WHEN connecting prime movers to driven equipment, manufacturers often encounter the same problem: start-up loads are frequently greater than the power needed to run the machinery. Oversizing the motor is a typical solution; however, this can create other problems. High in-rush currents, inflated energy costs and excess torque capacity that can damage equipment are a few of the issues facing manufacturers and end users.

This article explains the operating principles and selection steps for high-energy rare earth permanent magnet to conductor couplings used to solve these and other problems.

Coupling performance, efficiencies and torque overload protection characteristics are discussed. Several examples from existing installations demonstrate the safety and economy of permanent magnet couplings. In addition, design variations such as shaft connection options and V-belt sheave arrangements are shown. The article concludes with a discussion of suitable applications and coupling selections.

Background

Problems in starting equipment — Starting equipment under load requires high starting power. The same is true for equipment with high rotational inertia. Misalignment and vibration can further complicate the situation. Although several options are available to solve this problem, each has drawbacks. Magnetic couplings, a new option, solve these problems with few disadvantages.

In the past, equipment builders and end users frequently solved the start-up problem by substituting a larger motor that made more power available to start the equipment. However, this solution produced equipment overload damage and higher operating costs. Equipment builders who were aware of this problem applied clutches, variable-speed drives or fluid couplings to reduce start-up loads. Starting the motor and allowing it to reach full speed before engaging the equipment reduced in-rush currents and operating costs. However, the problems associated with this solution included maintenance costs and equipment downtime.

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Electronic variable-speed drives offered another potential solution, but mechanical variable-speed drives have many moving parts and require frequent maintenance. The electrical variable-speed drives occasionally used to provide controlled soft start have their own problems such as controlled environments for delicate equipment, isolation transformers and electrical feedback.

Fluid couplings have also been used to provide soft starts and allow the motor to reach higher speeds, and higher torque, before the load is engaged: they dampen vibration problems; accommodate soft starts/stops and dual drives; and provide torque overload protection. Because they cannot accommodate misalignment, however, it becomes necessary to add more couplings to one or both sides of a fluid coupling, increasing equipment and maintenance costs.

Magnetic coupling solution — Magnetic couplings solve these problems, and others, economically. These couplings accommodate misalignment, eliminating the need for additional couplings. Unlike the friction clutch or a fluid coupling, magnetic couplings have no wearing parts to replace, thus, lower long-term costs. Reducing motor in-rush currents improves motor longevity and lowers utility costs by reducing peak electrical demand. The price of these benefits is a slightly lower rpm, comparable to that of a fluid coupling.

Modern magnetic couplings use neodymium iron boron high-energy product rare-earth permanent magnets.

Permanent magnetic couplings

In addition to electric generators and motors, there are many other examples of magnetic power transmission devices. Eddy-current drives use induction principles with electromagnets. For very large equipment, magnetic brakes are used to decelerate loads before a friction brake is applied. Brakes for small equipment utilize magnetic induction circuits to provide constant tension on winding drums or bottle-capping equipment.

Magnet to magnet drives are often used on sealless pumps but employ attract/repel forces in place of electromagnets. These drives transmit 100% of the power because the connection does not slip; however, careful alignment is required to avoid vibration. Magnet to magnet drives are not couplings by definition because they do not accommodate misalignment.

In a magnet coupling, the driver shaft is connected to the steel conductor housing (Fig. 1). The housing supports the copper conductor discs on both sides of the permanent magnets and rotates at the input speed. The conductor housing is mounted on the driver side for better cooling when the motor is turning. Heat is generated.