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WATER REUSE – Complete Submersible Pump Station Systems

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

INTRODUCTION

Increasingly familiar in the landscape and infrastructure of cities, factories and agricultural operations are the purple pipes indicating reused water. Submersible pump stations are often specified for recycled water pumping applications. They are equipped with non-clog, centrifugal pumps that operate while submerged. In designing a submersible pump station for water reuse, the type, size and number of pumps is determined a variety of factors, including:

- 1) Average and peak flows to 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 unscreened solids in the water to be pumped
- 5) Possibility of flooding at the site where pumps and wet well are located

Submersible pumps are frequently specified in water reuse pump stations. Advantages of submersible pumps are:

- 1) They are designed to handle solids, which may be present in the recycled water being pumped
- 2) They work in sites that can become flooded, since they are designed to operate while submerged
- 3) They work efficiently for applications with moderate flow to the pump station and moderate TDH

There are a wide range of potential uses of submersible pumping systems for reusing water. Some common applications and scenarios include:

- 1) Site stormwater collection and recycling – Regulations can limit stormwater runoff from a various sites such as commercial and industrial developments. Treatment of this water may be required before it can be discharged off site. In such situations, surface water is collected in storm drains, flows underground 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 – A community uses a constructed wetland to biologically treat runoff from precipitation or irrigation. A submersible pump station is used to maintain the water in the wetland at the optimal level for biofiltration to occur. The treated water can then be reused for irrigation of the community's parks or even delivered to the water treatment plant for further treatment into potable water.

Upstream Storage

The rate of flow from a treatment facility, industrial plant or agricultural operation may vary significantly. A detention basin or 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, 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 sources of water being pumped and other factors, it is possible for trash, rags, rope and other difficult-to-pump 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 sump must be considered in the design. Romtec Utilities designs pump stations to work with all types of debris removal technologies.

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Non-clog, solids-handling submersible pumps can handle most solids. In extreme cases, chopper pumps that chop solids into small pieces before entering the pump can be utilized. Another option is the installation of a macerator in the influent line ahead of the sump or in the sump itself. This machine pulverizes all solids before they reach the pumps.

Sump (Wet Well)

If the water to be pumped is generally free of solids, there will be no build-up within the sump in which the pumps are located. Therefore, the sump can be round or rectangular, vertical or horizontal and made from concrete or fiberglass. A cylindrical sump works best if high concentrations of solids, especially fat, oil or grease (FOG) are present in the water, because each pump is best able to reach all parts of the bottom of the sump and draw all solids into the impeller.

The size and depth of the sump are largely 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 in the sump. This must be considered in selecting suction pipe and sump sizes, so that pump efficiency is optimized.

The exact locations, angles and sizes of influent and discharge lines and other penetrations of 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 lowered into the sump after it is installed at the project site.

Depending on the type of sump, 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 sump top includes the access hatch with fall protection. A davit crane for handling the pumps can be mounted on the sump top.

A precast concrete sump 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, lifted with a crane and stacked in alignment below ground to create the complete sump. Internal parts can be assembled within the sump after it is stacked.

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.

Several types of submersible pumps are commonly used:



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- 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 sump 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 sump 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.

An example of this type of submersible pumping system would be in a constructed wetland that used a small submersible pump most of the time to maintain water at the optimum level for biofiltration to occur, yet needed larger pumps to evacuate water from the wetland during and after storms.

In designing a submersible pump station for water recycling applications, 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. The familiar purple color indicates reused water in the pipes. 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. Piping and associated valves for multiple discharge points can be part of the complete 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

Pumping systems can be equipped with various additional 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. Examples of additional sensors are: a rain gauge sensor to report precipitation, a liquid level sensor in an upstream storage pond or vessel, a level sensor at the force main discharge point that can generate a "hold out" command by the controller, causing the pump station to wait until the level of the discharge pond or pipe dropped sufficiently to allow pumping.



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Valves, Pressure Sensor, Bypass Pumping Port, Odor Control, Other Devices

Romtec Utilities designs, manufactures and tests the complete valve assemblies included in package pumping systems. Equipment in the pump discharge lines, such as valves, can be located outside of the sump in a separate underground vault or 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 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
- 2) Chemical injection for reducing odor in the recycled water
- 3) Monitoring and chemical injection for adjusting the pH of the recycled water

Flow Calculating & Metering

Some 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, 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.

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 exterior yard lights, building heat and multiple electrical outlets 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.



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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.

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 recycled 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.