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INDUSTRIAL – Complete Vertical Turbine Pump Station Systems

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

INTRODUCTION

Vertical turbine pump stations are frequently specified systems for pumping water and other fluids within industrial sites. In designing a vertical turbine pump station for industrial use, the type, size and number of pumps is determined by the average and peak flows to the pump station, the total dynamic head (TDH) against which the pumps must operate and the size of the vessel or body of water in which the pumps operate. Three advantages of vertical turbine pumps:

- 1) They are very efficient (80-85%), ideal for moving large volumes of water against high TDH
- 2) They can handle most liquid effluent or process water from which solids and grit have been removed
- 3) They operate above ground, so the 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.

There are a wide range of potential uses of submersible pumping systems in industrial settings. Some common applications and scenarios include:

- 1) Site stormwater collection/site remediation – Regulations limit stormwater runoff from an industrial site, due to high levels of pollutants on the site. Water is collected in storm drains, flows to the pump station and is pumped to an onsite treatment system or into a municipal sewer for delivery to the municipal treatment plant.
- 2) Onsite water recycling – Water used in an industrial process, such as cooling water, is stored, treated and reused on the industrial site. A pump station receives water from one or more industrial processes and pumps it to storage, treatment or other locations, depending on plant operations.
- 3) Biological treatment – An industrial site uses a constructed wetland to biologically treat water from its operations. A vertical turbine pump station is used to maintain the water in the wetland at the optimal level for biofiltration to occur. The treated water can be discharged to various locations, depending on operations at the site and local environmental regulations.

Upstream Storage

Depending on operations in the industrial site, the rate of flow into the pump station may vary significantly. A detention pond or one or more storage vessels are often sited upstream of the pump station to receive and store water during periods of high water use. A steady rate of flow can be fed to the pump station sump from the pond or storage vessel(s), thus helping to optimize the efficiency of the pumps.

Often, an industrial pump station will be called upon to discharge at a steady rate or to maintain pressure in a discharge line. In this scenario, there should be adequate upstream storage to handle both high and low water flows, thus allowing the pumps to operate at a steady rate.

Upstream Debris Removal, Solids Handling

Depending on the fluid being pumped and other factors in the industrial setting, it is possible for trash, rags, rope sediment, rocks and other solids to enter the flow of water to the pump station. Equipment for removing debris and other solids can be installed in the line(s) upstream of the pump station. How this equipment may affect the flow to the pumping system's sump must be considered in the lift station design.

Vertical turbine pumps are not designed to pump water containing solids or high levels of sediment or grit. If these materials can be adequately removed before the water reaches the pumps, then vertical turbine pumps can be an excellent choice for many industrial pumping applications.



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Sump (Wet Well)

If the water to be pumped is generally free of solids, there will be no build-up within the sump (wet well) in which the pumps are located. Therefore, the sump can be round or rectangular, vertical or horizontal and made from concrete or fiberglass. If the fluid has a significant amount of solids, especially fat, oil or grease (FOG), then a vertical, cylindrical sump is preferred.

The size and depth of the sump are determined by a number of factors (see below). By utilizing an upstream detention pond or storage vessels, flow into the sump can be regulated, thus reducing the storage requirement of the sump and reducing the size and number of pumps to do the job.

When operating, the pumps create vortices in the water. This must be considered in selecting pump and sump sizes, so that pump efficiency is optimized for the vessel in which the pumps operate. Sometimes baffles are utilized to isolate multiple pumps from each other, thus preventing interference when two or more pumps are operating at the same time. Baffles can be prefabricated of concrete or reinforced fiberglass.

The exact location, angle and size of influent and discharge lines, baffles and other items within the sump 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 sump. Flexible seals in all sump penetrations are also factory installed. The pumps are installed in the sump after it is installed at the project site.

Depending on the type of sump, other equipment such as pump accessories and liquid level sensors can be factory-installed or field installed. The sump top includes the access hatch with fall protection.

To prevent damage to a concrete sump from chemical gasses and liquids that may be present in industrial process water and other fluids, an interior lining or coating can be specified for the concrete. Exterior surfaces of the concrete can also be coated to prevent moisture incursion and to 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.

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

Romtec Utilities offers sumps from 4 feet to 12 feet in diameter (ID) and up to 40 feet in depth. The sump 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 average and peak flows to the pump station
- 3) Storage available in upstream detention pond or storage vessels
- 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 sump diameter

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 industrial 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.

In a vertical turbine pumping system, one or more pumps are mounted on the top of the sump so their suction bowls extend down to the optimum position for efficient pumping.

Some vertical turbine 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 sump or demand from the pump station is greater.

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.



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In designing an industrial vertical turbine pump station, the type, size and number of pumps is determined 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

The discharge pipe is connected from the pump head to the valve manifold (see Valves below). The pumps, discharge 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 pump disconnect panel.

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.

It is common for the pump station to have multiple discharge points, i.e. a storage lagoon, an oil-water separator, a municipal sewer line. Piping and associated valves for multiple discharge points are part of the pump station design.

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.

Other Sensors

More sophisticated stormwater pump stations can be equipped with various sensors that place higher demands on the controller. Romtec Utilities integrates these functions into the pump station design and the selection of a PLC (programmable logic controller) or a multi-input proprietary controller.

Several examples are:

- 1) Rain gauge sensor to report precipitation
- 2) Level sensor in an upstream storage pond or vessel
- 3) Level sensor at the force main discharge point
- 4) Flow meter in the force main

Valves, Pressure Sensor, Bypass Pumping Port

Equipment in the pump discharge lines, such as valves, can be located outside the sump in a separate underground vault, or they can be fitted within the sump. They can also be above ground if protected from freezing. The package pump station is usually equipped with a check valve and an isolation or plug valve for each pump.

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. A pressure sensor indicates when the water is being pumped.



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Sometimes a bypass pumping port is specified for an industrial pump station. It provides the means of connecting an emergency pump, in the event of a major failure within the pump station. Romtec Utilities provides design services for all valve requirements, from simple to complex.

Flow Calculating & Metering

Some industrial 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. Romtec Utilities supplies a number of flow metering systems from leading manufacturers, as part of our complete industrial 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, located at the pump station control panel, receives electronic flow data and reports it to a display panel at the pump station. Transmission of flow data to a remote computer terminal 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 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 yard 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.



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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.

Treatment Systems

Increasingly, within the U.S. and abroad, the treatment requirements for industrial process water are not so different from the treatment requirements for wastewater. Romtec Utilities can integrate the pump station into a complete system that sends water to a treatment system, samples the treated effluent to ensure it meets regulations and discharges the treated water to a variety of locations.