MAGNETIC DRIVE CENTRIFUGAL PUMPS

1) Magnetic drive principle

A magnetic coupling consists of two sets of magnet assemblies (See Figure #1). One is the outer assembly (used as the driver magnet) and the other one is the inner assembly (used as the driven magnets). The outer assembly is connected to a motor and the inner assembly is directly or indirectly attached to a pump impeller. As the figure shows, magnet pieces of the outer assembly are lined up with their counterpart of the inner assembly. When load (torque) is applied and the coupling deflects angularly, then attraction and repulsion forces between the magnets are created. This force is used to transfer torque from the motor to the impeller. This is a **permanent-permanent magnet coupling** and there is no slippage and no induction current engaged while it is rotating. If excessive torque is applied, the magnets will de-couple. The magnets will not re-coupled unless the pump is stopped. There is no energy loss in this permanent-permanent coupling unless an electrically conductive containment is placed between the outer and inner magnets. If an electrically conductive material is used for the containment, eddy-currents will be generated and some energy loss will be created. **Ansimag's K-series pumps use only non conductive containment shells.** Ansimag's K series pumps have an inner magnet assembly which is directly molded onto the impeller.

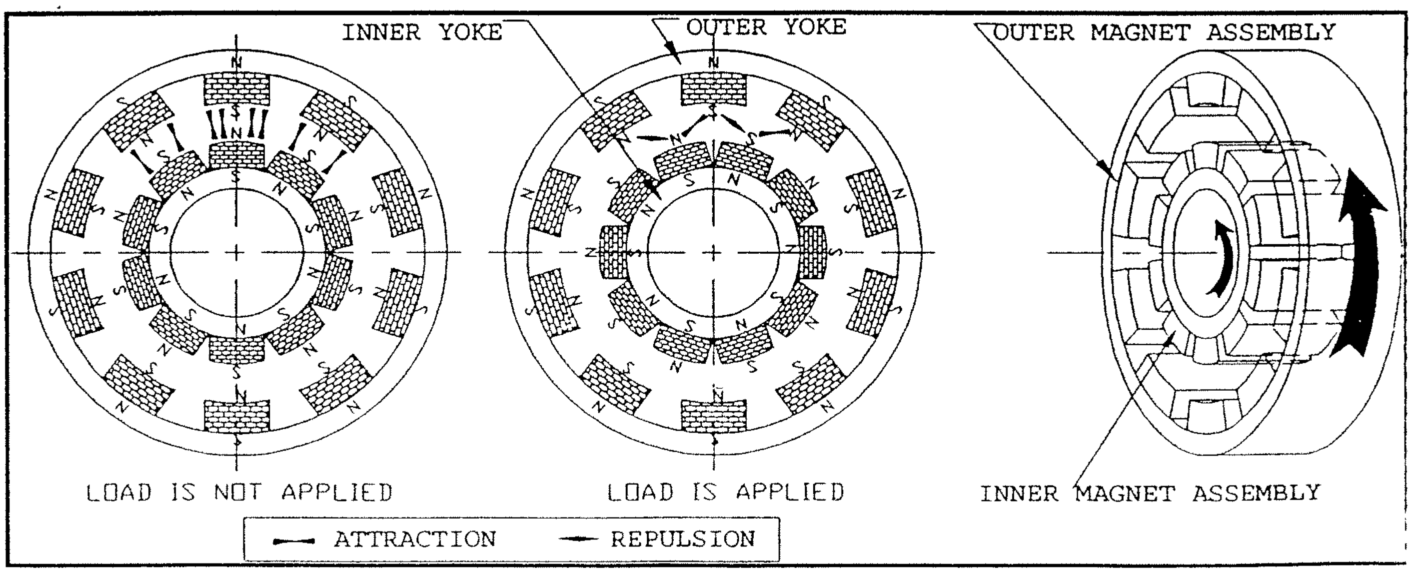


Figure #1

2) Types of magnets

Magnetic drive pumps have made significant improvements in many areas of design, however none has impacted the industry more than magnet technology.

Permanent magnets can be any material that will retain a magnetic field by itself. Originally, the only type of permanent magnets available were ferrite magnets which were bulky and weak. This required either large magnetic couplings or strict limitations on torque or specific gravity. This continued for many years limiting the applications for mag-drive pumps to small markets such as small aquarium filter pumps. Then came the development of rare earth magnets.

Rare earth magnets are made from elements in the periodic table that are not rare at all. In fact they are as abundant as copper or lead. However, they are very difficult to isolate, making them quite expensive. There are basically two types of rare earth magnets used for mag-drive pumps today: Samarium Cobalt and Neodymium Iron Boron.

Samarium cobalt magnets are very strong. They are approximately 15 times as strong as a basic ferrite magnet. They are also quite compact in comparison. Samarium magnets can retain their strength to as high as 450 degrees Fahrenheit! Neodymium Iron Boron magnets are even stronger. Approximately 15% stronger than the Samarium Cobalt magnets. Their temperature limitation is much lower however, reaching only 250 degrees Fahrenheit.

If a permanent magnet exceeds its temperature limitation it will irreversibly lose its torque capability. As the temperature increases past its limit, its relative strength will decrease at a given rate until the temperature decreases again. The magnet will then retain the decreased strength as its new maximum limit from when the temperature was at its highest. (See Figure #2)

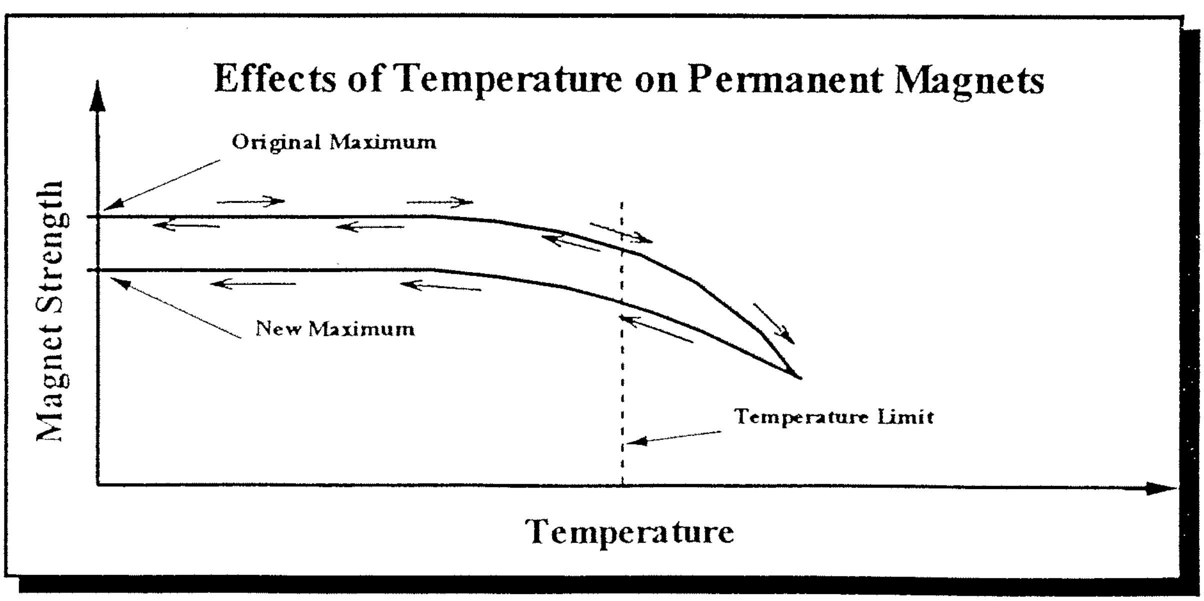


Figure #2

3) Containment Shells

In all magnetic drive centrifugal pumps there must be a barrier that separates the inner and outer magnets and thus the fluid from the atmosphere. This barrier is called the containment shell.

The containment shell is a critical component in mag-drive pumps because it is the most vulnerable to rupturing. There are inner and outer magnets rotating at high speeds and could run into the shell during a failure. Also, they are generally made as thin as possible so that the magnets are not seperated by much distance. The strength of a magnetic coupling is increased dramatically as you decrease the gap between them. The material in which a containment is constructed is also very important. These materials can be classified into two major categories: conductive (i.e. metal) and non-conductive (i.e. composite).

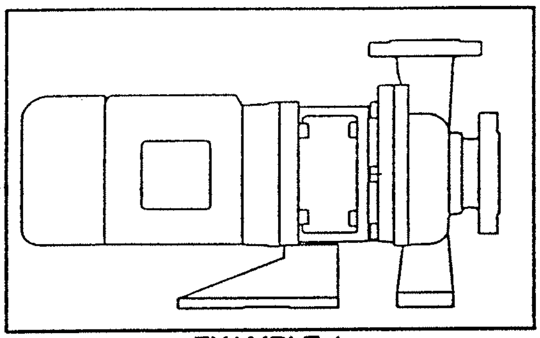
The reason we categorize the materials this way is that when a conductive material passes through a magnetic field, an electrical current is generated. This same principle is used for bicycle generators and is used in reverse in the case of an electric motor. In the case of a containment shell, there is no place for the electrical current to go so it is wasted away in the form of heat. These currents are known as eddy currents. Since the magnetic fields are very strong with rare earth magnets and the the field is moving at high speeds (1800 or 3600 rpm) the current/heat generated is quite substantial. Pumps using these containment shells rely on the fluid being pumped to carry away the unwanted heat. Without this fluid the shell will heat up to extreme temperature in a matter of seconds and cause a failure.

The second type of containment shell is non-conductive and therefore generates very little or no eddy currents. Common materials for these shells are silicon carbide, alumina ceramic and various plastics. All of these materials are chemically resistant but must rely on some type of reinforcement on the outside to give it additional strength. Without the reinforcement the pressure ratings on the pump must be limited. This arrangement is quite beneficial however. First of all, pumps with this type of containment are able to operate at much lower flows because they do not have to remove any additional heat. Because there is no heat generated, the pumping efficiencies are much higher which save on operating costs. Finally, these pumps can pump heat sensitive fluids or those with low flash points.

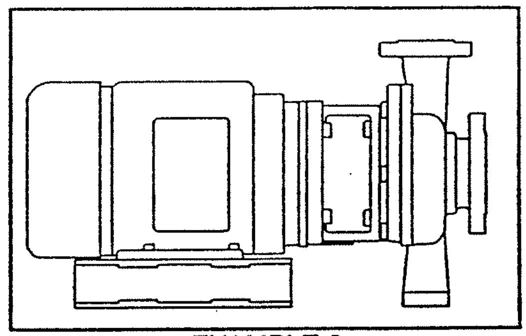
4) Close Coupled Configuration

With mag-drive centrifugal pumps, the drive shaft need not pass through the pump body. Because of this, the typical frame mounted configuration (See Figure #4) is no longer the only way to mount the pump.The most common way to couple a mag-drive centrifugal is to close couple it to the motor.

When a motor is close coupled to a pump, the flexible coupling and guard are eliminated. A C-face motor is used and the outer drive magnet is keyed directly onto the shaft. The motor is then bolted directly to a bracket piece where the magnetic coupling is made (See Figure #3).



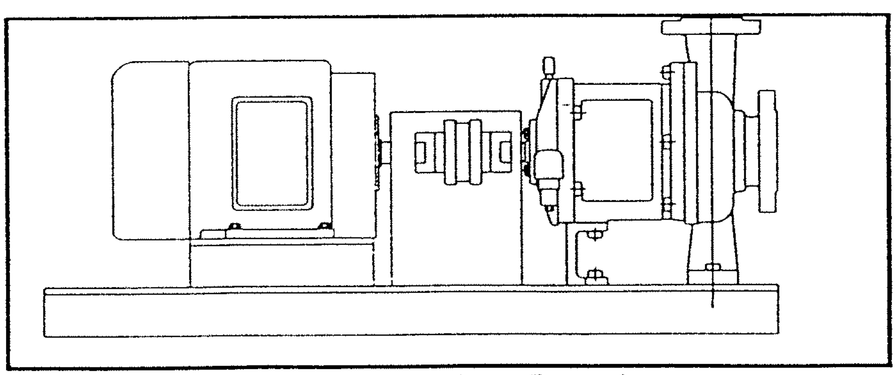
EXAMPLE 1
Close coupled with a round body motor.



EXAMPLE 2
Close coupled with a footed motor

(Figure #3)

The close couple arrangment is a convenient way to mount the pump because it eliminates the need for a flexible coupling, a long base and a coupling guard. This saves valuable space for the installation. The fact that there is no flexible coupling has many advantages. First, there is the obvious cost savings for the coupling and guard themselves but also there is now no need for a bearing frame. The flexible couplings and bearing frames must be constantly maintained by keeping them properly aligned and lubricated. Without these components the maintenance costs for a close coupled pump are reduced significantly.



Frame mounted configuration
(Figure #4)

5) Bearings

All mag-drive centrifugals utilize a journal or sleeve type bearing to handle the radial loads of the impeller. The axial loads are taken up by various thrust rings at the front and rear of the pump. Since mag-drive centrifugals are sealless these bearings must be product lubricated making the design and materials of construction critical.

Mag-drives are usually used with chemicals that may be extremely corrosive and/or hazardous so the materials of construction must be chemically resistant as well as have good wearing characteristics. These requirements have made certain materials stand out as being best suited for the application. Some of these materials include carbon, alumina ceramic, silicon carbide and fiber reinforced Teflon. These materials are typically utilized according to the actual pumpage. Silicon carbide is generally accepted as being one of the most outstanding materials available for this application. It is virtually chemically resistant to all known chemicals, it is extremely hard (second only to diamonds), it is mechanically strong and has very good thermal shock resistance. These features make the material an excellent choice when specifying your bearing material.

Because the bearings are product lubricated, mag drives are less resistive to solids handling. Solids in the process stream can cause excessive wearing in the bearing materials as well as restrict flow for lubrication and cooling to the critical areas. In a mag-drive design it is important to provide a means by which the solids can pass in the event that they enter the rear containment area. It is also important to have a bearing design that can resist extensive damage when a solid does become trapped between the wearing surfaces. For these reasons extra care should be taken in determining how much solids are in your application. Solids can be reduced by utilizing various filters or by changing the piping orientation so that the inlet is not positioned in a location that accumulates solids.

6) Dry Running

Over the years mag-drives have become associated with an intolerance of dry-running. This impression was created for two main reasons. First of all, nearly all of the first mag-drive pumps utilized metallic rear containment shells. These shells create eddy currents which generate an enormous amount of heat as described earlier. Because of this heat generation, there must be a certain minimum continuous flow through that area to carry away the unwanted heat. Without fluid the containment shell can reach temperatures in excess of 350°F in a matter of seconds. This rise in heat will cause the tight tolerances within the pump to seize causing a catastrophic failure. Secondly the materials of construction used in the earlier years of development did not have the dry-running characteristics that present materials have.

Advancements in both of these areas have reduced the sensitivity of mag drives to dry-running considerably. We now have various non-metallic containment shells that produce little or no heat and the materials used for the wearing areas have been drastically improved with the use of carbon and silicon carbide. But even with these advancements, the actual performance of the pump is very dependent on the fluid being pumped. Many chemicals leave a residue once the liquid has flashed away which can be quite abrasive. This residue can change the friction characteristics of the bearing which will cause an excessive amount of heat in the bearings and cause a failure.

7) Monitoring

Because mag-drive pumps are hermetically sealed it is difficult to monitor the various conditions inside the pump without compromising its sealless nature. Most mag-drive pump manufacturers offer or at least recommend different monitoring devices to help prevent premature failure. Monitors can be used to measure two kinds of parameters: the condition of the pump itself and the conditions of the process.

Some manufacturers have developed monitors that measure various pump conditions such as containment shell temperature or bearing wear or pump vibration. The pump manufacturers have determined through testing that a change in these conditions correlate to various problems inside the pump and can thus shut them down before failure.

Other monitors available can measure system variables such as the current or the power that the pump is drawing, discharge pressure, and flow rates and process temperature. These monitors can be programmed to shut the pump down when certain limits have been exceeded. These monitors are usually more universal in nature and can be used for a wide range of pump types, sealed or sealless.