



MV Drives, July 2012

# ABB drives in cement

## Medium voltage drives for reduced energy consumption and optimized process control

# Challenges

## Increasing product quality and reducing operation costs

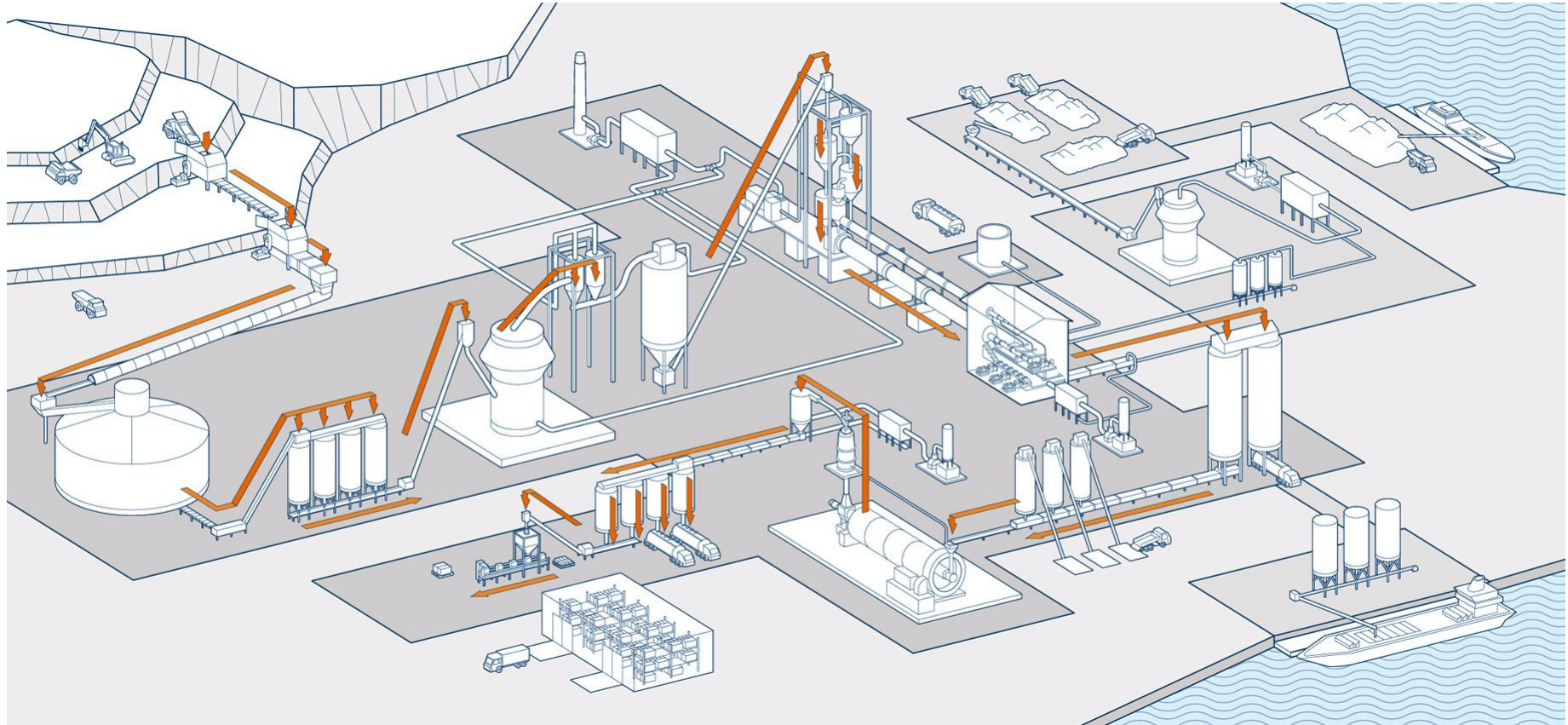


To be profitable cement producers need to:

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

**Variable speed drives (VSDs) optimize process control and save energy. VSDs are used in a wide range of applications.**

# Variable speed drives for cement applications



## 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 VSDs has a direct impact on a company's operating costs.

- Lower energy consumption and CO<sub>2</sub> 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

# Benefits of variable speed drives

## Fixed versus variable speed control

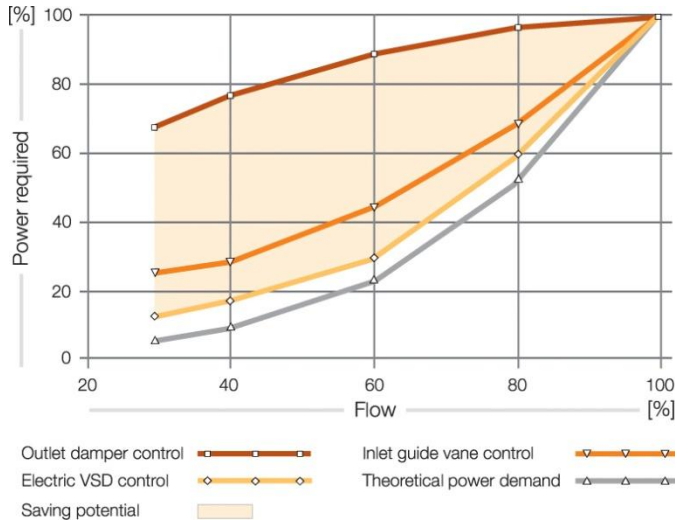
	Electrical	Mechanical
Variable speed	Variable speed drive	Hydraulic coupling
Fixed speed	On-off	Valve, fan inlet vane, damper

- Mechanical fixed-speed solutions
  - Flow is adjusted by a mechanical device, eg fan inlet vanes, dampers, resulting in:
    - Waste of energy
    - Wear out of equipment
- Electric variable speed drives
  - Change in production volume achieved by adjusting the speed and/torque of the motor
  - Equipment will be operated at Best Efficiency Point (BEP), resulting in:
    - Energy savings
    - Decreased CO<sub>2</sub> emissions
    - Minimized operating costs

# Benefits of variable speed drives

## Energy savings and reduced emissions

Power consumption for various fan control methods

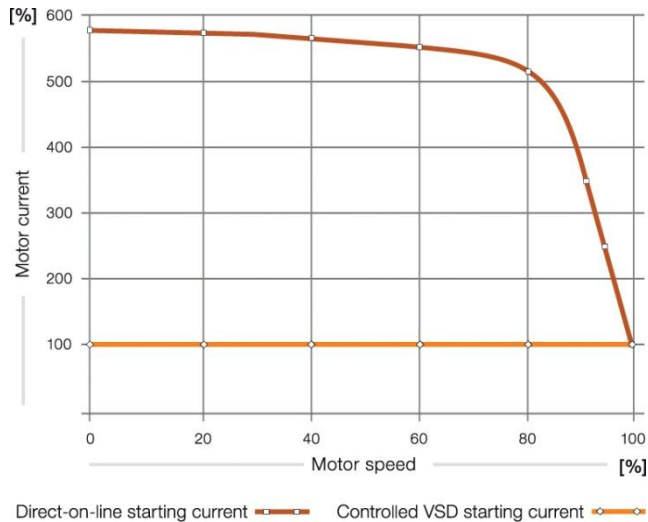


- Fans typically run at partial load
- Huge energy savings can be achieved by controlling their speed with variable speed drives
- A fan running at half speed consumes as little as one eighth of the energy compared to one running at full speed
- Energy consumption can be reduced by as much as 60% with variable speed drives
- Variable speed drives help to reduce CO<sub>2</sub> emissions

# Benefits of variable speed drives

## Reduced maintenance costs, longer equipment lifetime

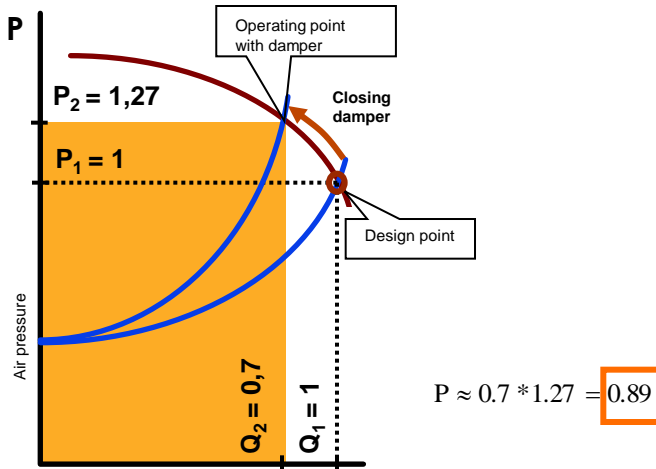
Motor current for various starting methods



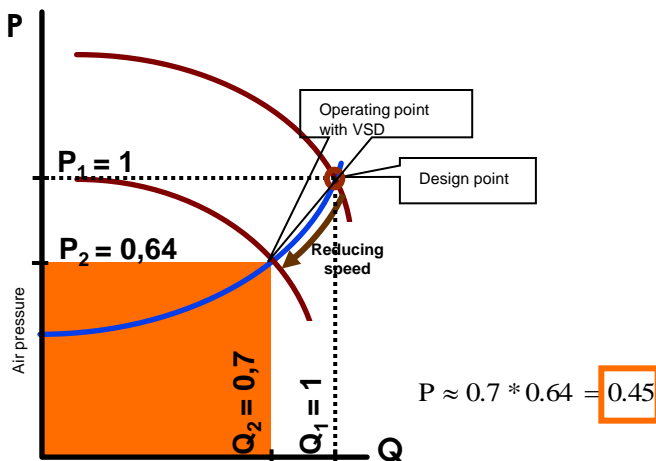
- A direct-on-line started electric motor can cause starting currents of up to 6 - 7 times the nominal current
  - Voltage drops can disturb processes especially in weak networks
- Benefits of soft-starting electric motors with variable speed drives:
  - No process disturbance due to voltage drops; no trips of other electrical devices connected to same bus
  - No excessive thermal or mechanical stress on the motor; longer lifetime of the motor
  - Controlled and smooth start-up

# Applications Fans

## Damper



## VSD Control



- Changing the operating point with a damper alters the system characteristic, increasing system losses
- Increasing or decreasing the fan speed with a variable speed drive changes the fan characteristic
  - No additional losses
  - Significant energy savings as lower pressure is needed for the same air flow

— Fan curve    — System curve



# Applications Mills



## Benefits of variable speed drives:

- Optimized plant production
  - More efficient use of grinding power - speed of the mill is tuned for optimal grinding and maximum throughput
  - Mill can be operated at partial load; no process stop required
  - VSDs adjust the speed according to charge volume
- Less wear and higher reliability
  - Direct-on-line start of the mill stresses the mechanical equipment, shortening its lifetime
  - VSDs help optimize the mill speed to match the material flow, minimizing the wear of the mill

# Applications Mills



- Energy savings
  - Grinding mills can consume more than 60% of a plant's total electrical energy
  - Controlling them with VSDs results in significant energy savings
- Smooth ramp up
  - Low starting currents and high starting torque enable a smooth start-up of the mill, even when fully loaded
  - Reduced stress on network and mechanical equipment

# Applications Conveyors



Benefits of variable speed drives:

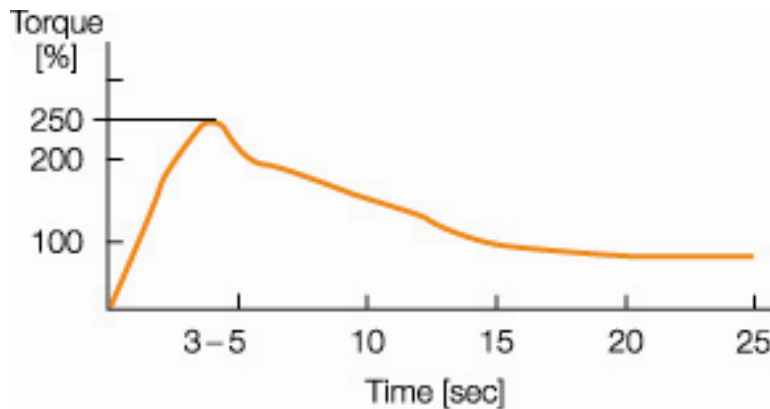
- Extended lifetime and increased availability
- Accurate and fast load sharing
- Power factor compensation
- Regenerative braking of downhill conveyors saves energy

# Conveyors

## Benefits of variable speed drives

- Extended lifetime and increased availability
  - Accurate torque and speed control reduces stress on mechanical equipment
  - Speed of the conveyor can be adjusted to production capacity reducing wear and saving energy
- Accurate and fast load sharing between several drives
  - All motors are loaded as needed if several motors operate on the same conveyor belt
- Power factor compensation
  - With ABB drives power factor is greater 0.95
  - No need for additional power factor compensation
  - Less losses on electrical network
- No inrush currents when conveyors are started
- Regenerative braking of downhill conveyors saves energy
  - The braking energy can be fed into the plant's electrical network, thereby generating electricity

# Applications Kilns



Special requirements of kiln drives:

- High reliability – a kiln needs to operate 24 hours a day
- A wide range of speed control – a kiln's most suitable speed is determined by material combinations and combustion even when load variations occur
- High control accuracy for an accurate load sharing if several motors are used
- High starting torque – the kiln must be driven with low speed until the temperature becomes sufficiently high

# Components of variable speed drives

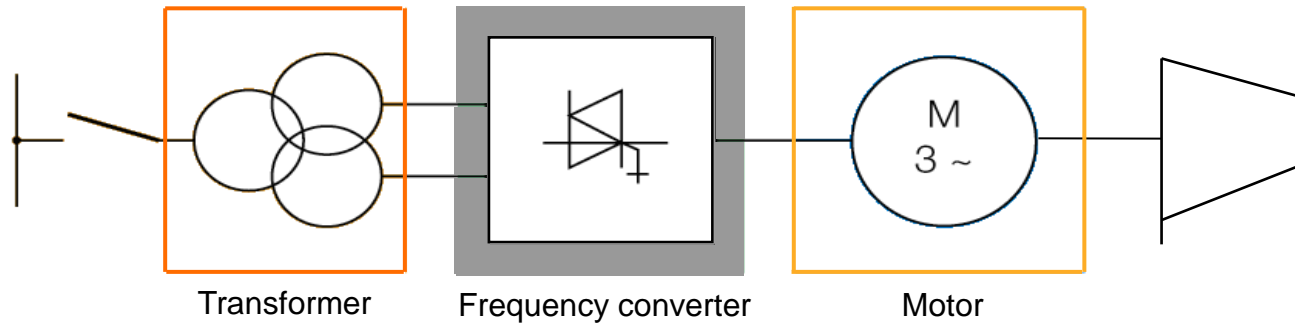


ABB can offer the complete variable speed drive system or assist in selecting components that match the process requirements.

A variable speed drive system consists of:

- Input transformer
- Frequency converter
- Electric motor

# Medium voltage variable speed drives



- Power range: 250 kW – more than 100 MW
- Voltage range: 2.1 kV – 10 kV
- Products available for operation with external transformer, integrated transformer or for direct-to-line connection (transformerless)

# Technology highlights



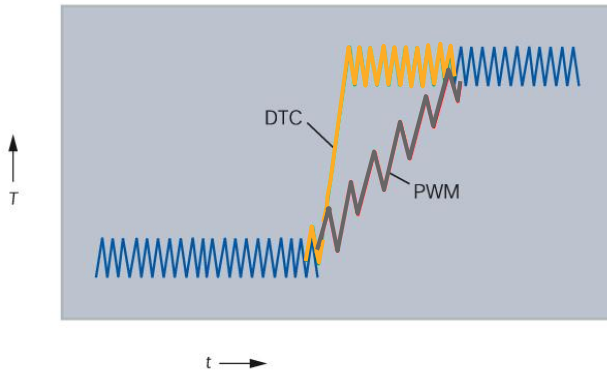
- Direct Torque Control (DTC)
  - For highest torque and speed performance
- Power loss ride through
  - The drive system is able to withstand power supply disturbances
- Low parts count
  - ABB uses high power semiconductor switching devices and a topology that minimizes the parts count
- DriveMonitor™ (option)
  - Remote and real-time monitoring and diagnostics of ABB drives from any location in the world



# Direct Torque Control (DTC)



Typical torque response (t) of a DTC drive, compared with flux vector control and open loop pulse width modulation (PWM)



## Direct Torque Control

- Provides fast, accurate and stepless control from zero to full speed
- Full torque with optimal speed accuracy over the whole speed range
- Negligibly low torque ripple
- Minimal inverter switching losses at maximal control performance
- High accuracy even without speed encoders

# DriveMonitor™

## Intelligent monitoring and control



DriveMonitor™ is an intelligent diagnostic system consisting of

- Hardware module (installed in- or outside of drive)
- Software layer (collecting and analyzing selected drive signals and parameters)

### Functions

- Monitoring of drive's performance, and, if required, other shaft line components (main circuit breaker, transformer, motor)
- Fast fault finding process

# High voltage motors



- Induction motors
  - Available up to 25 MW
  - Induction motors are usually the first choice for applications up to 10 MW
  
- Synchronous motors
  - Typically considered for higher power ratings (e.g. above 8 MW to more than 100 MW)

# Input isolation transformers



- Input transformers have several functions, such as:
  - To adjust the network supply voltage to match the converter
  - To provide galvanic isolation between drive and supply network
- ABB transformers are available for all ratings and primary voltages, oil or dry type

# Testing



ABB is committed to ensuring the reliability of every drive we deliver.

- Every component of a drive is subjected to thorough testing in ABB's modern test facilities
- Routine tests, functional tests
  - Integral part of the scope of supply
  - Performed in accordance with international standards and ABB quality assurance procedures
- Combined tests
  - Tests with the complete drive system including transformer, converter and motor – can be performed

# Worldwide service and support



- Worldwide service network
- 24 x 365 support line
- Local support
- Supervision of installation and commissioning
- System upgrades for optimized operation & migration
- Life cycle management
- Remote diagnostics
- Customized maintenance contracts
- Spare parts and logistics network
- Training

# Case example

## Jura Cement, Switzerland

Cement kiln at Jura Cement's cement plant in Wildeg, Switzerland



- Jura Cement replaced a cascade converter, which controlled the clinker cooler exhaust fan, with an ACS 2000 (550 kW)
- Benefits
  - Higher availability
  - Reduced maintenance costs
  - Fast installation and commissioning
  - Reduced energy consumption (estimated about 20%)
  - Wider range of speed control (from 0 to 1000 rpm)

# Case example

## Cementir, Italy

Cementir Italia, Spoleto plant



- An ACS 2000 variable speed drive replaced the damper control on a fan at Cementir Italia's Spoleto plant
- Benefits
  - Energy savings of 21%
  - Higher productivity and uptime
  - Less wear on mechanical equipment
  - Optimization of grinding process



# Case example

## Chettinad Cement Corporation, India

Chettinad's cement plant  
in Karikkali, India



- Chettinad installed ACS 1000 variable speed drives for speed and torque control of bag house fan, raw mill fan, cement mill fan and preheater fan
- Benefits
  - High reliability and availability
  - Reduced maintenance costs
  - High efficiency
  - Wider range of speed control (from 0 to 1000 rpm)
  - Network power factor >0.95

# Case example

## Cementos Cruz Azul, Mexico

The 10 year old fixed speed fan motor, now controlled by the ACS 1000



- Cementos Cruz Azul replaced the damper fan control of two 735 kW fixed speed ID fans with ACS 1000 variable speed drives
- Benefits
  - Revenue up - USD 900,000 through increased productivity
  - Energy savings USD 260,000
  - Maintenance reduced by 97%
  - Reduced motor noise and elimination of fan vibration
  - Payback on investment period: 6 months

# Case example

## Siam City, Thailand



Four ACS 5000 variable speed drives have replaced cascade converters controlling the flow rate of induced draft fans at Siam City Cement in Thailand.

### Benefits

- Wide speed control range
- Energy savings \$250,000 per year
- Reduction of CO2 emissions
- Reduced maintenance costs
- Ride through of power supply disturbances

Power and productivity  
for a better world™

