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WHITEPAPER:
Guide to Selection of Submersible Sewage Pumps

Bradley W. Roeth, P.E., Stanley Consultants, Muscatine, Iowa

Global Engineering Service Provider
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Submersible wastewater pumps are found in almost every wastewater utility in Iowa. These pumps are the workhorses of our industry and are typically out of sight, out of mind. Because they are so common, you may think that it doesn't take much to select or specify a wastewater pump, but there's actually a lot that goes into it. The purpose of this article is to provide an overview of submersible wastewater pumps and highlight the major options to consider when selecting a pump.

MAJOR COMPONENTS

Pump. Located at the bottom of the unit, the pump consists of the pump casing (a.k.a. pump housing, volute) and the impeller. The pump casing is the visible outer shell of the pump. The impeller is the part that spins and moves the liquid.

Motor. Located on top of the pump, the motor consists of the cable entry port, the electric motor, the motor casing (a.k.a. motor housing) and, on some models, the cooling jacket.

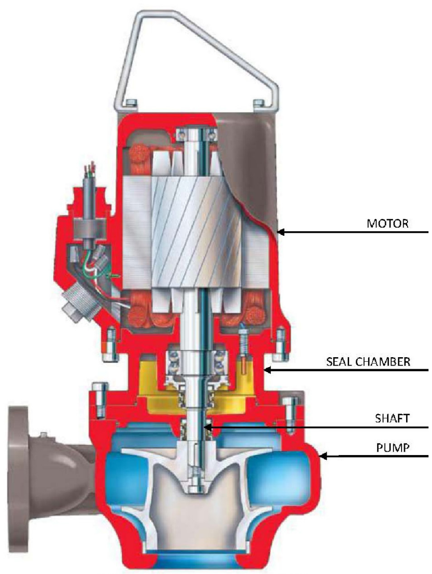
Shaft. Submersible pumps have a solid shaft that extends from the motor to the impeller.

Seal Chamber. Located between the pump and motor casings is an oil-filled seal chamber.

IMPELLER STYLE

Several impeller styles are available and should be selected based on the type of wastewater being pumped.

Grinder Impeller. For wastewater pumps close to the source of waste (such as in a residential neighborhood or industrial park), a grinder pump is usually selected. The grinder pump impeller is designed to break waste into small particles that will not clog a two-inch force main. The grinder impeller typically has low hydraulic efficiency (20-40 percent).



Chopper Impeller. For wastewater with high fibrous material (rags), the impeller is designed to cut the material as it is pumped. The chopper impeller may also be selected for high grease content wastewater due to its open impeller design. The chopper impeller has low hydraulic efficiency (40-60 percent).

Conventional Impeller. This style is selected for wastewater with relatively low solids and low fibrous material. The pathways through the impeller are usually partially enclosed, making it more hydraulically efficient (50-70 percent) but also more susceptible to clogging. The impeller should be specified as solids-handling passing a minimum three-inch sphere size.

Vortex Impeller. This style is selected for high solids content. Most of the pumped liquid does not come into contact with the vortex impeller. The impeller moves liquid by inducing a vortex in the pump casing. The vortex impeller has low hydraulic efficiency (30-50 percent).

Beyond the styles of impeller discussed above, the exact size and shape of the impeller depends on the desired operating characteristics of the pump (operating point). Selection of the pump operating point is beyond the scope of this article but requires careful consideration and calculations for proper application.

FEATURES THAT COOL THE MOTOR

The electric motor produces heat as it works. If not cooled, the motor will overheat and require repair or replacement. There are three approaches to cooling the motor.

First, the motor can be cooled by the liquid in the wet well. The motor casing is in direct contact with the liquid, and heat is transmitted through the casing to the liquid. This requires a liquid level in the wet well that is always above the motor.

Second, the motor casing can be surrounded by a cooling jacket, and some of the pumped liquid is circulated through the cooling jacket. Heat is transmitted through the motor casing to the liquid in the cooling jacket, and the liquid is circulated back to the wet well. This method allows for a lower liquid level in the wet well than the first cooling method but has the disadvantage that solids in the liquid can plug up openings in the cooling jacket. To minimize this, the pump manufacturer typically will require a minimum flow rate through the pump.

Third, the motor casing can be surrounded by a cooling jacket and filled with oil that is circulated by a small impeller or is disk mounted on the shaft. This method creates a self-contained pump without external cooling requirements but has the disadvantage of higher cost.

FEATURES THAT PREVENT MOISTURE PENETRATION

Electricity and water are not a good combination. Some of the important differentiators between manufacturers are the way liquid is kept out of the motor. One potential leak area is where the electrical cable enters the motor casing. Two levels of protection are available. The first level consists of a rubber seal that is compressed for a tight seal between the cable and the entry port. The second, higher level of protection is a connection chamber filled with epoxy sealant that is considered water pressure-tight.

Another potential leak area is where the shaft passes through the motor casing and seal chamber into the pump casing. The seal chamber contains mechanical seals to prevent moisture from entering the motor casing. There is one seal face between the pump casing and seal chamber and a second seal face between the seal chamber and motor casing. Some manufacturers use one double seal with a shared spring, while other manufacturers use two separate seals.

FEATURES THAT PROVIDE WARNINGS AND ALARMS

Submersible pumps, as the name implies, are most often located under water. They cannot be directly observed for temperature, vibration, or seal leakage. Most manufacturers offer a range of warning sensors that provide a signal if something goes wrong.

Temperature alarms can be located in the motor windings and/or in the bearings. This provides a signal when the temperature exceeds the preset level.

Thermistors are a step up from the temperature alarm. A thermistor provides the measured temperature. It is then up to the control system or operator to track the temperature readings and know when the temperature indicates a problem.

Leak detectors are provided in the seal chamber, the motor casing, and/or the cable entry port. A signal is provided if moisture is detected. Moisture in the seal chamber indicates that the seal between the pump casing and seal chamber has failed. The pump can continue to function with moisture in the seal chamber. Moisture in the motor casing indicates either that the seal between the seal chamber and the motor casing has failed or the cable entry seal has failed. The pump can no longer be operated; and, if not caught immediately, the motor will be damaged. Moisture in the cable entry port indicates a leak through the cable entry.

Often, the choice of leak detection is an "either/or" choice—either in the seal chamber or in the motor casing. With the leak detector in the seal chamber, the alarm typically occurs earlier in the life cycle of the seals. The operator has the choice of replacing the seal immediately or ignoring the alarm for a period of time in order to schedule the maintenance activity. The seal chamber leak detector may be the best choice if no installed backup pumps are available so that a maintenance shutdown can be scheduled in advance. If the leak detector is in the seal chamber, consider a separate leak detector in the cable entry port since leakage through the cable entry will not be detected in the seal chamber.

With the motor casing location, the alarm will occur when moisture is in the motor area, and the pump should no longer be operated. If backup pumps are available and the control system can automatically shut down the pump, the motor casing alarm may lead to longer maintenance intervals than the seal chamber alarm.

MATERIALS OF CONSTRUCTION

- Casings and Cooling Jackets - typically cast iron. Some manufacturers offer stainless steel for corrosive fluids.
- Impellers - typically cast iron. Stainless steel impellers are available as an option from most manufacturers. In heavy grit environments, the casing and impeller can wear out quickly. The solution for handling grit is usually to specify harder materials, such as chrome or ni-hard. Compare the hardness of the grit to the hardness of the metal before specifying.
- Wear Rings - located at the suction intake of the impeller. Available in cast iron, bronze, or stainless steel.
- Mechanical Seals - materials vary by manufacturer. The seal between the pump and seal chamber (primary seal) is typically made with two hard faces from a material, such as silicon carbide. The seal between the seal chamber and motor is typically made with one hard face and one soft face, such as ceramic/carbon.
- Shaft – heat-treated stainless steel.
- Bearings – specify an L10 life rating of 100,000 hours.
- Motors – at a minimum, must specify the voltage and the starting method: across-the-line, soft-start, or variable-frequency drives (a.k.a. adjustable-speed drives).
- Finishes – specify epoxy paint on the pump exterior.

PUMP SELECTION CHECKLIST

In summary, submersible wastewater pumps are the workhorses of our industry. They are out of sight/out of mind until something goes wrong. Considering the following items when specifying or purchasing a new pump will lead to longer pump life.

1. Impeller style: Close to the wastewater source? High rags content? High solids content?
2. Motor cooling: Will motor always be submerged? Will the solids clog a cooling jacket?
3. Cable entry seal: Compression seal or epoxy filled chamber?
4. Mechanical seals: Double seal with shared spring or separate seals?
5. Will motor and/or bearing temperature be monitored, or will simple high-temperature alarms work?
6. Are there an installed backup pump and a control system? Should leak detectors be placed in the seal chamber or motor casing?
7. Grit problem? Consider casing and impeller materials carefully.
8. Corrosive moisture? Consider stainless steel impeller and/or pump and motor casings.
9. Review materials for wear rings, mechanical seals, and shaft.
10. Specify long bearing life.
11. Know the required electric voltage.
12. Know the electrical starting system: Across-the-line, soft-start, variable-frequency drive.
13. Use epoxy paint on the pump exterior.

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