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How to Specify Nonmetallic Sealless Pumps for Transferring Acidic, Caustic, Abrasive and Toxic Solutions

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Ever tightening regulations and heightened environmental responsibility have driven industrial and municipal facilities to rethink leak prevention, particularly when handling acidic, caustic and abrasive solutions that cause packing and mechanical seals to fail, and toxic solutions that demand failsafe containment. To transfer these solutions, operations and engineering management is relying increasingly on sealless, non-metallic pumps. Given the variety of types offered, recent advances in pump design and the myriad of fluid-contact materials available, this article attempts to update specifiers with guidelines needed to select the optimum sealless pump according to individual application parameters.

Heightened awareness of environmental, safety and maintenance issues in recent years has made process-fluid leakage a paramount concern in chemical processing plants and municipal wastewater facilities. The ability of sealless pumps to prevent or minimize leakage has made them the often-preferred choice for pumping of acidic, caustic and abrasive solutions that cause seals fail, as well as toxic solutions that require absolute containment. After years of being considered niche products for specialty applications, sealless pumps have become mainstream.

Pump design trends with respect to the handling of corrosive and abrasive fluids, point to the use of sealless configurations to minimize leakage, and the specification of nonmetallic, chemically inert, and abrasion-resistant materials of construction to ensure resistance to acids, caustics, salts and other aggressive fluids. To select the optimum sealless pump for an application, one must become familiar with the technical and economic issues involved in the pump-selection process, the available pump types, and the various nonmetallic materials that are suitable for the service.

Defining a sealless pump

The Hydraulic Institute (Parsippany, NJ) defines a sealless pump as one in which the impeller shaft is completely contained in a sealed, pressurized vessel (called the containment shell) that contains the process fluid. Leakage of the pump fluid into the surrounding environment is prevented by the exclusive use of static, rather than dynamic, sealing technology. Only two pump designs meet this definition: the magnetic-drive pump (MDP), in which the impeller shaft is driven by a magnetic-coupling arrangement, and the canned-motor pump (CMP), which features a rotating magnetic field within the motor stator. The Hydraulic Institute definition is therefore valid, but unnecessarily limiting. For the purpose of this article, a sealless pump is defined as one that does not use packing or mechanical seals to isolate the process fluid.

This broader definition permits consideration of a larger group of pump designs. There is, however, no intent to imply that these other sealless-pump designs eliminate the risk of hazardous or toxic emissions. This discussion is based on a search of commercially available designs with a focus on ones whose fluid-contacting parts are made of nonmetallic materials. No implication is made that this search has been all-inclusive and that all commercial products have been reviewed.

A wide variety of nonmetallic materials is available for the construction of wetted pump components used in corrosive-fluid applications. These include thermoplastics, thermosets and elastomers. A general knowledge of the characteristics of each class of material is helpful in selecting the proper one for a particular application. Table 1 summarizes the significant physical characteristics of the rigid plastics and Table 2 compares the elastomers used most often in aggressive fluid applications.

TABLE 1. COMPARATIVE PROPERTIES OF RIGID PUMP MATERIALS

Material	Maximum operating temperature °F	°C	Specific gravity	Tensile strength psi	Abrasion resistance (weight loss) mg*
Polyvinyl chloride (PVC)	140	60	1.30	6,000–7,500	12–20
Chlorinated polyvinyl chloride (CPVC)	210	99	1.49	7,500–11,000	20
Polyethylene (PE)	200	93	0.92–0.94	3,500–5,600	5
Polypropylene (PP)	185	85	0.94	4,000–5,000	15–20
Polyvinylidene fluoride (PVDF)	275	135	1.75	5,500–8,250	5–10
Ethylene chlorotrifluoro-ethylene (ECTFE)	300	149	1.75	6,500–7,500	5–10
Polytetrafluoroethylene (PTFE)	500	260	2.14–2.20	2,000–5,000	500–1,000
Fiberglass-reinforced plastic(FRP)	250	121	3.4–5.0	10,000–13,000	388–520
Stainless steel	N/A	N/A	7.9	65,000–77,000	50

* Taber test: 1,000 cycles

TABLE 2. COMPARATIVE PROPERTIES OF ELASTOMERS

Material	Max. temp. °F	°C	Product description
Natural rubber	220	104	Good resistance to acids and caustics; swells in solvents
Buna-N (Nitrile rubber)	250	120	Resists acids, caustics, aliphatic hydrocarbons and oils; not suitable for solvents or chlorinated hydrocarbons
Neoprene* (Synthetic rubber)	250	120	Multipurpose; resists sunlight, weathering, ozone; good for use with vegetable and mineral oils, acids, caustics and chemicals
Butyl rubber (Synthetic Elastomer)	250	120	Resists corrosive chemicals and dilute acids; good for use with oils, but not with solvents or aromatic hydrocarbons
Nordel* (Ethylene-propylenediene monomer)	300	149	General purpose; resists chemical, ozone and heat; suitable for use with a wide range of chemicals; low absorption and swelling
Viton* (Fluoroelastomer)	400	204	Resists heat, corrosion, corrosive chemicals, ozone, oils and aromatic hydrocarbons
Hypalon* (Chlorosulfonated polyethylene)	275	135	Resists abrasion, oils, oxidizing chemicals, sunlight, weathering, dilute and concentrated acids and caustics

*Trademark, DuPont

Sealless pump types

If the elimination of the mechanical seal is an important factor in pump selection, then there are other pump types, in addition to the MDP and CMP, that deserve consideration. But the choices narrow as application and service requirements become more stringent.

For instance, if the pump must be chemically resistant to the process fluid, the scope becomes limited to units with wetted components made of the stainless steels, high and exotic alloys and nonmetallics. If the analysis is restricted to applications where non-metallic materials are considered ideal for providing the required chemical resistance, then the options are limited to five commonly used sealless pumps, whose wetted parts are made of thermoplastic, thermoset and elastomeric materials. These configurations are the magnetic-drive pump, the coupled wet-pit vertical sump pump, the flexible-tube pump, the flexible-liner pump and the controlled-volume diaphragm pump.

The next segment of this article briefly describes the design principles of each of these nonmetallic pump configurations. Subsequently, the critical design factors are detailed.

Magnetic drive pump

The magnetic-drive centrifugal pump (Figure 1) offers flows to approximately 1,000 gal/min (227 m^3/hr), and heads up to 350 ft (107 m). A nonmetallic containment shell or can, encloses and statically seals the entire impeller-rotor assembly, as well as the pumped fluid. This pump has two shafts. The driven shaft is located in the liquid end of the pump and is supported by sleeve bearings. The impeller and the inner magnet are mounted on this shaft. The other shaft, called the driving shaft, is either a close-coupled motor shaft or one that is supported by antifriction bearings in the pump-bearing housing. The driving magnet surrounds the containment shell and is mounted on this shaft.

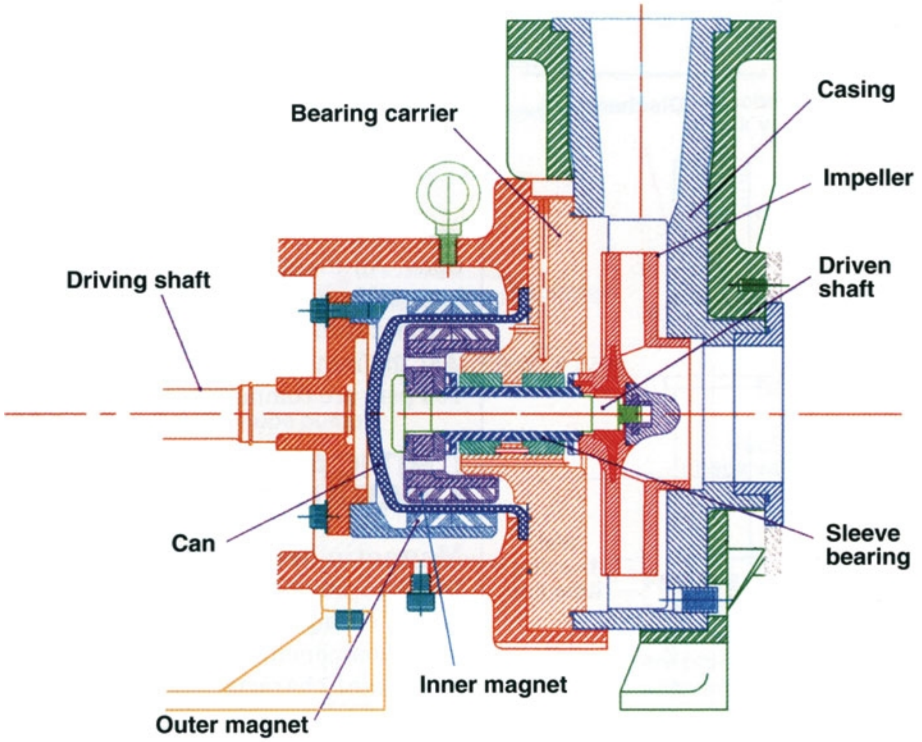

Figure 1
Magnetic-drive pump

Coupled, vertical sump pump

The coupled, wet-pit vertical sump pump (Figure 2) discussed here is a non-metallic sump pump that does not employ shaft-sealing arrangements. It offers flow rates up to 4,000 gal/min (908 m^3/hr) and heads up to 350 ft (107 m), and can be used in sumps as deep as 50 ft (15 m).

In this class of pumps, the impeller's hydraulic design is of a radial type, and the pumped fluid exits through a separate discharge pipe rather then coming up through the column. The pumped fluid that fills the column is returned to the sump through radial leakage holes in the column. The pressure in the column is atmospheric at the uppermost leakage hole situated below the manhole cover, so that the liquid level in the column remains below the point at which the shaft penetrates the pump support plate —hence a shaft liquid seal is not required. A dynamic vapor seal is employed in many cases, at the juncture between the shaft and cover plate to prevent escape of corrosive fumes that might attack the motor and its support bracket. The open-line shaft bearings are typically product-lubricated.

Vertical pumps are furnished in a variety of configurations, including: cantilevered-shaft designs, which are suitable for dry-running conditions; vortex-recessed impeller designs, for handling fluids with solids or stringy debris; and segmented-shaft designs, for installation in extremely deep sumps, or for installations of tall pumps in low-headroom areas.

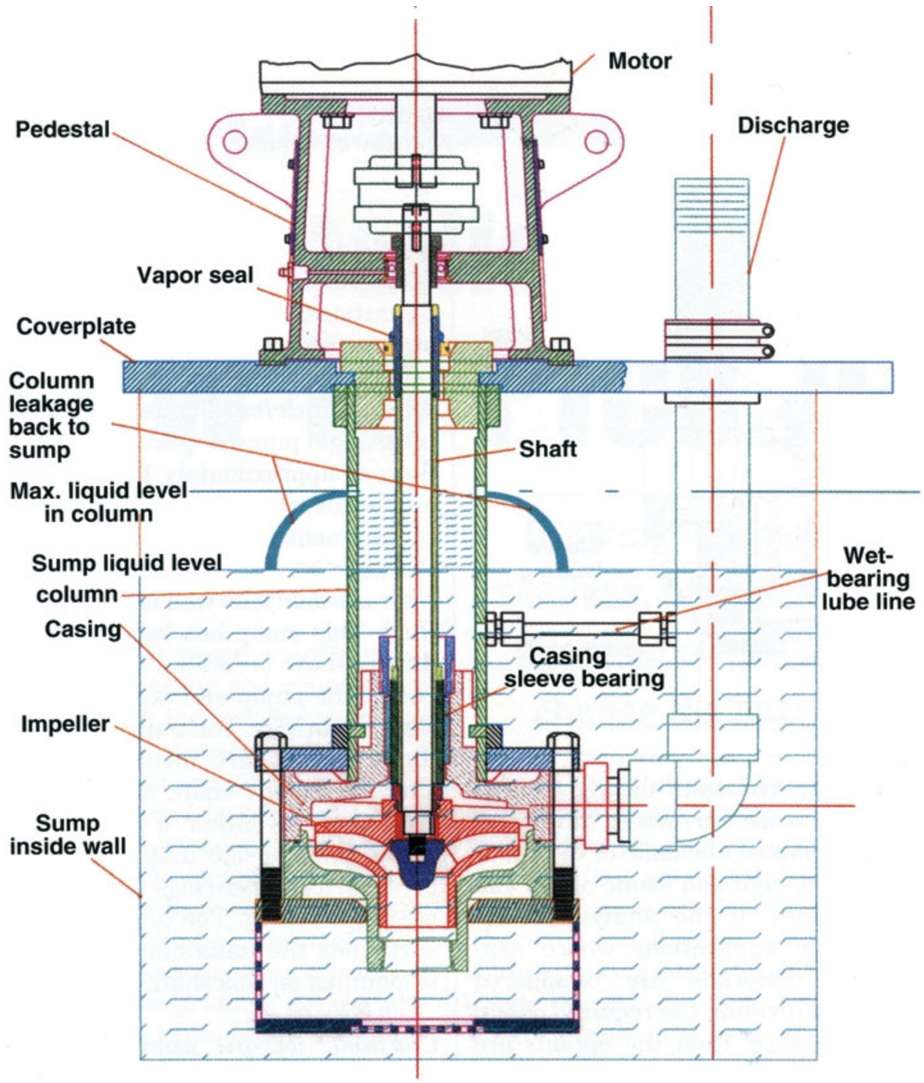

Figure 2
Vertical, centrifugal sump pump

Flexible-tube pump

The flexible-tube pump (Figure 3) does not use mechanical seals. Instead, the fluid is contained within the smooth walls of an elastomeric, tubular structure and is moved forward as the tube is squeezed by a rotating element. As the squeezed tube returns to it natural shape, the vacuum produced by the displaced fluid draws more fluid into the tube. Pumping is achieved by a gentle, peristaltic action that allows for a controllable flow of the fluid trapped between the two contact points on the inside of the tube. This configuration requires no seals, glands or valves. Models are available with flow rates up to 200 gal/min (45 m^3/hr) and differential pressures to 200 psi (1379 kPa).

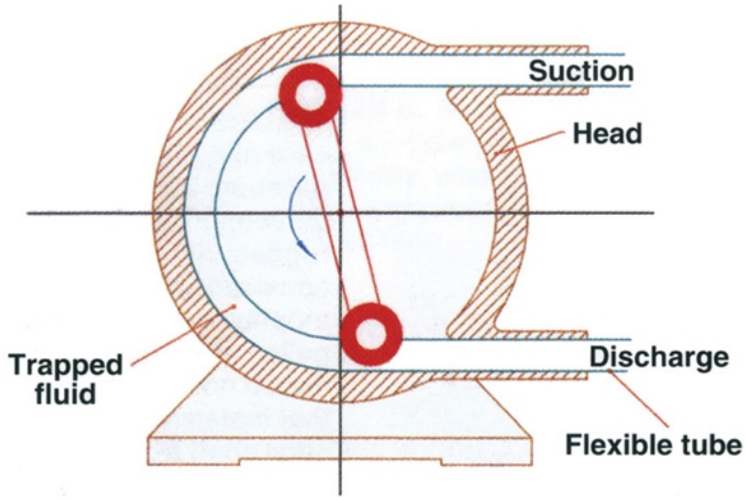

Figure 3
Flexible-tube pump

Flexible-liner pump

The flexible-liner pump (Figure 4) moves the fluid forward peristaltically via an eccentrically mounted rotor that applies pressure from the inside of a flexible liner within the pump body. Fluid is contained within a channel-like cavity formed by the outer surface of this elastomeric liner and the inner surface of the thermoplastic pump body. The rotor is mounted on an eccentric shaft that oscillates within the liner and progressively moves the sealing contact point between the liner and pump body, effecting a squeegee action on the trapped fluid.

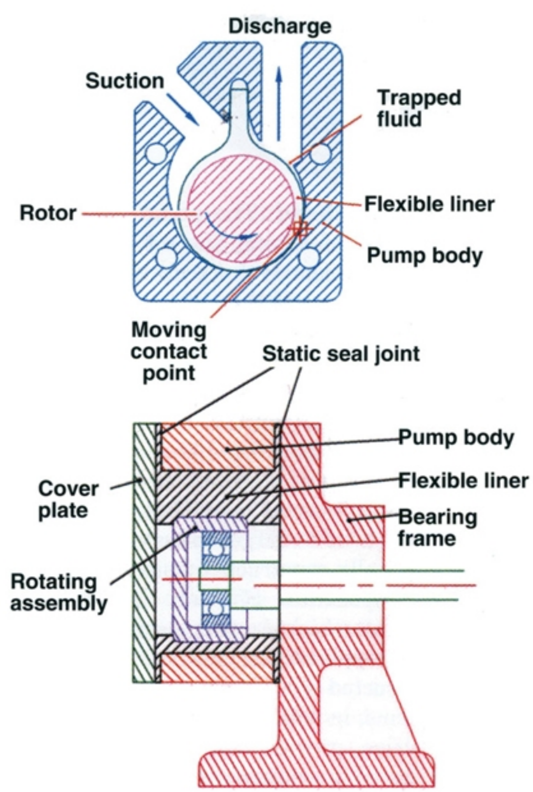

Figure 4
Flexible-liner pump

The flexible-liner pump is available in either close-coupled or pedestal-mounted configurations. It is self-priming and has no stuffing boxes, glands, valves or gaskets. Flow rates range from 0.30 to 40 gal/min (.075 to 9 m^3/hr), with a maximum differential pressure of 30 psi (207 kPa). The pump can be driven by an electric, gasoline or air motor.

Diaphragm pump

The controlled-volume diaphragm pump (Figure 5) has a flexible diaphragm that directly contacts the process fluid. This diaphragm also acts as a seal between the drive mechanism and the pumped liquid.

Many design configurations are available. The diaphragm can be driven mechanically, hydraulically, pneumatically or electromagnetically. The pumps are available in single-, double- and multiple-diaphragm configurations. All diaphragm pumps are sealless and self-priming, and can be run dry without causing damage. Flow rates of 200 gal/min (45 m^3/hr) and outlet pressures of 100 psig (6.89 bar) are common.

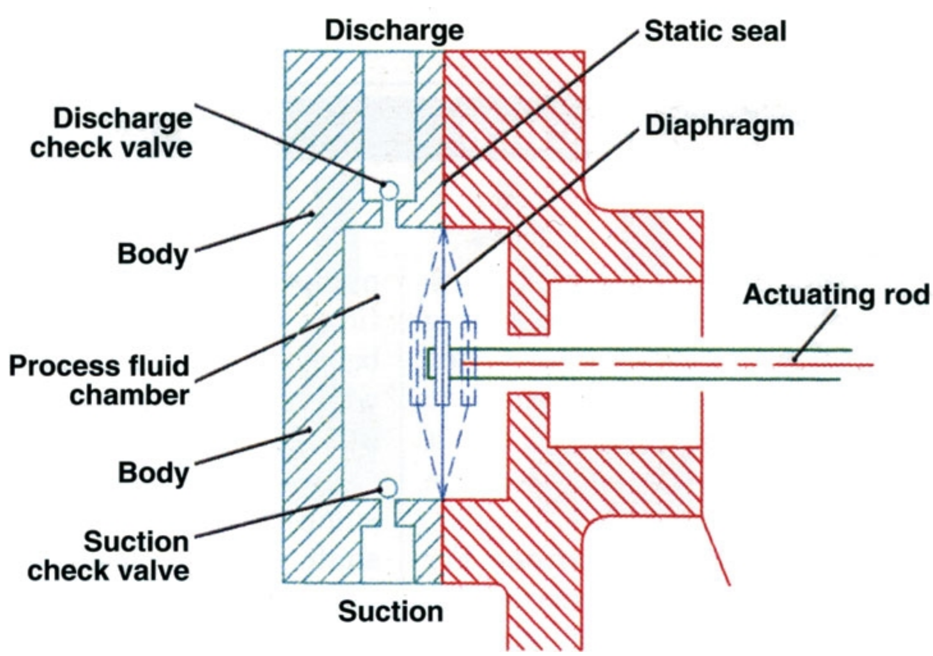

Figure 5
Controlled-volume diaphragm pump

CRITICAL DESIGN CHARACTERISTICS

Magnetically driven pumps

In the magnetic-drive pump, the pump casing is a pressure-containment component whose strength is a significant characteristic. Mechanical strength is also an important factor to consider when determining the flange loading that can be carried by the pump. MDPs are available with metal casings that are lined with thermoplastics or constructed of

Figure 6 - This magnetic-drive, close-coupled pump is shown with wet end opened and the solid, molded-thermoplastic casing, impeller and bearing housing exposed. All components are produced from polypropylene or polyvinylidene fluoride. In this design, no metal comes in contact with the pumped fluid.

fiberglass-reinforced thermoset resins and solid, molded thermoplastics. Some solid thermoplastic designs also incorporate cast-iron structural supports to provide enhanced pressure-containing and nozzle-load capabilities that match those of metal pumps meeting ANSI process-pump standards.

When considering the use of metal casings lined with corrosion-resistant thermoplastics, special consideration of the service conditions is critical. The following questions should be addressed when selecting the special material: How will the lining hold up under the flow conditions? How abrasion-resistant is the lining material? How significant is the danger of wear or pinholing, which might lead to corrosion of the metal or contamination of the product? These concerns become less significant as lining thickness increases, or with designs that utilize thick-sectioned, replaceable wet-end components.

Driven shaft: This component features a stainless-steel or high-alloy shaft that is completely encapsulated, or sleeved, in a chemically inert, nonmetallic material, such as polypropylene (PP) or polyvinylidene fluoride (PVDF). This design provides strength, and allows one to select the thermoplastic material based on the required corrosion resistance to the chemicals being pumped. Some pumps utilize a ceramic shaft, which eliminates concern about chemical resistance or product contamination

Bearing carrier or housing: This structural component houses the wet-end bearings. The bearing housing features either solid thermoplastic construction (Figure 6) or a plastic-lined metal component. The same precautions noted for selecting the thermoplastic with suitable corrosion resistance for pump casings apply here. Bearings that are immersed in the process fluid are generally furnished in non-metallic materials, such as ceramics, carbon-filled polytetrafluoroethylene (PTFE), or silicon carbide

Containment shell (the can): The containment shell, like the casing, must withstand high pressure. Its material of construction is selected according to the required corrosion resistance and mechanical strength. Most nonmetallic MDPs utilize a two-layer can, whereby the inside can —the one in contact with the corrosive fluid —is made from chemically inert fluoropolymers. The outer can, which is not in contact with the aggressive fluid, and mainly provides mechanical strength, is generally furnished in a fiber-reinforced-plastic resin composite. Sometimes, the outer can is of metallic construction. In addition to providing corrosion resistance, the nonmetallic cans generate less heat than metallic ones. Heat is generated by wet-end-bearing friction, by hydraulic losses due to the rotation of the inner magnet in the fluid and by eddy currents on the surface of the can, caused by the rotating magnetic field in the coupling. This heat is carried away by circulating some of the pumped fluid between the outside of the inner magnets and inside of the can. The circulated fluid leaves the can at a higher temperature than that at which it entered, and the temperature of the liquid in the can is actually higher than the process temperature. Non-magnetic cans effectively avoid troublesome eddy currents and the associated heat generation that reduce pump efficiency and reliability

Driven magnet: The inner magnet is constructed of rare-earth metals such as samarium cobalt or neodymium. To provide the chemical resistance required, these magnets are completely encapsulated with

PTFE, PVDF or PP.

Coupled, vertical sump pumps

Figure 7 - Cut-away view of a vertical centrifugal sump pump made of polyethylene showing rugged ribbed column construction, molded thermoplastic casing and impeller, and a thick-sectioned nonmetallic sleeve that isolates the stainless steel shaft from the fluid. There are no bearings inside the fluid cavity and no seals, except for the nonmetallic vapor seal in the cover plate, which protects the motor bracket assembly from corrosive fumes.

These chemical pumps, intended for corrosive services, are available in PP, polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), PVDF and fiberglass-reinforced plastic (FRP). Wetted parts of the pump assembly consist of the portion of the pump shaft situated below the pump mounting plate (also called a coverplate), the shaft sleeve bearings, the casing, the impeller and the pump column, which structurally supports the immersed casing and shaft (Figure 7).

This pump is available in various design configurations. Typically, the motor mounts above the mounting plate. In cantilevered designs, which are recommended for use where dry running may occur or where acceptable wet-bearing lubrication is not attainable, the pump shaft is supported by anti-friction bearings above the mounting plate. There are no bearings immersed in the fluid. These pumps are limited to sump depths of approximately 5 ft (1.5 m), but with tail pipes they can effectively be used in slightly deeper sumps.

Motor-support configurations: For light-duty, low-cost and intermittent service, the pump motor may be mounted directly on top of the thermoplastic mounting plate. On the more rugged, heavy-duty designs, the motor is mounted on a cast-iron, motor-support pedestal. This pedestal elevates the motor above the mounting plate, as well as above the vapor seal in the coverplate, thereby protecting the motor from exposure to trace amounts of corrosive fumes that might escape through the seal. The elevation also provides the vertical height necessary to utilize separate anti-friction bearings for extra shaft support

Shaft configurations: When selecting a vertical pump, the user should note that reliability is, in part, dependent on whether the shaft is supported by means of a cantilever or by a wet bearing.

In wet-bearing designs, the shaft is supported from above the mounting plate using antifriction, grease-lubricated bearings in the pedestal, and is additionally supported from below the mounting plate with product-lubricated sleeve bearings.

Material selection is the key to protecting these bearings from the fluid. The choice for the outer bearings includes ceramic, silicon carbide, siliconized carbide, carbon-filled PTFE and glass-filled PTFE. For extreme conditions, the shaft journals (or inner bearings) are constructed of ceramic materials.

It is important to note that wet bearings must remain wet in order to operate properly. Serious damage can occur if wet bearings are allowed to run dry. Sealless sump pumps provide bearing lubrication by tapping fluid from the pump discharge and routing it to each bearing. This product lubrication method is required because the upper wet bearings are not flooded by the liquid in the sump when the liquid level is low. Furthermore, when the pumped fluid contains solid particles that can damage the wet bearings, an independent clean-water flush must be incorporated in the pump design.

By definition, a cantilevered sump pump must provide all shaft support from above the mounting plate. This design stipulation stems from the fact that the impeller is overhung on the pump shaft and is not supported from below the mounting plate. Additionally, in the cantilever sump pump, the hydraulic radial and axial loads must be sustained by the anti-friction bearings located in the motor pedestal. The shaft must be rugged and of a large-enough diameter to minimize shaft deflection and stresses caused by these hydraulic loads. It also requires heavy-duty antifriction bearings that can carry the larger loads imposed by a cantilever design.

Unlike horizontal, overhung designs, these vertical pump configurations may require different bearings and shaft diameters as the pump length, and hence the overhung length, changes. Corrosion and potential metal contamination of the fluid can be prevented by constructing the shaft of Type 300 Series stainless steel, and sleeving the shaft with a thermoplastic material. If metal contamination is not a problem, superior corrosion resistance can be achieved by upgrading from stainless steel to more-costly metal alloys. In any case, it is important to select the shaft and encapsulation material on the basis of cost, anticipated service life and the ability to resist attack from the process liquid.

Flexible-tube pumps

Flexible-tube or flexible-hose pumps were originally designed for low-flow metering applications, and have gradually worked their way from the laboratory into production-level applications. They handle slurries, high-viscosity fluids and abrasives, can be run dry, and have excellent self-priming capabilities. Pulsations are present in the discharge line due to the nature of the pumping mechanism. The following section discusses the three major assemblies of the flexible tube pump —the head, tubing and drive.

Figure 8 - In a flexible-tube pump, the tube passes through the pump body, where a set of rotating rollers compresses the tube and enables flow.

Pump head: The pump head contains the tubing, the roller or shoe-drive assembly that traps the liquid in the tube, and the casing that houses these components. The rollers or shoes squeeze the outside of the tube against the bore of the casing, trapping the liquid between the squeeze points (Figure 8). Since the corrosive liquid does not contact the head under normal operating conditions, the head on larger industrial units is usually constructed from cast-metal components. Smaller, lighter-duty units, which are often used for metering applications, may have heads constructed of rigid plastic. Duplex systems, in which two heads utilize one drive, provide higher flows and reduced pressure pulsation.

Tubing: A variety of elastomeric materials, including polyurethane, chlorosulphonated polyethylene, and nitrile, butyl and natural rubber, are available for tubing construction. Some manufacturers offer proprietary materials, such as cord-reinforced tubing or special natural and synthetic rubber or plastic composites designed for specific service requirements. Although numerous references offer information on the chemical resistances and temperature limitations of these standard and proprietary elastomeric materials, they often fail to account for variables such as fatigue, repetitive flexing and similar factors

The service life of a flexible tube pump is highly dependent on the specific material selected for the tubing. Since the pumped fluid is totally contained inside the tubing, the fatigue life and the maximum pressure of these pumps are dictated by the material characteristics and the fluids being pumped. Flexible-tube-pump hoses undergo many cycles of compressive and tensile stress. Even if the original tubing were replaced by tubing with similar characteristics, the pump might not perform as it did with the original material, unless that material were provided by the original supplier.

Drive: Most flexible-hose pumps operate at a shaft speed below the motor's synchronous speed. This is achieved by employing reducing gears or a variable-speed drive. The use of a variable-speed drive permits the pump flowrate to be varied so that specific metering requirements are met. This also helps extend the fatigue life of the tube.

Flexible-liner pumps

Figure 9 - Pedestal-mounted flexible-liner pump with all fluid-contacting parts made of nonmetallic materials.

Flexible-liner pumps are available in close-coupled configurations with a C-face motor, and frame-mounted designs coupled to a foot-mounted, horizontal motor (Figure 9). These units are self-priming, can be run dry, and can dependably handle slurries and viscous liquids. Like flexible-tube pumps, flexible-liner pumps also tend to produce pressure pulsations. At selected speeds, however, the pumping action is gentle enough to prevent the settling out of suspensions and provide for the effective handling of latex emulsions and similar materials. Duplex designs are available for higher flows and for reducing the pulsation tendency. The use of two opposing eccentric shafts oriented 180 deg out of phase cancels pumping pulsations generated within each fluid cavity. The user should provide flexible-hose suction and discharge connections to avoid transmitting piping loads to the pump nozzles and system piping.

Flexible-liner pumps operate at 1,800 rpm or less and are available with variable-speed drives. Unlike some positive-displacement pumps, flexible-liner pumps can be operated at zero flow for short periods of time, but it is not recommended that the differential pressure exceed 30 psi (207 kPa) for continuous service on most sizes. The major components consist of the liner, body block, rotating assembly, cover plate and bearing frame.

The two components for which material selection is critical are the body block and the liner. These are the only components in contact with the fluid.

Rotating assembly: The rotating assembly of the flexible-liner pump consists of an eccentric rotor that is mounted on an overhung, frame-mounted shaft, and is completely isolated from the pumped fluid. The liner acts as a joint gasket between the pump body and cover plate, and between the body and the bearing frame. Since the aggressive fluid does not contact the rotor, the rotor does not require special materials of construction. As the rotor oscillates within the liner, it creates a sealed, rolling contact point between the inside surface of the body block and outer surface of the liner. This imparts a progressive squeegee action on the trapped fluid

Body block: The body block contains the suction and discharge nozzles, and is considered to be the pump casing. Constructed from rigid

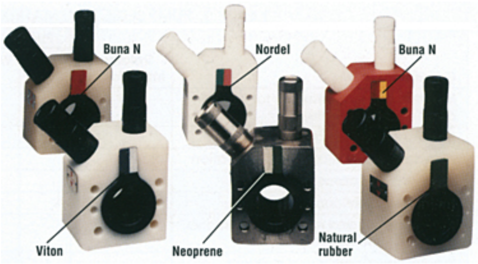

Figure 10 - The flexible-liner pump has a wide choice of body-block and liner materials. Liner materials include natural or butyl rubber, neoprene, fluoropolymers, ethylene-propylene-diene monomer (EPDM), Buna-N and chlorosulfonated PE. Liners are shown with various pump casing materials, which are: Left to right (top row): PP, Teflon, Rulon; (bottom row): PE, stainless steel, PP.

thermoplastics, the body block is sandwiched between the two external flanges of the liner, which act as gaskets. The interior surface of the bore is in direct contact with the fluid, making material selection critical. Standard units provide a choice of ultra high-molecular-weight polyethylene (UHMWPE), PP and PTFE (Figure 10)

Flexible liner: The liner is a thick-walled, molded elastomeric component that can readily be replaced in the field without the use of special tools. Only the outside circumference of the rugged unit is in contact with the pumped fluid. Its cross section forms an "H" pattern — the vertical legs of the "H" act as static gaskets between the body block, the cover plate and the bearing frame. It is this feature that makes the flexible-liner pump a "sealless" pump. The flanges on this liner are pressed to the sides of the body block by concentric grooves on the pedestal assembly and cover plate, isolating the fluid within the formed channel

Although this type of pump is well suited for pumping clear or viscous liquids and slurries with soft solids, it may experience difficulty with fluids that contain hard or sharp solids. The wide choice of liner materials available, and the ease with which liners can be changed, makes it economically feasible to utilize a single flexible-liner pump for numerous applications.

TABLE 3. PUMP SELECTION MATRIX

Criteria	Relative importance	Pump option 1		Pump option 2	
		Raw score	Weighted score	Raw score	Weighted score
Meeting the requirements for flowrate, head and temperature					
Resistance to fluid attack					
Avoidance of metallic contamination					
Resistance to abrasion					
Initial and installation cost					
Maintenance and repair requirements, or mean-time between repairs					
Product availability and delivery					
Manufacturer and supplier experience					
Total score					

SCORING PROCEDURE

1. List the significant criteria
2. Determine the relative importance of each characteristic and assign a numerical value:
   3=very important
   2=significant
   1=not critical; minor value
3. Assign a raw score by numerically rating each option according to how effectively it meets each criterion.
   2=complete compliance
   1=medium compliance
   0 =no compliance
4. Multiply the relative-importance value by the raw-score rating to obtain the weighted score for each criterion.
5. Add up all the weighted scores for each pump option. The highest total suggests the optimum choice.

Diaphragm pumps

The controlled-volume diaphragm pumps are widely used with viscous liquids, abrasive slurries, shear-sensitive liquids (such as paint) and fluids containing small, suspended solids. The diaphragm's relatively low oscillation frequency and low velocity are gentle on the fluid being pumped.

The air-operated, duplex nonmetallic pump is the type most widely used

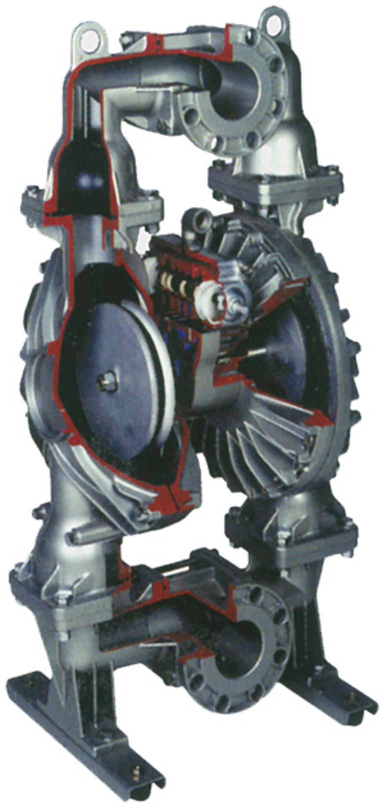

Figure 11 - Shown is a cutaway of a controlled-volume diaphragm pump with double diaphragms and check valves exposed.

in the CPI. This configuration features two diaphragms linked by a common shaft (Figure 11). An air-valve mechanism controls the oscillating stroke of the shaft. The suction stroke that draws pumped liquid into the pumping chamber doubles as the discharge stroke on the opposing diaphragm, which expels liquid out of that pumping changer. Like many positive-displacement pumps, the diaphragm pump has a pulsating discharge pressure. Pulsation modulation is achieved via dampeners and flexible-hose connections.

In addition, diaphragm pumps are self-priming, and can be run dry. Air-operated units may be submerged if all of the pump components are corrosion resistant, and if the driving air can be vented through the pumped liquid. Automatic, variable-speed capability is achieved by controlling the inlet-air pressure and flowrate. The major components of the wet-end assembly include the body, diaphragm, and suction and discharge check valves and valve seats.

Body: The body of the controlled-volume diaphragm pump is the pump casing. The joint between the body and the diaphragm separates the wet-end pumping chamber from the mechanical power end. Materials of construction for this component include PP, PVDF and PTFE

Diaphragm: The flexing of this elastomeric component is responsible for the pumping action. The material of construction for this critical component should be selected on the basis of its resistance to the aggressive fluid that is being handled. Options include neoprene, polyurethane, PTFE, Buna-N, EPDM, fluoropolymers, and chlorosulfonated PE

Check valves: The check valves control the flow of liquid into and out of the pumping chamber, and are exposed to the corrosive pumped liquid. Materials of construction are similar to those used for the diaphragm. There is one check valve at the inlet and one at the exhaust of each liquid pumping chamber

Check-valve seats: During the discharge stroke of the diaphragm, the check valve at the inlet of the pumping chamber is pushed against the seat at the pumping-chamber inlet. Likewise, during the suction stroke, the check valve at the discharge end of the pumping chamber is pushed against the seat at the respective location. Since the check-valve seats are exposed to the pumped fluid, they must be chemically resistant. They can be supplied in the same variety of elastomers as the diaphragm

The selection process

The selection of the ideal sealless thermoplastic pump for a particular application requires a thorough awareness of the application requirements, including the ability of the pump to handle the required flow and differential pressure, and what materials will perform reliably in the service. When selecting a material of construction, three criteria are used to simplify the choice of a specific thermoplastic: The maximum fluid temperature, the desired abrasion resistance of the pump and the chemical inertness of the pump material to the process fluid.