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CLEAN WATER – Complete Vertical Turbine Pump Station Systems

Basic information on the design of this type of pumping system is provided here. Please contact us for more information.

INTRODUCTION

For this discussion, clean water is defined as water usually containing very low concentrations of solids and non-aqueous liquids such as oil. Raw water pumped from a body of water is also included in this definition.

Vertical turbine pump stations are commonly used in clean water pumping applications, some of which include:

- 1) Water intake to a water treatment plant
- 2) Transfer of water from a reservoir or storage basin to an industrial plant
- 3) Irrigation water pumped from a river, lake or reservoir

In designing a vertical turbine pump station for clean water, the type, size and number of pumps is determined by the average and peak demands of water from the pump station, the total dynamic head (TDH) against which the pumps must operate and the size of the vessel in which the pumps operate. Two advantages of vertical turbine pumps:

- 1) They are very efficient (80-85%), ideal for moving large volumes of water against high total dynamic head (TDH)
- 2) They operate above ground, so the pump motor and discharge 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 filtered from water before reaching the pump.

Intake Structures

Pumps typically do not draw water directly from a body of water. Instead, the pumps are installed in a well located alongside or near the water. Intake pipes connect from the well to one or more intake structures located in the reservoir, lake or river. The intake structure supports and protects the intake pipe.

It may be necessary to divert or screen floating debris from the intake structure and pipe, so it cannot enter the well. This can be accomplished with deflector panels, removable screens or mechanical screening devices, which must be accessible for periodic maintenance.

The water level in the well is the same as the level of the body of water. The well must be deep enough for there to always be adequate water for efficient pumping, even when the body of water is at its lowest level.

A sluice gate is installed in the well at the end of the intake pipe. This makes it possible to drain the well for periodic cleaning, if necessary.

Well

A clean water pump station requires careful design to ensure it will meet the demands placed on it. Romtec Utilities offers numerous designs for the pump station well: concrete or fiberglass, cylindrical or rectangular, vertical or horizontal. The size and depth of the well are largely determined by:

- 1) The size and number of pumps required to deliver water at the preferred rate (gpm)
- 2) The lowest water level in the reservoir, lake or river feeding the well

IMPORTANT: If using lineshaft vertical turbine pumps with non-sealed motors, the top of the well must be above the highest flood water level to prevent damage. Alternatively, pumps can be removed from the well prior to high water periods or submersible pumps can be used instead of pumps with non-sealed motors.

When operating, the pumps create vortices in the water. This must be considered in selecting pump and well 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 the intake pipes, baffles and other items within the 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 to ensure precise fit of the intake pipes to the well. Flexible seals in all well penetrations are also factory installed. The pumps are lowered into the well after the well is installed at the project site.

Other equipment such as liquid level sensors can be factory-installed or field installed, depending on the type of well. The well top includes the prefabricated access hatch with fall protection.

A precast concrete well is 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 well. A fiberglass well can be delivered to the site as a single piece with internal parts fully-assembled.

Romtec Utilities offers concrete and fiberglass cylindrical wells from 4 feet to 12 feet in diameter (ID) and up to 40 feet in depth or length (depending on vertical or horizontal installation). The well in every Romtec Utilities clean water pump station is sized for the specific site requirements, which can be quite varied and include:

- 1) Depths of intake and discharge lines
- 2) Current and future flows to and demands from the pump station
- 3) Pump sizes (physical size and power rating)
- 4) Relationship between pump area of influence and well diameter
- 5) Consistency of the water level in body of water supplying pump station

Pumps

One or more vertical turbine pumps are mounted on the top of the well so their suction bowls extend down to the optimum position for efficient pumping. Vertical turbine pumps use air-cooled motors mounted on top the discharge head. The stainless steel lineshaft extends from the motor, down through the column and is supported by bearings within the column. One or more bowls house the pump 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 discharge pipe is connected from the pump head to the valve manifold. The pumps, discharge piping and valves must be protected from freezing. A secure, insulated enclosure or building can be used for this purpose. 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 well or demand for water from the pump station is greater.

Piping

The types, diameters and lengths of pipes, including the intake pipe(s), pump discharge and force main piping, are predetermined 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 to have more than a single discharge point in a clean water pumping system. For example: a pump station that discharges directly to a water treatment plant during the day can be reconfigured to discharge to a reservoir at night. Piping and associated valves for multiple discharge points can be part of the pump station design, depending on various criteria.

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. For example, if debris blocked the intake line to the point where water could not enter the well, the controller would prevent the pumps from starting.

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

Equipment in the pump discharge lines, such as valves, can be located outside of the well in a separate underground vault or within the well. They can also be located above ground if protected from freezing. The packaged 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.

Sometimes specified for clean water pump stations is a bypass pumping port for connecting an emergency pump, in the event of a major failure within the pump station.

Flow Metering

Some pump stations must measure the volume of fluid being pumped over a period of time. Flow metering may be necessary for proving the volume. An electromagnetic flow meter inserted in the force main can be located in a separate vault after the valves. 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 often included in the flow meter vault.

A flow readout unit, usually located at the pump station control panel, receives electronic flow data and reports it to a display panel and a memory device. 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 provide power to the pumps, control the pumps, receive operational and fault data from sensors within the pumps and the 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.

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 when 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 at the water 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. Generators 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, trailer-mounted generator can be brought to the pump station 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.