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# Application Possibilities Grow for Plastic Pumps

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# Application Possibilities Grow for Plastic Pumps

Reprinted from WATER/Engineering & Management
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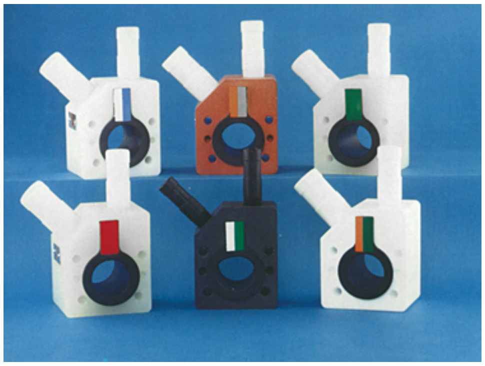
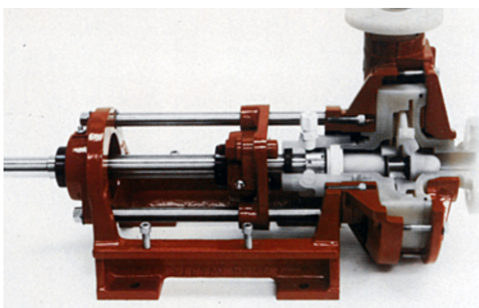
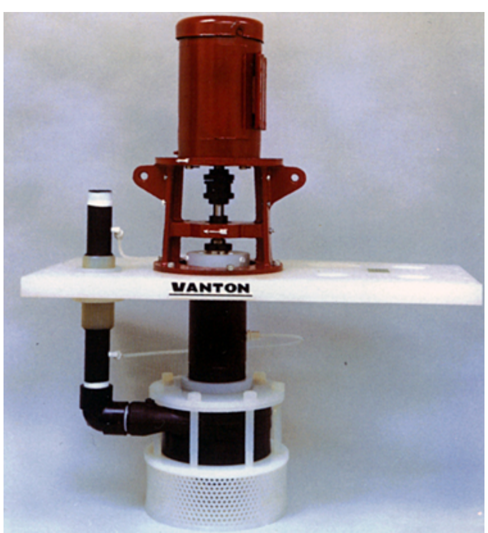


Common materials for the bodies and liners of plastic pumps are, clockwise starting at top left: polyethylene body, Viton liner; reinforced Teflon body, Hypalon liner; polypropylene body, natural rubber liner; Teflon body, Nordel liner, carbon-filled Teflon body, Neoprene liner; and polypropylene body, Buna-N liner.



Cut-away view of centrifugal pump shows construction using Halar ECTFE fluoropolymers, which extends service life in extremely corrosive and abrasive applications.




This vertical centrifugal pump fabricated from plastic materials is equipped with a proprietary seal which prevents the escape of corrosive or toxic fumes and liquids from pressurized tanks and sumps.

## GROUNDWATER TREATMENT

No matter what design solutions engineers and construction contractors devise to contend with the growing number of water and air pollution regulations, they can't do very much without pumps. Gravity sometimes may play a role in water and wastewater systems but pumps are, without a doubt, the prime movers in the business of fluid handling. And as water pollution control technology continues to develop to meet the needs, it is becoming more evident that non-metallic pumps are particularly suitable for many applications in the field.

Unfortunately, the quantity of published information covering the design features, materials of construction, and applied experience of non-metallic pumps used for water pollution control purposes is meager compared with what is available in published form on metallic pumps and other equipment. Plastic pumps have been around for decades (our company developed thermoplastic pumps in 1950), but the bulk of experience with them has been acquired in the chemical and other process industries, where they have been applied in numerous cases for handling corrosive and hazardous fluids.

As a result of government regulations affecting water quality and waste disposal, municipal facilities now are seen as chemical operations requiring the same degree of knowledge and sophistication associated with manufacturing and processing plants. With this in mind, a review of significant information on plastic pumps, and their design and application, should be of interest and value. Three important aspects are covered.

• The non-metallic materials in widest use for pumps handling corrosive and abrasive wastewater, water and wastewater treatment chemicals, and corrosive fumes. Which materials for which service?

• Design aspects unique to non-metallic pumps in water pollution control service, and how metallic contact with pumped fluids can be avoided.

• The expanding use of non-metallic tank/pump systems to handle a variety of wastewater streams.

An additional area of increasing importance to engineers and managers in the water/wastewater field is the control of undesirable atmospheric emissions. The incorporation of thermoplastic pumps and other components in the design of scrubbing and odor control systems has solved a number of problems, and will be the subject of a future article in WEM.

## Materials of Construction

Let's look first at materials of construction. Several years ago a study aimed at knowledgeable engineers and others involved with wastewater treatment revealed that a large majority had used non-metallic pumps for some purpose. But generally they were unaware of the range of potential applications for them, and the specific reasons for selecting non-metallic rather than metallic pumps.

Corrosion resistance was identified as the major attribute of non-metallic pumps. But their abrasion resistance and ability to avoid metallic contamination of the product they are pumping, thus preserving its purity, also are important characteristics. Of even greater significance is the inert chemical nature of the thermoplastics, which are suitable for use over the full pH range. This property simplifies the choice of the specific material, and extends the usefulness and service life of a given pump in a variety of applications.

Several other attributes of plastic pumps, in addition to their being chemically inert and resistant to abrasion, are worth taking into account. For instance, they are light, being 25 to 50 percent the weight of the metallic items they can replace. Since the plastic parts will not rust or seize, they are easy to service, and their initial cost is lower than pumps fabricated with exotic alloys.

The plastic materials of construction for rigid wet end components such as casings and impellers, which received the most mentions in the study were:

1. PVC/CPVC-polyvinyl chloride and chlorinated polyvinyl chloride. These relatively low-cost thermoplastics are widely used for acids, caustics and salts. PVC has an upper temperature limit of 140°F, but CPVC can be used at temperatures to 210°F. Neither material is suitable for solvents.

2. PP-polypropylene. This is the lightest of the thermoplastics and is recommended for acids, caustics and organic solvents to temperatures of 185°F. It is not suitable for use with strong oxidizing acids, chlorinated hydrocarbons or aromatics.

3. PVDF-polyvinylidene fluoride, most commonly known as Kynar, a product of Elf Atochem. Fluoropolymers such as PVDF and a very similar thermoplastic, ECTFE or ethylene chlorotrifluoroethylene, are tough, abrasion-resistant materials which retain their mechanical properties in the temperature range -40°F to 275°F. They are chemically inert to most solvents, acids, and caustics, as well as to chlorine, bromine and other halogens. Also, they are recommended for use with ultrapure water and reagent grade chemicals–in fact, wherever freedom from contamination is a key consideration.

4. PTFE-polytetrafluoroethylene, which is DuPont's Teflon. This also is used for a variety of pump components, which must be chemically inert, and withstand temperatures up to 500°F.

5. FRP/GRP-polyester, vinyl and epoxy resins reinforced with glass or other fibers. These thermosetting materials are more like metals in structural properties. They represent a group of composite materials, which offer higher strength than thermoplastics, but limited corrosion or

abrasion resistance. Also, their use is not recommended above 240°F.

Clearly, choosing a material of construction for specialized water or wastewater treatment pumping applications should be based on checking the corrosion resistance of the material in terms of the fluids to be handled and the anticipated temperatures. In many cases, a pump manufacturer may have experience in dealing with identical or similar service conditions. When it comes to handling waste streams containing unknown or varying chemicals and concentrations, engineering and operating personnel can be confident in the ability of thermoplastic pumps to be up to the task because the wetted parts are so chemically inert.

## Spotlight on Pump Design

Some so-called plastic pumps on the market are misnamed. They are basically metallic pumps with non-metallic casings and impellers. For best results, plastic pumps should be designed to take maximum advantage of the unique properties of the plastic material. If the application requires non-metallic parts to be in contact with the fluids being pumped, the following points are important:

1. Make sure the pump shaft is completely sleeved in a thermoplastic material inert to the fluids. In a horizontal centrifugal design, the thick-sectioned sleeve need only isolate the short section of the shaft within the pump head.

2. In a vertical sump pump, the encapsulating sleeve should run the entire submerged length and through the cover plate. A vapor seal where the sleeved shaft penetrates the cover plate is required to protect the external bearings and motor from corrosive fumes.

3. Horizontal and vertical pump designs should have an O-ring seal between the thermoplastic sleeve and the impeller, and between the impeller and the lock nut, to prevent metal-to-fluid contact.

4. In horizontal centrifugal pumps, the design should permit installing the mechanical seal so that its non-metallic face is in contact with the fluid. This reverse mounting avoids the use of expensive seals with exotic alloy retainer assemblies or cages, and ensures no metal is exposed to the fluid.

5. Since there is a significant expansion differential between a sump pump's metal shaft and its thermoplastic column, the design should incorporate a self-adjusting mechanism to compensate for this differential if service conditions involve sudden or extreme temperature changes. Without such a device there is a danger of impeller binding.

6. To provide a positive drive and prevent damage from reverse rotation, thermoplastic impellers should be key driven. Another advantage is to use an impeller with the metal key molded in. This offers additional rigidity at higher temperatures and pressures. Also, plastic impellers should be dynamically and hydraulically balanced at the factory.

7. For maximum service life, vertical pump designs should be furnished with chemically inert sleeve bearings in the submerged area. Best results appear to be achieved with ultrapure ceramic inner sleeves, and

silicon carbide, reinforced Teflon, or Vanite outer bearings.

8. Various sealless pump designs are being selected in response to the tighter regulatory requirements, three types in particular.

*Peristaltic pump*
This pump group with fluid contact parts limited to non-metallics includes tube type and flexible liner type which trap the fluid temporarily between an elastomeric member and a thermoplastic housing. The latter type has been in industrial and municipal service since the 1950s. Fluid contact is limited to two parts: the thick thermoplastic body available in such materials as high molecular weight polyethylene, polypropylene and Teflon; and the liner furnished in pure rubber or an assortment of synthetics from neoprene to various Dupont elastomers like Nordel, Hypalon and Viton (see photograph showing six versions). The Flex-i-liner pump design makes liner changes easy to accommodate a variety of chemicals.

*Diaphragm pumps*
These pumps isolate the pumped fluid so that there is only non-metallic contact. Carefully chosen for a specific application, and closely monitored, they provide good service, but have three drawbacks. First, they are noisy devices, being driven with compressed air, and indoor application can present problems for nearby workers. Second, diaphragm failure can lead to difficult-to-handle spills. If hazardous or toxic fluids are being pumped, this is a serious concern. Third, atmospheric oil emissions can be troublesome, but manufacturers are attacking this shortcoming.

*Magnetically driven non-metallic centrifugal pumps*
These pumps have a number of attractive characteristics. In addition to being inherently sealless, they permit the use of devices for leakage monitoring, and avoid the emission of hazardous and toxic fumes. Polypropylene, PVDF and Teflon are commonly used in these designs. When severely corrosive, hazardous or toxic chemicals are present, Teflon appears to be the material of choice for the containment can in direct contact with the fluids, since it offers the broadest range of chemical resistance. One design approach has a dual containment system, with one can of Teflon for fluid contact, and a secondary can of a high strength thermoset composite. The non-metallic materials provide corrosion protection, and the design permits incorporation of leak and temperature monitoring devices if called for.

## Non-Metallic Pump/Tank Systems

The traditional below-grade concrete sump with a mounted pump of some style is no longer the best way to contain and deal with hazardous liquid wastes. Regulations now require these to be lined with corrosion-resistant coatings to prevent chemicals, oils and other materials from leaching into adjacent groundwater. But concrete sumps are difficult to seal completely, and keep sealed. Coatings are typically 125 mils thick since sump service is considered immersion service, and anything less might not last long and also be inadequate. Regular inspections are necessary to ensure continued integrity of the coating. When chemicals penetrate it through constant immersion, patching is possible but difficult, and seldom acceptable. In many cases the coating must be completely stripped off and the concrete surfaces recoated.

Packaged non-metallic pump-tank units now available often can provide economical solutions to some of the problems described above. These are standard or customer-engineered self-contained tanks containing not only pumps, but level controls, control panels and related piping as well. Welled parts machined or fabricated from a number of thermoplastic or thermosetting materials, for instance the five families of plastic compounds discussed earlier, make the systems suitable for handling a broad range of corrosive or otherwise hazardous materials up to temperatures of 275°F. Installation usually involves only electrical and influent/effluent connections. In most cases they are free-standing and require only a concrete pad, but some have been installed in existing concrete basins.

To sum up, plastic pumps and plastic sump systems have established a dependable service record over the last few decades that points to their suitability for many fluid-handling duties. They are particularly capable where corrosive and hazardous liquid wastes or chemicals have to be contained and pumped. As a result they are being applied increasingly for such tasks in the water/wastewater field. Their development continues.

**Definitions**:

A thermoplastic resin will repeatedly soften when heated and harden when cooled.  Decomposition occurs only at higher temperatures.

A thermosetting resin cannot be melted or remolded without changed its chemical structure.