Braking a drive system

When is braking needed?

In many applications, being able to stop safely and precisely is as important as being able to start and accelerate quickly. Obvious examples include cranes, elevators and ski lifts, but quick and precise stopping is also necessary in machine tools, feed equipment and many other processes.

Being able to stop can in some applications be just as important as being able to start and accelerate quickly

Design of the braking system

Evaluating the braking requirement goes back to the mechanical fundamentals of the process. Typically, there will be a requirement to brake the mechanical system within a specific time. There may also be sub-cycles in the process where a moving load forces the motor to operate as a generator.

Any devices used for braking must be dimensioned for the braking power required. This depends on braking torque and speed; the higher the speed, the higher the power. In electrical braking systems, this power is transferred as a certain voltage and current; the higher the voltage, the lower the current needed for the same power. Further information on how to design the braking system is available in Technical Guide no. 8, available from ABB.

Braking methods

Brake motors

Motors fitted with mechanical brakes stop the load quickly and efficiently and provide holding torque at standstill. Their disadvantage is that the linings wear and require replacement from time to time. Brake lining wear can be reduced by combining mechanical braking with any of the electrical braking methods listed below.

Countercurrent braking

This involves switching a motor to the opposite rotational direction. After deceleration to standstill, the motor starts in the opposite direction unless the current is disconnected at the right moment. This method creates a very high braking torque, resulting in a large amount of heat being developed in the motor. Temperature monitors should always be used to protect the windings.

DC injection braking

DC braking can be performed with or without a frequency converter. With a frequency converter, a stop command makes the frequency converter switch to supplying the motor with direct current, developing a braking torque. The same effect can also be achieved using suitable DC excitation equipment. This method gives a considerably longer braking time than countercurrent braking, but its heat losses are much lower, so more frequent

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Controlling motor speed with a frequency converter is more efficient than controlling it with mechanical means, up as well as down. Frequency converters can also re-use excess energy released during deceleration. This, however, requires investment in additional equipment, and as there are cases where this cannot be justified, ABB provides a full range of braking equipment for a range of applications.

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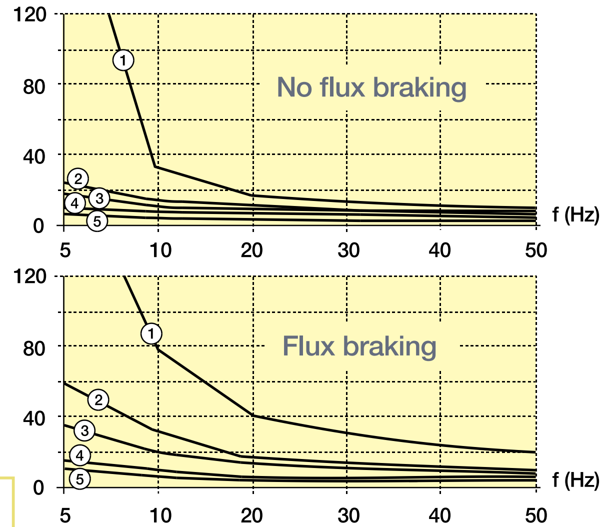
braking is possible. Still, its use is confined to applications in which braking accounts for a relatively small proportion of the running time.

Flux braking

Flux braking is a method based on increasing motor losses in a controlled way. This method is available in frequency converters based on DTC (Direct Torque Control). When braking is needed, the flux in the motor is increased, which in turn increases the motor's capability to brake. When braking is not needed, DTC brings the motor flux down to its nominal value. Unlike DC braking, the motor speed remains controlled during braking.

Rated motor power

① 2.2 kW ③ 37 kW ⑤ 250 kW
② 15 kW ④ 75 kW



Percentage of motor braking torque of rated torque as a function of output frequency

Brake chopper and braking resistor

The braking chopper is an electrical switch that connects the DC bus voltage to a resistor, where the braking energy is converted to heat. During deceleration, the motor changes to generator operation and supplies energy back through the inverter. As brake energy cannot be fed back to the supply via the normal diode bridge, the brake chopper will turn on at a certain level and feed energy out via the brake resistor. Here, the energy is converted to heat and wasted, unless a separate heat recovery system is installed; additional ventilation for the room may be required. The chopper works even during loss of AC supply. This method is used when the braking cycle is needed occasionally, when the amount of braking energy with respect to motoring energy is small, or when braking operation is needed during mains power loss. Other solutions may be considered when the braking is continuous or regularly repeated.

Controlled mains bridge - anti-parallel thyristor solution

The diode rectifier bridges can be replaced by two thyristor controlled rectifiers, allowing the power flow to be reversed, effectively feeding mechanical energy back to the supply network, saving energy. However, the DC bus voltage is always lower than the AC supply voltage in order to maintain a commutation margin, which may cause a drop in torque. Additionally, the *cos phi* varies with loading, total harmonic distortion is higher than in IGBT regenerative units (see below), and the braking capability is not available during mains power loss.

Controlled mains bridge - IGBT solution

The IGBT, or insulated gate bipolar transistor, is a type of semiconductor power switch that can replace the anti-parallel thyristor. It has a low amount of supply current harmonics in both motoring and regeneration, as well as high dynamics during fast power flow changes on the load side. It also offers the possibility to boost the DC voltage higher than the respective incoming AC supply. This can be used to compensate for a weak network or increase the motor's maximum torque capacity in the field weakening area. The IGBT solution is useful when the braking is continuous or repeating regularly, when the braking power is very high, when space savings can be achieved compared to the braking resistor solution, when network harmonics limits are critical, or when energy savings are targeted.

Common DC bus

When a process consists of several drives where one motor may need braking capability while others are operating in motoring mode, the common DC bus solution is a very effective way to reuse the mechanical energy. A common DC bus solution uses the DC bus as the channel to move braking energy from one motor to benefit the other motors.

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