors have earned an excellent reputation for performance and reliability. ABB's product range includes induction as well as synchronous motors.

Induction motors are the workhorses of industry due to their versatility, reliability and simplicity. In the power range up to 10 MW, a squirrel cage induction motor is usually the first choice. They are available up to 25 MW.

Synchronous motors are typically considered for higher power ratings (eg above 8 MW to more than 100 MW). In addition to their high power capabilities, synchronous motors offer the benefits of high efficiency and high performance through the utilization of different rotor designs.

Converter transformers

Converter transformers are especially designed for operation with variable speed drives. They adapt the converter to the supply network and provide a galvanic isolation between drive and supply network.

Converter transformers are available for nearly all ratings. Secondary voltages are optimized to match the converter and motor voltage. Oil or dry types for indoor or outdoor mounting are available. Busbar connections can also be provided.



Testing, service and support

ABB drives are backed by comprehensive service and support, from the customer's initial inquiry throughout the entire life cycle of the drive system.

Testing

ABB is committed to ensuring the reliability of every drive it delivers. To verify that quality standards and customer requirements are fully met, every component of a drive is subjected to thorough testing in ABB's modern test facilities.

Routine tests and functional tests form an integral part of the scope of supply of ABB's medium voltage drives. They are performed in accordance with international standards and ABB quality assurance procedures.

Additionally, ABB can perform a combined test with the complete drive system – including transformer, converter and motor – to verify the performance and to ensure a smooth integration into the customer's facility.

Installation and commissioning

Proper installation and commissioning of the equipment, done by qualified and certified commissioning engineers, reduces start-up time, increases safety and reliability and decreases life-cycle costs.

Life-cycle management

ABB's drive life-cycle management model maximizes the value of the equipment and maintenance investment by maintaining high availability, eliminating unplanned repair costs and extending the lifetime of the drive.

Life-cycle management includes:

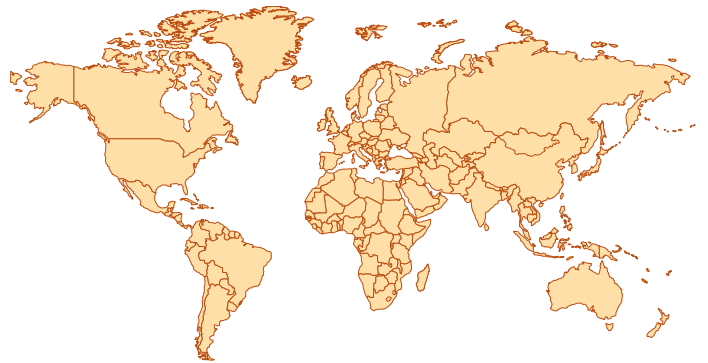
- Providing spare parts and expertise throughout the life cycle
- Providing efficient product support and maintenance for improved reliability
- Adding functionality to the initial product
- Providing a smooth transition to a new technology at the end of the life cycle

Training

ABB provides extensive training for its medium voltage drives. A range of training programs is offered from basic tutorials to programs tailored to the customer's specific needs. In addition, site personnel can be given practical training by experienced specialists on site.

Global network, local presence

After sales service is an integral part of providing the customer with a reliable and efficient drive system. The ABB Group of companies operates in more than 100 countries and has a worldwide network of service operations.



Services for ABB's medium voltage drives

- Installation and commissioning
- Training
- Remote services
- Preventive maintenance
- Customized service agreements
- Local support
- 24 x 365 technical support
- Spare parts and logistics network
- Worldwide service network

Contact us

www.abb.com/drives