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## **WATER REUSE – 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 are commonly used in water reuse applications, some of which include:

- 1) Treated municipal wastewater effluent reused for irrigation or to recharge groundwater
- 2) Treated industrial process water recycled within the plant or reused for other purposes within the site or offsite
- 3) Agricultural irrigation runoff collected and reused on site or treated and pumped offsite for other uses

In designing a vertical turbine pump station for water reuse, 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 total dynamic head (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 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.

### **Upstream Storage**

The rate of flow from a treatment facility, industrial plant or agricultural operation may vary significantly over time, thus a detention pond or one or more storage vessels are often sited upstream of the pump station to receive and store water. With this upstream storage, 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.

If a pump station must discharge at a steady rate or maintain pressure in a discharge line, there should be adequate upstream storage to handle both high and low water flows, allowing the pumps to operate at a steady rate.

### **Upstream Debris Removal, Solids Handling**

Depending on the fluid being pumped and other factors, 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 recycled water pumping applications.

### **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, so the sump can be round or rectangular, vertical or horizontal and made from concrete or fiberglass. If the fluid has significant 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



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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 locations, angles and sizes of influent and discharge lines, baffles and other items within the sump are predetermined and can be prefabricated in a complete package pump station. To reduce the need for field work to fit the influent and discharge lines to the sump, coring of concrete or fabrication of fiberglass is done at the factory. Flexible seals in all sump penetrations are also factory installed.

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. The hatch is fitted with hardware for fastening level sensor cables and other items such as a maintenance worker's safety harness.

Precast concrete sumps 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, lifted with a crane and stacked in alignment below ground to create the complete sump or wet well.

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) Depth of influent pipe
- 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 pumps in each individual Romtec Utilities pump station are carefully selected. The specific types and sizes of pumps used in a package 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.

An example of this type of system would be a golf course using recycled water from a wastewater treatment plant for irrigation and equipment maintenance. During the day, if a hose at the course is opened to wash down a mower or other piece of equipment, only the small pump is required to maintain pressure in the line delivering water to the course. When the fairways and greens are being irrigated at night, the larger pumps are used to maintain pressure and/or fill irrigation ponds at the golf course.

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.

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



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- 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 there to be more than a single discharge point. For example: a recycled water pump station that discharges to a golf course at night can be reconfigured to discharge to an agricultural irrigation pond during the day.

### **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 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, Odor Control, Other Devices**

The package pump station is 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 single non-contact pressure sensor is 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 reuse 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



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- 2) Chemical injection for reducing odor in the recycled water
- 3) Monitoring and chemical injection for balancing the pH of the recycled water

### **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 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 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. 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, supplied by Romtec Utilities, can be brought to the site and plugged into the control panel to temporarily supply electricity until grid power returns.



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### **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.