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WASTEWATER – Complete Vertical Turbine Pump Station Systems

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

INTRODUCTION

Short set lineshaft vertical turbine pump stations can be used for a number of wastewater pumping applications, including: liquid effluent, industrial process wastewater, screened agricultural waste liquid slurry and the like.

Three advantages of vertical turbine pumps are:

- 1) They are very efficient (80-85%), ideal for moving large volumes of water against high total dynamic head (TDH)
- 2) They can handle most liquid effluent or process wastewater from which solids and grit have been removed
- 3) They operate above ground, so motor and pump head are easily accessible for maintenance

IMPORTANT: Vertical turbine pumps are not designed for handling solids. Even moderate concentrations of grit can be damaging to some vertical turbine pumps. Solids must be separated from liquid effluent before reaching the pump.

In designing a vertical turbine pump station, the type, size and number of pumps is determined by a variety of factors, including:

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

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.

In many instances there can be a detention basin or storage vessels upstream from the pump station. With this upstream storage of wastewater, a steady rate of flow can be fed to the pump station from the detention basin or storage vessel(s). The upstream storage thus provides a means of holding extra wastewater during periods of high flow. Also, by evening out the flow to the pump station, the upstream storage helps optimize the efficiency of the pumps.

Upstream Solids Removal/Separation & Screening

Equipment for removing and screening solids can be installed in the line(s) upstream of the wastewater pumping system. Some wastewater collection systems separate solids in settling tanks, thus allowing only liquid effluent to flow to the pump station. This can be an ideal system for utilizing vertical turbine pumps for wastewater.

Cleaning and maintenance of this equipment must be considered, since vertical turbine pumps are not designed to handle solids. In other words, if the upstream solids removal equipment is offline for maintenance, would it be inadvisable to use the pumps during that time?

How this equipment may affect the flow to the pump station must be considered in the overall design. Romtec Utilities works with suppliers of upstream solids removal/separation and screening equipment to ensure the pumping system operates efficiently and reliably with this equipment in line ahead of the pump station.



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Wet Well

Romtec Utilities vertical turbine pump stations for wastewater use a cylindrical or rectangular wet well of precast concrete or reinforced fiberglass. The wet well receives influent from a gravity sewer line. The size and depth of the wet well are determined by a number of factors (see below). By utilizing an upstream detention basin or storage vessels, flow into the wet well can be regulated, thus reducing the storage requirement of the wet well.

When operating, the pumps create vortices in the water. This must be considered in selecting pump and wet well sizes, so pump efficiency is optimized for the vessel in which the pumps operate.

The interior walls of the wet well base can be angled to help 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 coated with epoxy sealer to provide a slick, non-porous surface that discourages collection of FOG.

The exact locations, angles and sizes of influent lines and other penetrations of the wet well 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.

Depending on the type of wet well, other equipment such as 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 attachment points for pump and liquid level sensor cables, worker safety harnesses and other items.

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.

Precast concrete wet wells are delivered to the project site in sections. The base, one or more barrels or shaft sections 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.

Fiberglass wet wells can be delivered to the site as a single piece with all internal parts fully-assembled. Fiberglass wet wells do not require chemical or moisture protection.

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 lines and other wet well penetrations
- 2) Current and future average and peak flows to the pump station or demands for water from the pump station
- 3) Upstream storage available in manholes, detention basin and/or storage vessels
- 4) Pump sizes (physical size and pump power rating)
- 5) Average number of pump starts per time hour for optimum pump efficiency
- 6) Relationship between pump suction bowl area of influence and wet well diameter or rectangular dimensions

Pumps

One or more vertical turbine pumps are mounted on the top of the wet well so their suction bowls extend down to the optimum position for pumping. Vertical turbine pumps use air-cooled motors mounted on top the discharge head. The stainless steel lineshaft extends down through the column and is supported by bearings within the column. One or more bowls house the impellers. At the bottom of the column is the suction bowl, which is surrounded by a strainer to prevent solids from entering the pumps. The pump electrical cables are connected to the pump station control panel through a junction box or pump disconnect panel.

The discharge pipe is connected from the pump head to the valve manifold (see Valves below). The pumps, piping and valves must be protected from freezing. The pump electrical cables are connected to the pump station control panel through a junction box or disconnect panel.

Some pump stations have pumps of two different sizes. The smaller pump handles small demand, and the larger pump(s) operates when the flow into the wet well or demand from the pump station is greater.



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In designing a vertical turbine pump station for a water/wastewater treatment application, the type, size and number of pumps are determined by a variety of factors, including:

- 1) Average and peak flows to the pump station and peak demands for water from the pumping system
- 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 through the last valve connected to the pump station end of the force main. Romtec Utilities designs pump stations with all common pipe materials: stainless steel, ductile and PVC.

Liquid Level Sensors

One or more liquid level sensors are suspended in the wet well to report the fluid level. This data 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 liquid level sensors are: micro switch floats, multi-electrode probes, pressure transducers and ultrasonic sensors.

The types and number of sensors used are 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, Odor Control, Other Devices

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 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 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) Chemical injection for reducing odor in recycled water

Flow Calculating & Metering

Flow metering may be necessary for proving the discharge volume over a period of time. An electromagnetic flow meter inserted in the force main can be located in the force main. To allow maintenance of the flow meter without disabling the pump station, a bypass line with piping and valves to pump around the flow meter is included in the design.

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

Control Panel & Electrical Power

Typically, the electrical controls of the pump station are located in a control panel within a weatherproof enclosure. Various devices supply power to the pumps, control the pumps, receive operational and fault data from sensors within the pumps and the wet well, 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.



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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 are not 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 report operational data to remote sites, such as an online computer terminal at the wastewater authority office, 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 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. 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 packaged pump station, so the optional equipment is integral to the complete lift station design for function, power requirements and other factors. Romtec Utilities specializes in designing pump stations that accommodate various 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.

Water & 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.