A REPRINT FROM THE NOVEMBER 1991 ISSUE OF

CEP
CHEMICAL ENGINEERING PROGRESS

MODIFY SEALLESS PUMPS

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Canned motor pumps aren't limited to clean fluids. You have several options for handling slurries.

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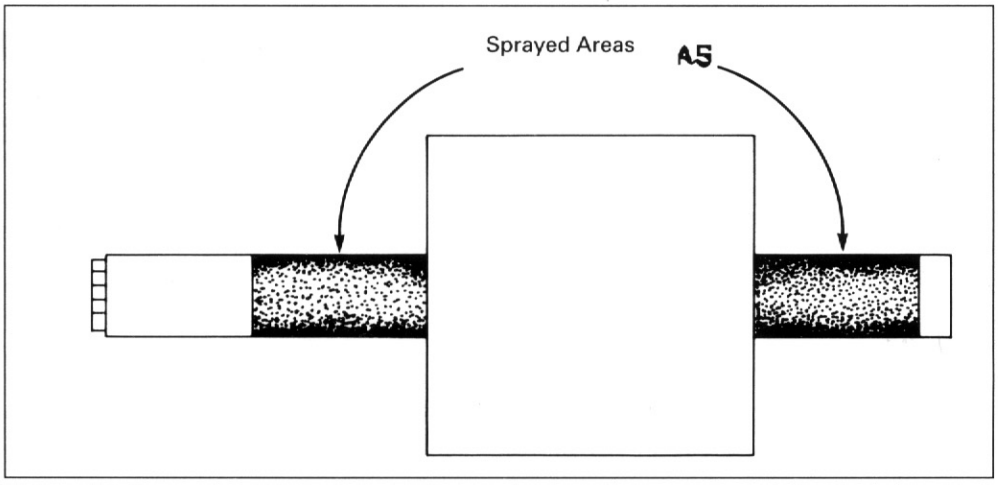
A general misconception about canned motor pumps is that they can only be used on clear, clean fluids because of the tight internal clearances of the rotating parts and the fact that bearings must be lubricated by the pumped fluid. The truth, however, is that canned motor pumps have been pumping solids-laden fluids and even slurries since their inception. Here are some design modifications and equipment alternatives for handling solids.

Hardened bearings and journals

Canned motor pumps that have an external circulation usually include a self-cleaning filter in the neck of the discharge flange that prevents any large particles from entering the motor section of the pump.

If low concentrations of solids are present (about 2%) and their size is relatively small (25 μm maximum), hard bearings running against a hardened journal work very well. The hard bearings and journals allow the solids to pass through the motor section without causing damage. Typical bearing materials are silicon carbide or aluminum oxide. The journal area of the shaft can be either coated or sleeved with tungsten carbide, silicon carbide, or chrome oxide, see Figure 1. Some pump manufacturers offer hard bearings and journals as standard items, others offer them as an option. The added cost for hard bearings and shafts is about $750 to $1,500, depending on the size and number of bearings required.

This modification works very well in most cases. But if the solids have a tendency to gel or cling there is a possibility that the filter or flow passages will become blocked and the recirculation flow will be reduced or completely shut off, which will cause the bearings to lose lubrication and the motor to overheat. Also, if the solids present are harder than the pump's materials of construction, liners may erode and premature failure may occur. Last, due to the difference in the coefficients of expansion of the bearings and journals, it is recommended that the pumps not be run dry for any length of time. If the pump is allowed to run dry, the



■ *Figure 1. Spray-coated shaft in a canned motor pump.*

shaft may sieze onto the bearings to cause a locked rotor condition.

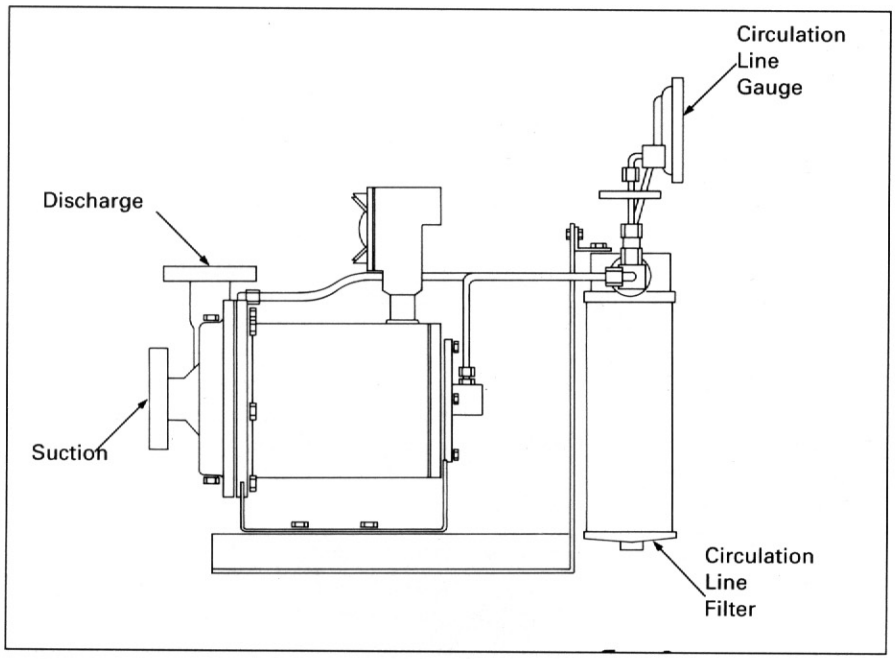
Filters on the recirculation line

Canned motor pumps that are designed for external circulation can be modified to have filters installed on the recirculation line, see Figure 2.

The flow that lubricates the bearings is filtered prior to entering the pump. Cartridge-type filters are installed in the circulation line to trap particles as small as 1 μm, depending on the type of cartridge selected. A differential pressure switch is placed across the filter to detect when the cartridge is becoming clogged to a point that may affect the flow into the motor section. When there is a significant pressure differential between the inlet and outlet of the filter, the differential pressure switch can either activate an alarm or shut down the pump. Block valves installed across the filter are used so the cartridge can be changed without isolating the pump from the process. If a large quantity of particles are anticipated or if the process cannot be shut down to change cartridges, duplex filters installed in parallel should be used.

The cost for installing a single cartridge-type filter complete with block valves and a differential pressure switch, in stainless steel, is about $1,500. After this initial investment the only expenditure involved is regularly replacing the filter cartridge.

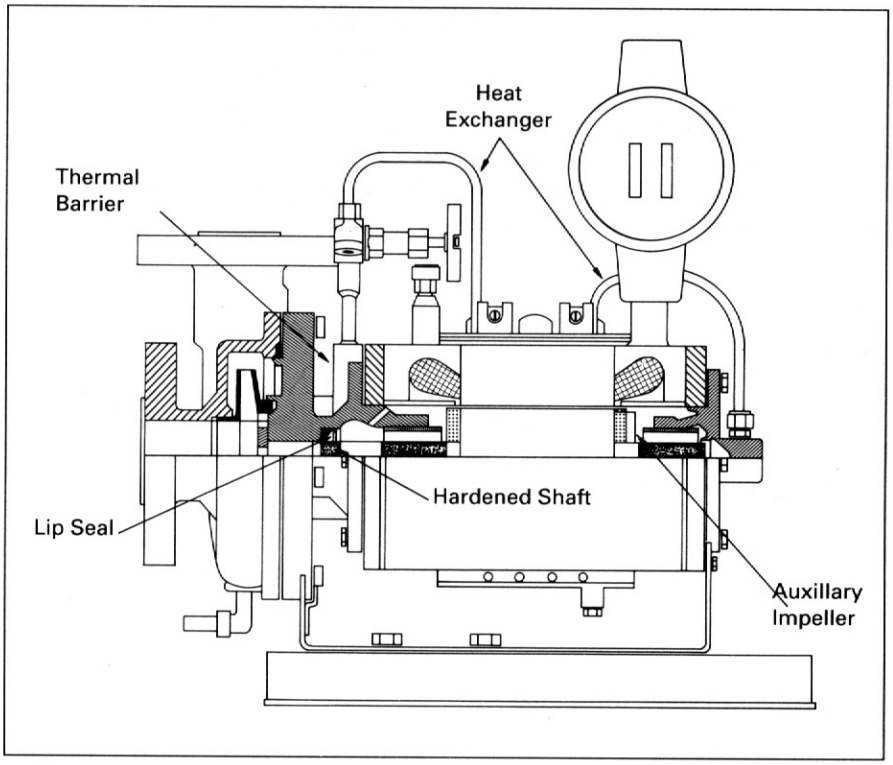
The advantage of filtering the circulation flow is that only the fluid entering the motor section of the pump is filtered, from 2 to 6 gal/min, as opposed to filtering the entire process fluid. In addition, no special flow or pressure monitoring devices are required, other than the differential pressure switch.



■ *Figure 2. These options give clean, filtered bearing lubrication.*

Backflushing

Backflushing is recommended when a fairly high amount of solids (above 2%) are present. A clean fluid that is compatible with the process is introduced into the motor section of the pump, normally through the rear bearing housing. This clean fluid lubricates the rear bearing, flows between the stator and liner to cool the motor, lubricates the front bearing, and enters the



■ *Figure 3. Backflushing with a lip seal is a way to handle solids-laden media at high temperatures.*

pump through the shaft clearance hole. The backflushing fluid then becomes part of the process fluid.

Any fluid can be used for backflushing as long as it is compatible with the process fluid, has a viscosity of 30 cP or less, and is not near its boiling point. Typical fluids used for backflushing are mineral oil, water, or a filtered stream of the process fluid.

Instrumentation including a flow meter, pressure gauge, control valve, and check valve should be installed on the backflush line to assure that the proper flow rate is maintained through the pump. The correct flow rate for backflushing is very important because improper flow rates will affect the hydraulic thrust balance and cause wear on the axial thrust surfaces, generate bearing wear, and possibly cause the motor winding temperature to rise.

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Modifying a pump for backflushing does not normally involve any added cost. The only cost involved is the expense of the equipment installed on the backflushing line. Depending on the type of instruments used and the electrical classification of the area, this cost may be $500 or more.

When backflushing is used it is also very important to have the correct start-up and shut-down procedures. The backflush fluid *must* be started at least 30 s prior to energizing the pump and *must* continue to operate for at least 30 s after the pump is shut down to ensure that the motor section is full of the clean, backflushed fluid and not the process fluid.

The drawback is that a flow rate from 2 to 6 gpm is required and this fluid will be added to the process fluid.

Backflushing with a lip seal

Backflushing with a lip seal has the benefits of a standard backflushed pump with the added advantage of reducing the backflushed flow rate to as low as 2.64×10^{-4} gal/min (1 cm^3/min). The flow rate is reduced by modifying a high-temperature canned motor pump that is designed for fluid temperatures to 1,000°F, see Figure 3.

The high-temperature design is actually two pumps in one because a separate recirculation system is established for the motor section. The pump end and motor section are separated by a thermal barrier, and there is very little intermixing of the fluids.

Fluid in the motor section lubricates the bearings and re-moves motor heat. An auxiliary impel-ler located on the rotor assembly pumps the liquid in the motor section through a liquid-cooled heat exchanger normally located on the outer housing of the stator assembly.

To modify this design for handling solids, a seal is placed in the barrier between the pump and the motor section. The motor section is then filled with a clean fluid that is compatible with the process fluid. The majority of this fluid is recirculated through the motor and heat exchanger.

A backflushed flow of as low as 1 cm^3/min must be introduced onto the motor section to maintain a positive flow from the motor section to the process end to ensure that no solids enter the motor cavity and to lubricate the seal. The flush fluid enters the process stream, but dilution of the process fluid is minimized. The backflushed flow rate can be maintained either by a steady-flow metering pump or by pressurizing a vessel.

The added cost for this type of pump is about 40–50% higher than a standard canned motor pump.

Slurry pumps

There are canned motor pumps in service today that are specifically designed to pump slurries. These pumps have features that are not normally found on canned motor pumps, namely, an open impeller, ball bearings, and a mechanical seal. Open impellers are much better for moving solids than closed impellers because the clearances in the pump casing are larger, the ball bearings are designed to limit the axial and radial movement of the rotating element, and a mechanical seal prevents the liquid in the motor section from escaping into the process.

The motor cavity is filled with a clean lubricating oil that is suitable for the ball bearings, and this oil is also used to remove motor heat. A small tank located in the rear of the motor is used to supply a source of backflushed fluid to the motor.

These pumps are designed for applications where a 10% or higher concentration of solids is present.

An isolation chamber can also be mounted between the motor and pump casing. This chamber is designed to be purged with an inert gas to prevent the process fluid from backing up into the motor section. A sensing device or visual indication can be installed on the isolation chamber to detect the presence of either process or motor fluid. The cost of this type of pump can be twice or more as high as a standard canned motor pump.

Sealless pumps in severe services

The methods described here illustrate the versatility of canned motor pumps for many difficult applications where process fluids are considered beyond the scope of this type of pump's capabilities. With some modifications and relatively low-cost accessories, the canned motor pump can be used on most fluid applications. Canned motor pumps have been used on fluids at temperatures to 1,000°F and working pressures to 5,000 psi, some of which have abrasive solids. CEP