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WASTEWATER – Complete Submersible Pump Station Systems

Basic information on the design of this type of pump station system is provided here.

INTRODUCTION

Lift stations using submersible, non-clog, centrifugal pumps are the most frequently specified systems for pumping raw sewage. They are equipped with pumps that operate while submerged in the wet well. In designing a wastewater submersible pump station, the type, size and number of pumps is determined by:

- 1) Characteristics of the sewage being pumped, presence of difficult-to-pump solids
- 2) Manholes, storage vessels and sewer lines upstream from the pump station
- 3) Total dynamic head (TDH) against which the pumps must work
- 3) Size of the wet well
- 4) Peak and average flows to the pump station

Characteristics of the Sewage Being Pumped

The constituency of wastewater and the other things in it can be quite varied, depending on the source. For example, the wastewater from a residential subdivision likely contains water, solid and liquid human waste, lint and soap from clothes washing, food waste and oils from kitchens, paper and other fiber and the occasional child's plastic toy. By contrast, the wastewater from a prison contains all that plus rags, trash, contraband and other items that can clog pumps and build up inside of pipes, manholes and wet wells.

Therefore, wastewater pump stations must be designed for the sort of sewage flowing to them. If a sewer collection system is equipped with tanks for separating out the solids before they reach the pump station, then the wet well, pumps and discharge pipes are designed for pumping mostly liquid. On the other hand, if raw sewage and everything else that can be flushed down the toilets of a college dormitory are flowing to the pump station, then macerator pumps or separate grinders are probably necessary. Romtec Utilities designs wastewater pump stations for the sort of stuff that has to be pumped, no matter what the source.

Macerator or Chopper Pumps

If the wastewater contains high concentrations of fiber, rags and trash, it may be necessary to install a macerator to pulverize solids in the gravity influent line upstream of the wet well or even in the wet well itself, at the point where the influent enters the wet well.

Another option is to use submersible chopper pumps in the wet well (see Pumps below). Romtec Utilities designs wastewater pump stations with macerators or chopper pumps sized for the demands of the individual pumping system.

Upstream Storage

In the event a wastewater pump station has a catastrophic failure (pumps clog, no power, no back-up pumping, etc.) the volume of storage upstream from the pump station in manholes and other storage vessels, even sewer lines, comes into play in determining the amount of time before an overflow will occur. This information, which is provided by the project's site engineer, is factored into the wastewater pump station design.

Wet Well

Romtec Utilities submersible pump stations for wastewater use a cylindrical wet well of precast concrete or reinforced fiberglass. The wet well receives influent from a gravity sewer line. The diameter and depth of the wet well are largely determined by the peak flow to the pump station, the depth of the influent line and the size and number of pumps.



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Precast concrete wet wells are delivered to the project site in sections. The base, one or more barrels and the top are fitted with sealing gaskets and are lifted with a crane and stacked in alignment below ground to create the complete wet well. Internal parts are assembled within the wet well after it is stacked. Fiberglass wet wells can be delivered to the site as a single piece with all internal parts fully-assembled.

To prevent damage to concrete wet wells from sewer gasses an interior lining or coating can be specified. Exterior surfaces of the concrete can also be coated to prevent moisture incursion and protect the concrete. These materials are installed or applied by Romtec Utilities at the factory, and they are fitted with weld strips and additional sealing in the field.

Romtec Utilities offers wet wells from 4 feet to 12 feet in diameter (ID) and up to 40 feet in depth. The wet well in every Romtec Utilities wastewater pump station is sized for the specific site requirements, which can be quite varied and include:

- 1) Depths of influent and discharge lines
- 2) Current and future peak flows and average flows to the pump station
- 3) Storage available in wet well and upstream manholes (for calculating time to overflow)
- 4) Pump sizes (physical size and power rating)
- 5) Average number of pump starts per hour for optimum pump efficiency
- 6) Relationship between pump area of influence and wet well diameter

The interior walls of the wet well base are angled to help direct solids to the pump impeller. This feature helps prevent the build up of a solid layer of fat, oil and grease (FOG). Romtec Utilities wet well bases can be lined with fiberglass or PVC plastic or coated with epoxy sealer to provide a slick, non-porous surface that discourages collection of FOG.

The exact location, angle and diameter of influent and discharge lines are predetermined and can be prefabricated in a complete package pump station. Coring of concrete or fabrication of fiberglass is done at the factory to eliminate the need for field work and ensure precise fit of the influent and discharge lines to the wet well. Flexible seals in all wet well penetrations are also factory installed. The pumps are lowered into the wet well after it is installed at the project site.

Depending on the wet well type, other equipment such as pump discharge fittings, pump guide rails, influent deflector panels or drop tubes, pump accessories and liquid level sensors can be factory-installed or field installed. The wet well top includes the access hatch with fall protection and attachments for liquid level sensors, pump cables, hoist chain and other items. A davit crane for handling the pumps can be mounted on the wet well top.

Pumps

Romtec Utilities offers pumps of virtually every type from the leading manufacturers. The specific type and size of submersible pumps used in a package wastewater pumping system are determined by many criteria, including: best performance and efficiency, customer preference for a particular brand or type of pump, overall value and other factors.

Several types of submersible pumps are commonly used in wastewater pumping systems:

- 1) Solids-handling, non-clog pumps that pass 3-inch diameter solids
- 2) Grinder pumps with impellers that grind solids
- 3) Chopper pumps that macerate difficult solids such as rags

Each submersible pump is lowered into place near the bottom of the wet well with the aid of pump guide rails that align the pump to engage its discharge pipe coupling. The guide rails also steady the pumps whenever they are being lifted out of the wet well for maintenance. The pump electrical cables are connected to the pump station control panel through a junction box or pump disconnect panel.

Some pump stations have pumps of two different sizes. The smaller pump (often called a jockey pump) handles small demand, and the larger pumps operate when the flow into the sump or demand for water from the pump station is greater.

In designing a wastewater submersible pump station, the type, size and number of pumps are determined by a variety of factors, including:



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- 1) Average and peak flows to the pump station
- 2) Total dynamic head (TDH) against which the pumps must work
- 3) Presence of unscreened solids in the water to be pumped
- 4) Possibility of flooding at the site where pumps and well are located
- 5) Availability of a detention basin or storage vessels upstream from the pumping system

Piping

The types, diameters and lengths of the pump discharge and force main piping are predetermined and can be prefabricated in a package pump station. Romtec Utilities pump stations generally include all piping from the influent through the last valve before the force main. Romtec Utilities designs pump stations with all common pipe materials: stainless steel, ductile and PVC.

Liquid Level Sensors

One or more electronic liquid level sensors are suspended in the well and connected by wire to the pump station control panel. They indicate the fluid level, data which is used by the pump station controller to turn pumps on or off and, in the event of a problem, to turn on alarms and transmit alarm data. Common types of liquid level sensors are: micro switch floats, multi-electrode probes, pressure transducers and ultrasonic sensors.

The type of sensors used is determined by customer preference or by the controller chosen for the pump station. Many controllers can operate with any type of level sensor, while other controllers are exclusive to one type of sensor. Romtec Utilities designs with all types of liquid level sensors and controllers.

Valves, Pressure Sensor, Bypass Pumping Port, Pigging Port

Most Romtec Utilities package pump stations are equipped with a check valve and isolation or plug valve for each pump. Valves and other equipment in the pump discharge lines must be protected from freezing. They can be located in an underground vault or above ground in a secure, insulated enclosure.

A pressure sensor indicates when the water is being pumped. A single non-contact pressure sensor can be located in the force main, although some pump systems require individual pressure sensors for each pump discharge line. Other devices can be located in the force main. Often specified for water and wastewater treatment pump stations are equipment such as:

- 1) A bypass pumping port for connecting an emergency pump, in the event of a major failure within the pump station
- 2) A pigging port for sending a "pig" into the force main for cleaning and/or removing an obstruction.
- 3) Chemical injection or other equipment for reducing odor in the wet well and force main

Flow Calculating & Metering

Some wastewater pump stations must measure the volume of fluid being pumped over a period of time. An easy and inexpensive way to accomplish this is by calculating the flow. This is done by multiplying the volume of water pumped with each pump start by the number of pump starts.

Flow metering may be necessary for proving the discharge volume over a period of time. Romtec Utilities supplies a number of flow metering systems from leading manufacturers as part of our complete wastewater submersible pump stations.

An electromagnetic flow meter is inserted in the force main after the check and plug valves. The meter and associated piping and valves can also be preassembled in a separate vault. To allow maintenance of the flow meter without disabling the pump station, piping and valves to bypass the flow meter are also located in the flow meter vault.

The flow readout and reporting device, usually located at the pump station control panel, receives electronic flow data and reports it to a display. Transmission of flow data to a remote computer terminal is also available.



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Control Panel & Electrical Power

Typically, the electrical controls of the pump station are located in a control panel within a weatherproof enclosure. Various devices provide power to the pumps, control the pumps, receive operational and fault data from sensors within the pumps and the sump, report elapsed operational time for each pump and report operational status and alarm conditions both locally and to remote sites through telephone circuits, radio transmissions and other means.

The control panel in a Romtec Utilities pump station can be placed in a variety of locations, generally wherever the customer wants and needs it to be. As an important part of the design process, Romtec Utilities produces a scale drawing showing the equipment layout on the site. No two pump stations have the same equipment layout.

The source and type of electrical power to the pump station site is an important design factor. Romtec Utilities can design the pump station for whatever type of single-phase or three-phase power is available to the site. Generally, the control panel is designed to operate just the pump station. Other electrical demands at the site, such as lights and building heat can be considered in the pump station design, unless specifically required by the customer.

SCADA

Pump stations can be equipped with SCADA (Supervisory Control and Data Acquisition) devices to both report operational data to remote sites, such as an online computer terminal in the plant operations center, and to receive operational instructions and requests for operational data from the same computer or other computers or mobile data devices. This two-way communication capability provides many benefits to pump station operators. Romtec Utilities designs industrial pumping systems to work with all kinds of communications hardware and software.

Electrical Generator

A standby electrical generator that operates the pump station during power outages may be required. The generator is usually sized to operate just the pump station; however a larger generator can be specified for operation of the pump station plus other equipment, such as space heaters and exterior lights. A generator using natural gas, propane or diesel fuel can be permanently located at the pump station site and wired to the control panel through an automatic transfer switch that senses the loss and return of grid power and switches the generator on or off accordingly.

The generator can be housed in a sound-attenuating enclosure. This is an important feature if the pump station is located where sound from the generator would be a problem for nearby residents, businesses, schools and the like. The generator can also be installed within a building equipped with a ventilation system.

Alternatively, a portable generator can be brought to the site and plugged into the control panel to temporarily supply electricity until grid power returns.

Other Optional Equipment

All design parameters to accommodate any additional optional equipment are predetermined in the design of a Romtec Utilities package pump station. The optional equipment is thus integral to the complete pump system design for function, power requirements and other factors. Romtec Utilities specializes in designing pump stations that utilize specialized equipment required by the customer or by various regulatory agencies.

Shelter or Building

A structure to shade the control panel enclosure and provide shelter from weather for operation and maintenance personnel is a good idea, and it may be required. It might also be necessary to house the pump station electrical control panel, generator and other equipment within a building for equipment security and shelter. Romtec Utilities supplies a wide range of shelters and buildings that can be custom fitted to the specific requirements of any pumping system.

Wastewater Treatment Systems

Romtec Utilities supplies a range of water and wastewater treatment systems. Romtec Utilities can integrate the pump station into a complete system designed for the specific treatment requirement.