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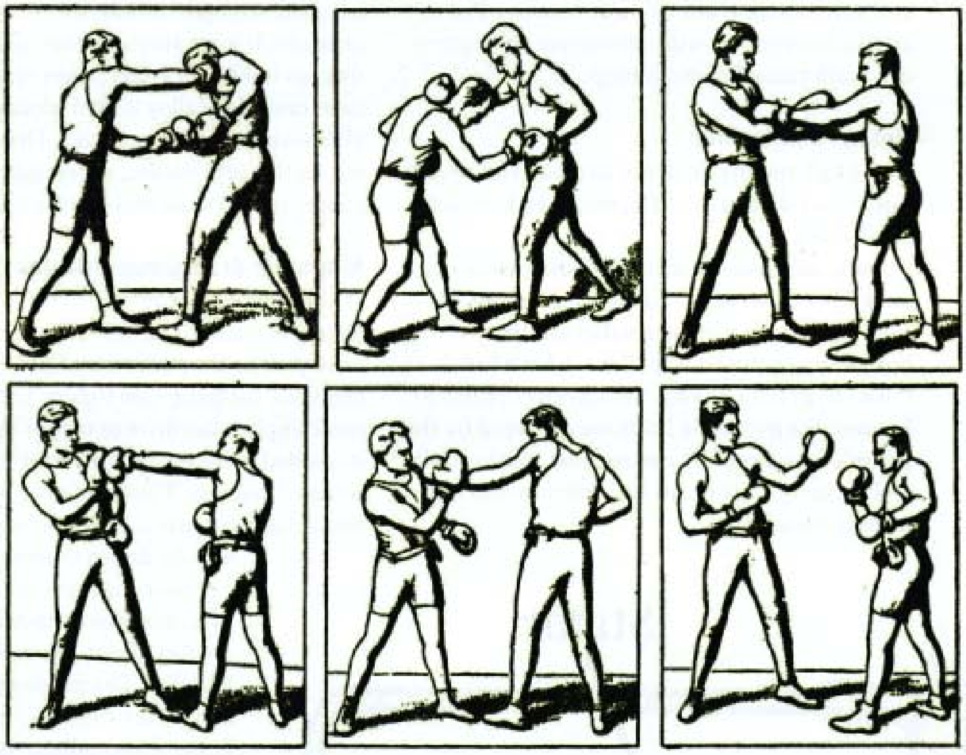

The battle of the pumps

Magnetic drive or canned motor pump? Here's what to investigate before you make your purchase

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With greater frequency, system designers and process engineers are evaluating sealless pump designs for their process pumping needs. On first pass, sealless pump designs appear to be the ultimate solution for two reasons:

- They "eliminate" mechanical seals, often considered a primary cause of pump failures.
- They are "leak-free," which is useful in complying with existing and future environmental regulations.

While these perceptions are true in most cases, it's important to understand the design principles for each type of sealless pump before making your selection.

When the pump industry speaks generally of sealless pumps, it's referring to the two most common designs, magnetic drive and canned motor. However, other sealless pump designs, such as the diaphragm, peristaltic (hose pump) and gear or screw, offer similar benefits. For this article, however, we will concentrate on magnetic drive and canned motor pumps.

Design similarities

Although magnetic drive and canned motor pumps are distinctly different, they have some similarities.

Both use virtually identical liquid ends—the same kind as those found on standard mechanically sealed pumps. One notable similarity is that both have enclosed impellers, which produce lower hydraulic loads. This point is critical, because the hydraulic loads are managed by the pump's liquid end. By comparison, mechanically sealed pumps rely on an anti-friction bearing to manage these loads.

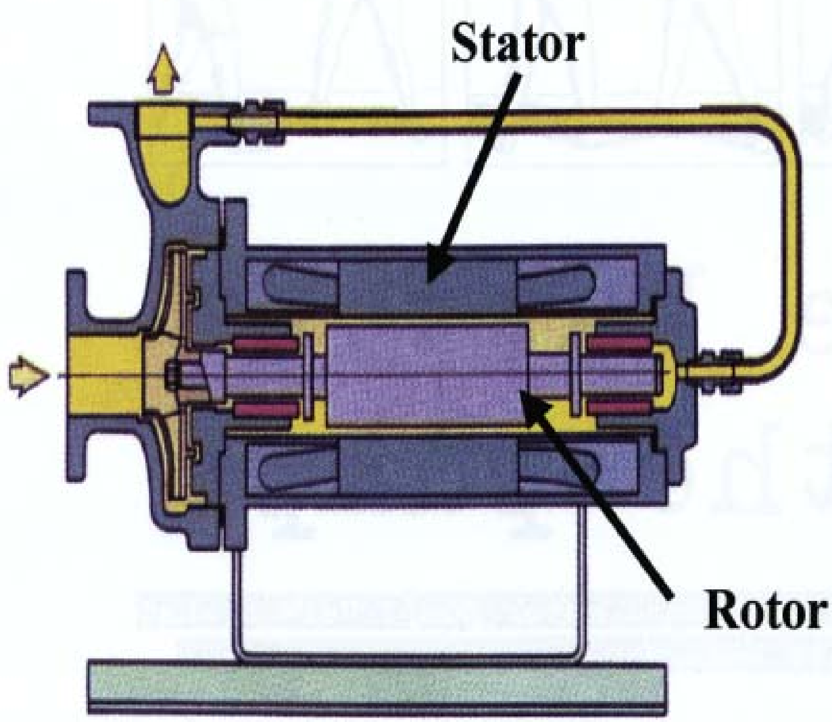


Figure 2: With a canned motor pump, the driven rotor (inner rotor) is directly connected to the pump impeller, which effectively unitizes the pump and driver (motor). The electric motor is encapsulated in a can that isolates the rotor and process liquid from the stator.

A second common feature is the use of a hydrodynamic/sleeve bearing system to support the rotating pump shaft within the liquid end. In most cases, these bearings are constructed of silicon carbide or carbon, materials commonly used with mechanical seal faces. These materials offer superb corrosion and wear resistance.

The last common feature is the use of a shell or liner that isolates the pumped liquid from the "drive" side of the pump and acts as a pressure barrier. The containment shell/liner must be chemically resistant to the liquid being pumped and have adequate strength to resist the pump's developed pressure. It must also offer low resistance to field flux, so it will not affect power transmission. In most cases, Hastelloy is used because it best complies with these characteristics. However, depending on the application, other materials, such as metals, ceramics and non-metallics, can be used.

Magnetic drive pump designs

What separates the two is the way the drive energy is transferred to the liquid. For magnetic drive pumps, the power transfer is achieved with a magnetic coupling (see Figure 1, pg. 55). As the name implies, the drive or output shaft of a driver is coupled to the pump's driven or input shaft by a series of magnets. The magnetic couplings can be divided into two parts: the drive or outer magnets and the driven or inner magnets.

Drive magnets typically consist of a cast iron cylinder\carrier that rotates about the same axis as the impeller. The magnets are affixed to the inner cylinder surface with either epoxy adhesives or mechanical bonds. The drive magnets are located outside the pressure barrier (containment shell), unexposed to the pumped liquid.

Driven magnet assemblies are constructed in a similar fashion. However, the magnets are placed on the outer diameter of the driven rotor in a configuration that is matched to the drive magnets by polarity. This arrangement generates a magnetic flux field of attraction between the two, causing the driven magnets to follow the drive magnets at the same speed (synchronously). Because the driven magnets must operate while immersed, they must be encapsulated within a thin-metal sheath. This protects them against corrosion.

While this coupling is relatively effective, it does have some drawbacks. The rotating magnetic field passing through the stationary metallic containment shell produces eddy currents within the shell. They manifest themselves in the form of heat, which decreases the efficiency (weakens) of the coupling. The heat is typically absorbed by the pumped liquid, which can have a negative impact if the liquid is heat sensitive or near its vapor point.

A second issue centers around the magnet spacing. The magnetic forces, or flux between the drive and driven magnets, is greatest when they are touching. As they separate, the forces weaken. To provide a reliable design, you must specify running clearances and an adequate containment shell thickness for both pressure containment and corrosion allowance. Unfortunately, as these gaps increase or the design is made more robust, the effective power transmitted decreases. As a result, costs increase because additional magnets are needed.

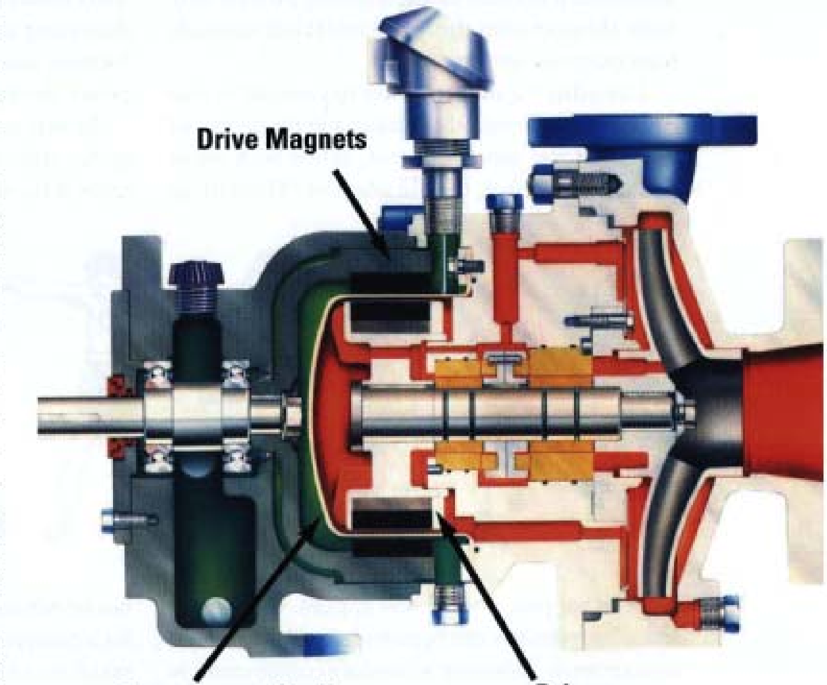


Figure 1: For magnetic drive pumps, power transfer is achieved with a magnetic coupling. As the name implies, the drive or output shaft of a driver is coupled to the pump's driven or input shaft by a series of magnets.

Canned motor pump design

As its name suggests, the electric motor is encapsulated in a can that isolates the rotor and process liquid from the stator (see Figure 2, pg. 57). With a canned motor pump, the driven rotor (inner rotor) is directly connected to the pump impeller, which unitizes the pump and driver (motor). This results in a compact pumping package.

Power transmission with canned motor pumps is effectively the same as with any standard electric motor. The stator portion of the motor receives electrical impulses from the leads, which, in turn, induces a revolving magnetic field. This field then acts upon the metal core located in the (inner) rotor of the canned motor pump, which is connected directly to the impeller. This transfers the electrical energy to the pumped liquid.

Because the rotor and stator are immersed, they must be isolated to prevent corrosive attack and electrical failure. For the driven (inner) rotor, this is accomplished by encapsulating it within a corrosion-resistant metallic sheath. Isolation of the stator (outer) is done much like the containment shell on a magnetic drive pump. A precisely machined, thin tubular cassion is fitted to the stator's inside diameter, then welded at the end of the assembly. Like the containment shell used on the magnetic drive pump, the material must be both chemically resistant and have a low resistivity to the field flux. The latter prevents a reduction in the power transmission efficiency.

However, the canned motor's containment shell can be thinner. Pressure containment is not as critical, because of the added support provided by the stator. This close fit also provides maximum heat dissipation to the process liquid, thereby preventing a breakdown of the insulation coating used to protect the stator.

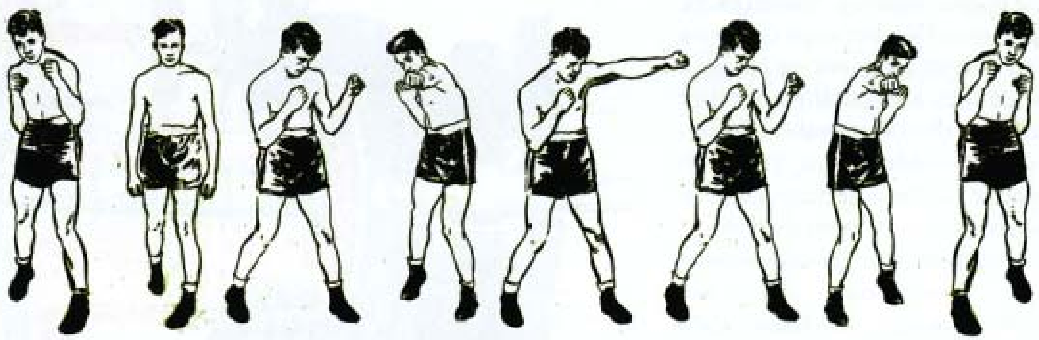
Selection

By now you're asking yourself, "How are these points relevant to selecting the right pump for my application?" Unfortunately, there's no universal answer. In addition, most suppliers have engineered magnetic drive or canned motor configurations that are suitable for virtually all types of applications. However, the following areas should be considered when selecting the best one for your needs.

Application details

One of the most important areas to evaluate is the *properties of the liquid being pumped*. For both designs, selection of the correct metallurgy is critical. It is important to investigate the anticipated corrosion rate and the expected pump life. For these pump designs, the "weak link" is likely to be the containment shell or isolation can. As mentioned earlier, canned motor pumps may have thinner containment\isolation shrouds than magnetic drive pumps.

The other liquid parameter to consider is *how hazardous or harmful the liquid is*, and *the safety and environmental impact of a leak*. While both are in principle leak-free, the old adage of "If anything bad can happen, it will" still applies. To prevent leaks, both designs can be provided with secondary containment. However, secondary containment is inherent in the canned motor pump's design. Therefore, if the liquid is hazardous or harmful, the canned motor design provides the added insurance of secondary containment.



Another factor to examine is the *liquid's thermal and vapor pressure properties*. Transmission losses in the containment/isolation can can generate heat. With both designs, the pumped liquid will absorb this heat. Therefore, it may be necessary to provide external cooling.

(Note: Non-metallic and lined magnetic drive pumps are used more frequently today because they offer superb corrosion resistance and eliminate eddy current losses and the heating effect inherent with magnetic drive pumps that incorporate metallic containment shells.)

Maintenance practices

Although the goal is to purchase a sealless pump that will meet your specifications and provide years of trouble-free operation, you would be naïve to think that the pump will never need maintenance. One essential element of a sound maintenance program is pump and motor alignment. If proper alignment cannot be guaranteed, one should consider either the canned motor or a magnetic drive pump with a close-coupled design. Both feature machined components that guarantee proper alignment.

Another consideration is the labor policies at your site. If separate disciplines for mechanical and electrical service are required, a magnetic drive pump may offer one advantage since the pump and motor are separate pieces of machinery. This allows the pump to be maintained without disturbing the electric motor. (Note: Prior to performing maintenance on any machine, the driver power should be locked out to prevent injuries.)

As with any good plan, one must have a contingency strategy. Determine what actions will be taken if the pump needs to be replaced or if it cannot be repaired quickly. The worst case situation for a pump is dry running or cavitation, which can result in a breach of containment. With a magnetic drive pump, this may require both the drive and driven magnets to be replaced, as well as the containment shell and bearings. The same damage can occur to the canned motor pump; however, a breach of containment may require that the stator be re-wound. That most likely results in off-site repair. Because of this, a magnetic drive pump may offer a slight advantage because it can be repaired on site.

Installation

The last item to consider is the proposed installation site. If the space is constrained, or if it's not practical to construct a solid foundation for the pump, the compact unitized arrangement of a canned pump may offer an advantange over a mag drive design. (However, many closed-coupled magnetic drive pumps on the market are equally as compact and rigid.)

While today's sealless pump designs can help users solve their process design challenges, one should remember that they are not "fits-all, fix-all" solutions. Problems caused by improper operation (cavitating, dry running, etc.) or poor maintenance practices (misalignment, improper lubrication) will not be solved by installing a magnetic drive or canned motor pump. It's important to evaluate pump installation, operating conditions and maintenance when selecting the best pumping solution for your application.

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