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How to ruin an electric brake

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Electric brakes are used on many types of equipment to control positioning or stop motions. In most cases, they operate for hundreds of thousands of cycles with minimal attention. Overlook a few of their basic needs, however, and these normally unassuming components suddenly can cause major downtime headaches.

While brakes may differ in their design, operating principles are similar for troubleshooting and problem-solving purposes. This article focuses on positive-action brakes that are mechanically actuated or spring-set (Fig. 1). This type includes brakes with manual-adjusted and self-adjusting wear features.

Most problems show up as overheating, loss of torque, or coil failure. When a failure occurs, it is easy to see the effect, but it takes a little more investigation to determine the source.

Key concepts

Three common failure modes can have several root causes.

Ignoring NEMA mounting tolerances accelerates brake wear.

Read the mounting instructions first.

Misalignment

Because electric brakes are usually installed in a direct-drive configuration, alignment is just as important as it is with a motor. When bearings and shafts are not in alignment, extra stresses and vibrations develop that increase with wear and can turn into major problems.

Many brakes are similar in design and operate with very small air gaps between the rotating friction disc and stationary components. The effect of any misalignment is magnified, resulting in loss of torque as well as vibration and noise.

When installing or replacing brakes, be aware that there are NEMA specifications on how they fit to motors or gearboxes and governing tolerance ranges for such factors as register and bolt circles (Fig. 2). It is the manufacturer's responsibility to verify that proper alignment has been achieved.

A problem can occur when mounting a new brake to used equipment if the motors or drives are not checked to see that they are within NEMA tolerances. If the motor end bearings wear, any wobble in the shaft is exaggerated further out from the motor, where the brake is mounted. What is actually a motor problem may first show up as a brake failure.

To avoid trouble, measure the shaft runout, both axially and radially, and check it against NEMA tolerances. These are usually around 0.004-in. radially and 0.002-in. axially, but vary by motor size. Also check the axial movement of the motor shaft. Most equipment can tolerate a float of up to about 0.020 in. Many instruction sheets include the allowable indicator runouts for mating equipment.

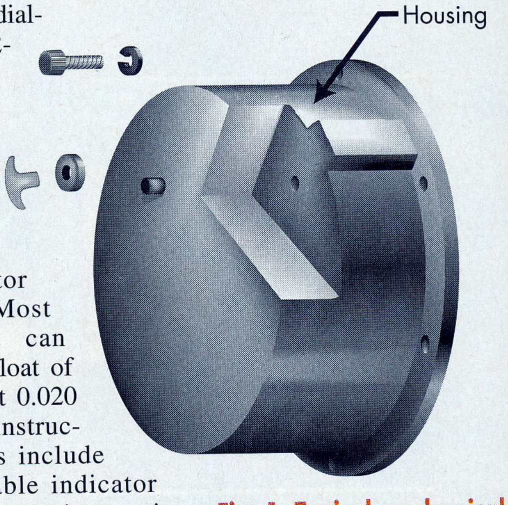

Fig. 1. Typical mechanically actuated electric brakes are solenoid-powered.

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Coupler-style brakes (Fig. 3) are usually not designed with a load bearing and are intended for inline applications only. Side forces — from overhung loads or output shaft misalignment — can cause accelerated wear at the motor shaft-to-coupler fitting. This wear can lead to early failure of the coupling shaft and damage the drive shaft.

Improper voltage

Spring-set or failsafe brakes require power to release the spring force against the friction discs holding the motor shaft and/or load. Solenoid/coil assemblies are designed to overcome the spring force against the disk pack so it can float apart. These coils are designed to operate within ±10% of the coil voltage rating. Operating above that limit eventually causes overheating of the coil due to higher operating currents.

Undervoltage conditions may not be able to overcome the spring force. The result can be an overheated coil and damaged friction discs.

A more damaging mistake, though an easy one to make, is to apply ac voltage across a dc coil. While the coils on most brakes operate on ac, they can be wound for dc and supplied with a switching device that allows them to use dc line input. In some applications, a dc coil may operate inefficiently on ac for a short time before it fails, making the failure look like the fault of the equipment.

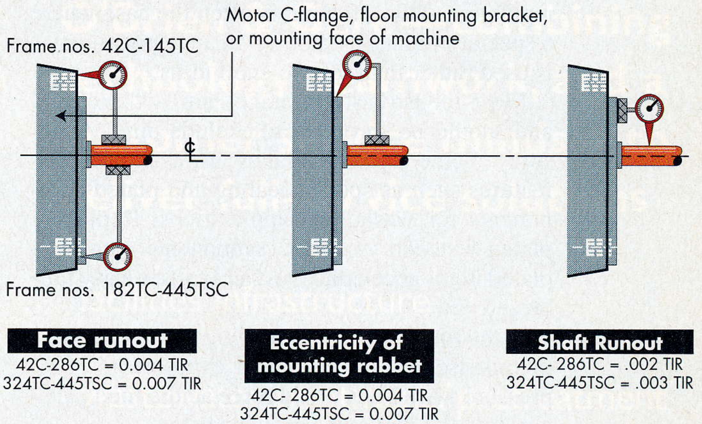


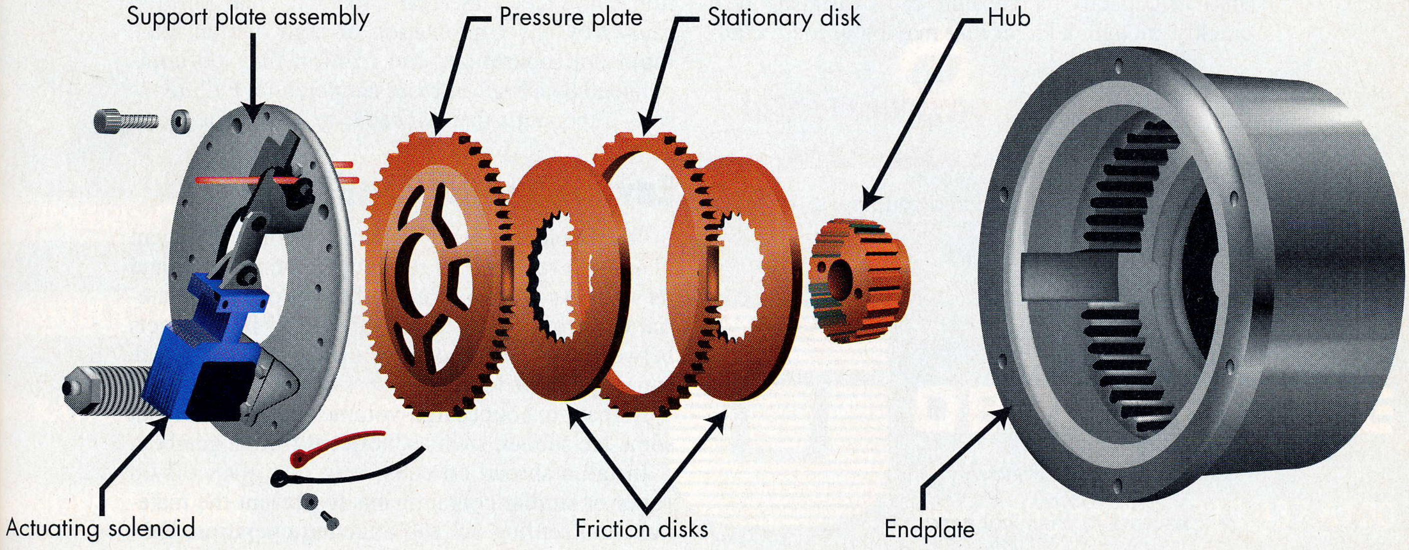
Fig. 2. NEMA specifications spell out the tolerance ranges for electric brake mounting details.

Misassembly

Avoiding brake problems often begins at "read the instructions," and when repairing or replacing a brake, this simple step can avoid many opportunities for misassembly.

Setscrews are often overlooked. They are found on the driven hubs that mount to a motor shaft. Depending on size, hubs may be keyed or coupled with a taper-lock bushing and secured by setscrews. Failure to read the instruction sheet that calls attention to them is likely to result in a failure.

A related problem can occur when improper in-



stallation or maintenance contradicts a desired rating, such as a NEMA class, API standard, or FDA regulation. This situation is often the case where a special product — tailored to an application — is used rather than off-the-shelf units.

Most industrial-type brakes are not enclosed and should be shrouded to exclude direct water spray. Some types of brakes are available with features such as special sealing and plated components for washdown applications. Replacing plated fasteners or other components with nonplated items accelerates rust and causes early failure.

In the food industry, damaging sealing surfaces or misassembly of seals and exposure to high-pressure washdown could force acidic food particles into the unit and cause corrosion.

Replacing components such as friction discs with nonoriginal parts may drastically change the operating characteristics of a unit. Use of components that were not designed and tested with a specific brake may compromise performance. A friction disc may look the same and fit the same, but it could have a totally different coefficient of friction and much shorter service life.

Thermal capacity

Problems may occur when a brake is replaced or when the equipment on which it is mounted is used for a different application. If the unit is overworked because it is too small for the job, it may function for a while before exceeding its thermal capacity.

While the problem may look like a simple component failure, look further if a brake appears to lack thermal capacity. If the unit can't dissipate heat quickly enough, a larger unit may be needed. Finding a solution may require close cooperation between the manufacturers of the equipment and the brake, as well as the user.

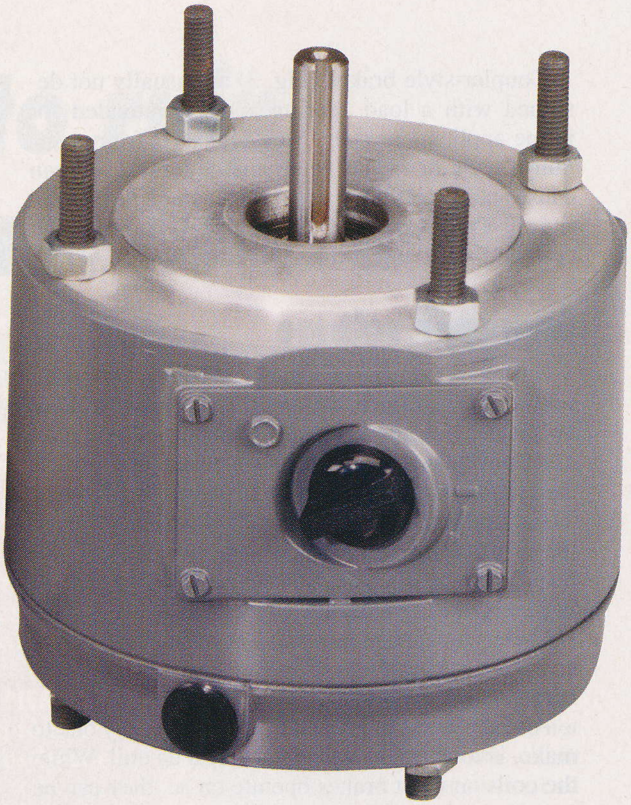


Fig. 3. Coupler-style brakes are inline mounted and cannot carry side loads.

Failing to size the unit for a high-cycling operation can exceed thermal capacity. Heat buildup caused by any combination of high inertial load, rapid coil operation, and friction may be compounded by a high ambient temperature. Failure results if the unit's thermal capacity is exceeded.

Troublesome environmental and service conditions

- Operation in wet or damp conditions, such as steam
- Exposure to gritty dust
- Poor ventilation
- Exposure to oil vapor
- Exposure to salty air
- Exposure to radioactivity
- Exposure to chemical fumes.

Environmental conditions

Operation of a brake depends on the coefficient of friction between its rotating friction disc(s) and its stationary plates. When lubricant or other material that can change the coefficient of friction gets between these components, up to 75% of torque capacity can be lost.

It's easy to notice large-volume contaminants, but some are subtler, such as lubricant from a gearbox.

Install a shroud on equipment that gives off oil vapor or similar contaminants to prevent the material from settling out and affecting operation. Otherwise, contaminants accumulate and reduce the coefficient of friction over time.

Another kind of environmental caution is the opposite of what might be expected. Early in the operating period, do not blow out excess dust that accumulates. This dust helps maintain proper torque, as well as improve any burnishing that is necessary. Sometimes it is possible to be too clean.

Vibration

Operating vibrations from uneven loads, poor alignment, or misassembly destroy the brake if left unchecked. These forces often have a cumulative effect, growing in magnitude as they cause wear or loosen mountings.

Environmental vibrations are more subtle, caused by other adjacent or mobile equipment. These vibrations and the static load on the bearings may cause false brinelling when a brake or motor, that contains ball or roller bearings, is stored or inactive for a long period. The result is a small flat spot on the bearing that vibrates and causes wear when put into service. A simple solution is to periodically rotate the shaft on which the unit is mounted, perhaps once a month.

Shelf life

When a brake is properly stored and sealed, it can be kept indefinitely. Normal factory packaging should be sufficient for about 3-mo of storage in a nontemperature controlled plant that is not subject to temperature or humidity extremes.

For longer storage periods, the brake should be sealed inside an airtight container with a desiccant to trap any moisture that may remain in the package and prevent rust. Superficial rust does not affect operation, but if it is heavy enough to cause some deterioration of the solenoid, it can cause an increase in holding current and coil overheating. If stationary components are not free to float, they drag and generate excess heat.

Burnishing

Many brakes are factory preburnished to deliver nameplate-rated torque. Typically, this torque increases 20–40% under normal load and stopping conditions. However, low speed (<200 rpm) and holding-only applications present special considerations. If the brake is not properly burnished, the friction material may not seat properly, and the unit may eventually lose the rated torque.

When a brake is used on a PC-controlled application — where the load may be electronically driven to a stop before a brake sets — it sets at zero speed and does not complete the burnishing process. On these applications, check with the manufacturer to see if an alternate friction material is available.

Tensioning

Friction brakes described in this article are not designed to slip or feather the load like a slip clutch or tensioning brake, which are designed for soft starting or protecting equipment down line. Instead, they are designed to produce the minimum amount of torque needed to keep the drive shaft from rotating after power is removed. The more they slip, the faster they wear; and the more heat they produce because of excess friction between the faces.

This cycle can be avoided by sizing the unit for minimum torque needed to stop and hold the drive components and applying an appropriate service factor, generally 1.4–2.

Check before calling

Often, a simple oversight can become a much bigger problem. In one case, there was an equipment noise problem. After a service call, involving several people and many hours of downtime, the problem was traced to the installer's failure to properly tighten setscrews, as described in the instructions.

By one estimate, 20% of trouble calls could be taken care of by simply referring to the instruction sheet.

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More info

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