Sealless Pumps: The Effects of Heat

Handling Friction and Flow Problems

You have to understand the temperature rise of the recirculation fluid and how the fluid will respond to heat.

Heat input to the recirculation and process fluid can adversely affect the performance and life of sealless pumps and should be a major consideration when installing a pump. However, if you know or can anticipate the environment the driver will operate in and have good information about the fluid, the operating conditions and the manufacturer's background, you will have a better chance for successful pump operation.

The primary reason that heat is more of a concern in sealless pumps is that the fluid being pumped (process fluid) is used as a coolant for the motor and a lubricant for the bearings in the drive sections. When you're selecting materials and designing the pump and driver, you have to understand the temperature rise of the recirculation fluid and how the fluid will respond to heat.

WHERE DOES THE HEAT ORIGINATE?

In magnetic drive pumps, the interaction of the outer drive magnets and the inner driven magnets have electrical losses (heat) due to flux. The magnitude of this heat loss, which is transmitted to the process fluid, is dependent on many factors:

- the type of magnetic drive (synchronous or asynchronous)
- the gap between magnets
- the material of the containment shell (metallic or nonmetallic)

The "drive system" is the portion of the pump assembly where the canned motor or the magnetic drive is located. This is the section cooled and lubricated by the process fluid, and it is the critical area of the sealless pump which determines the success (or failure) of the application.

You should look at the flow rate of the recirculation fluid through the drive section. Manufacturers of sealless pumps should give you this data on request. Most flow data is based on testing with water at 20 C, so you also need to keep in mind the fluid's viscosity. The internal clearance of most sealless pumps is close, and the flow rates can be drastically reduced with fluids with viscosities above 30 cP.

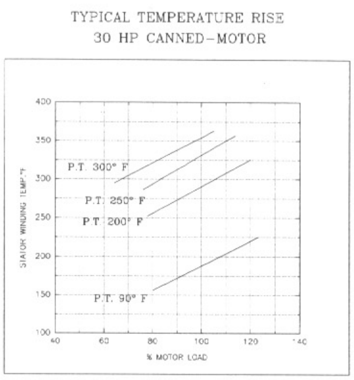
One manufacturer reports a 12 percent increase in torque by using Hastelloy-C instead of 316 stainless steel for the containment shell, however nonmetallic containment shells theoretically have no losses and, therefore, do not add heat to the process fluid. This advantage is offset by pressure and temperature limits imposed by the use of nonmetallic materials.

The canned motor also has efficiency and eddy current losses that add heat to the process fluid (Figure 1). A properly designed canned motor is completely sealed to provide true leakage protection in both the primary and secondary containment areas. This design meets the standards established by industry associations based on increased interest in sealless pumps. However, the sealing of the motor windings causes additional impediments for the removal of heat.

Cooling jackets or heat exchangers can be used to remove the majority of the heat, but these devices require plant cooling water. Providing and maintaining this cooling water could result in additional costs.

Filling the stator cavity with oil, which increases the motor power capacity by about 20 percent, increases the heat transfer to the outer band of

FIGURE 1



- P.T. INDICATES FLUID PUMPING TEMPERATURE BASED ON A SPECIFIC HEAT OF 1.0

Typical temperature increase in motor windings

BY JOSEPH A. CLEARY AND STEVEN A. JASKIEWICZ

the stator assembly. The presence of oil in the stator windings and its expansion requires an expansion chamber or inline relief valve system to maintain the secondary containment feature of canned motor pumps.

Other sources of heat are bearing friction and the disc friction of the impeller. These sources of heat are not as easily determined as in the drive section. Laboratory measurements, which are the most common, test the temperature increase at critical areas in the pump. However, some parts of the canned motor and magnetic drive pumps are not easily accessible for testing.

The canned motor has efficiency losses that add heat to the process fluid.

HOW HEATED LIQUID RESPONDS

What will happen to the process fluid in the drive section? Will it boil, form crystals, polymerize, decompose, accelerate corrosion, vaporize upon entering the pump casing from the motor, affect the bearings, form vapors that will affect the thrust balance, or form vapors that will create dead spaces in the drive section which will result in "hot spots"? You must consider these factors when applying a sealless pump.

Lastly, you need to be aware of what happens to the fluid when the pump is shut down. Residual heat in the drive section can affect static fluid. Fluids with low boiling points, for example, can form vapors which will cause the pump to vapor bind upon restarting. In other cases, the added heat can cause decomposition, leaving deposits on surfaces with critical clearances, or it can leave abrasive crystals or polymers which can cause bearing wear at restart.

You can make modifications to your system or ask the manufacturer to make changes to your sealless pumps to handle heat input problems. Pressurizing the circulation fluid keeps the added heat from boiling the fluid. Reversing the circulation path diverts the flow away from the low pressure of the impeller.

ADDRESSING FLOW RATES

The analysis is not complete without addressing the efficiencies and flow rates in sealless pumps. The lower the efficiency, the more heat will be added to the fluid. The greater the flow through the drive section, the lower the heat input to the fluid.

The best pump selection, however, may not be the most efficient pump. You also need to ask "What design will provide the longest life?" It may be a canned motor with a high recirculation rate, or a magnetic drive with a non metallic liner, or the addition of a heat exchanger or water jacket.

Sealless pumps, whether canned motor or magnetic drive, are application sensitive. Complete information on the process fluid, the application and the manufacturers' experience must be combined to achieve a successful service life for the equipment.

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