Fundamental to life, clean water is perhaps the most important natural resource on the planet. Unfortunately, with the increasing recurrence of droughts, poor management of resources, and climate change, a scarcity of clean water is reaching crisis status. Four billion people — almost two thirds of the world's population — experience severe water shortages for at least one month each year. ① Even in countries with adequate water resources, water scarcity is not uncommon.

Water scarcity has made the operational reliability of wastewater treatment plants all the more urgent. Wastewater treatment ensures that contaminated water can be safely reused or returned to the water cycle, but never discarded. Wastewater ("sewage") contains many harmful substances and cannot be discharged into the environment until it is treated. Therefore, the importance of wastewater treatment is twofold: to restore our water supply and to protect us from toxins. Since the Clean Water Act was issued in 1972, more than 15,000 publicly owned wastewater treatment plants (WWTP) have been brought online in the United States, furnishing primary, secondary and tertiary levels of treatment to 34 billion gallons of wastewater each day. ②

In this white paper, we address the serious challenges posed to WWTP by cold weather, specifically how freezing temperatures can jeopardize the piping infrastructures that enable plants to convert sewage into clean water. Piping systems are like the veins of a wastewater treatment plant, carrying water, sewage, chemicals, and mixtures from one location to another. Damage to one pipe can lead to a cascading effect onto the entire infrastructure. Unfortunately, the complexity of wastewater treatment systems often means that isolating, repairing, or replacing a single damaged or cracked pipe requires an expensive, time-consuming shutdown of machinery. Thanks to modern-day freeze protection technologies, specifically heat trace cables, WWTP have access to a solution, safeguarding mission-critical pipelines against severe cold weather events.

Winter Weather Challenges

As if the many variables of wastewater treatment aren't enough to keep a supervising technician busy, winter weather makes the task even more demanding. Snow, ice, and freezing rain can easily create obstacles that will prevent a plant from running at peak performance. Cold temperatures not only slow down the activity of the system's microorganisms, which do the important work of breaking down contaminants; but it also leads to frozen and cracked pipes, hoses, valves, pumps and process components, as well as ice formation on outside tanks and reservoirs, among other issues.

If left unprotected, just about any machine or component within a WWTP can freeze. Once they do, the plant may need to be partially or completely shut down for repairs. Meanwhile, wastewater will continue building up until the facility restarts, or it may need to be released untreated into a nearby body of water leading to environmental contamination, hefty EPA fines, and bad publicity. A major cause of delays that extend downtime is waiting for vital replacement parts. Generally, these parts are ordered beforehand, however, emergencies like a frozen pipe or valve are rarely anticipated. Besides cracks and flooding, limited freezing of water or vapors in pipes can lead to changes in system conditions that can throw off the ratios of treatment products, rendering them less effective. Not only does this affect system health, but it also greatly reduces efficiency.

The Need for Freeze Protection

An overwhelming two-thirds of capital expenditures for conventional wastewater treatment plants can go toward pipelines and pumping stations to maintain flow. ③ Given this investment, extra measures need to be taken to keep this infrastructure performing at optimal efficiency during the cold weather months.

When pipelines freeze in WWTP, the consequences are severe. Leaks and bursts pose a danger to employee health, the environment, and the plant's financial and reputational status. A recent example is the historic 2021 winter storm in Texas. The brutal cold engulfed vast swaths of the Southwest, shuttering water treatment centers and hindering repairs. Some of the winter storm damages at Texas plants included broken pipes, valves, basins, and impacts to chemical feed systems. This led to service disruptions for water systems in more than 140 counties across Texas, affecting some 14.9 million people at its peak.

Heat Trace Cable

To ensure that wastewater treatment pipelines can operate during the winter, freeze protection needs to be applied. Electric heat trace cables play a major role, offering reliable, safe, and energy-efficient performance.

Heat tracing cables are designed to prevent pipes from freezing by use of a resistive element that heats up when electricity passes through it. Replacing lost heat allows the pipe and water/liquids inside to be kept at a constant temperature. If using self-regulating cable, heat output is

adjusted by the pipe temperature. This means that the heater cable will automatically alter the heat output in response to temperature changes across the pipe; it will increase the heat output as areas of the pipe cool, and decrease heat output in areas where the temperature is rising.

Areas of a WWTP requiring heat tracing include the headworks, supply pump stations, influent lift stations, filtration systems, and chemical feed systems (if located outside). Additional areas that should be considered are stairs/walkways, loading docks, and platforms to ensure employee safety. Faucets and washdown areas may also require heat tracing if exposed to the cold temperatures. However, areas such as reactors and digestor systems have enough mass to prevent freezing without additional protection.

When you are specifying a heat trace cable, it is important to establish parameters. These parameters are determined by pipe sizes, lengths, material, number of valves and pumps attached to the pipes, and the type of pipe supports. Other factors are the supply voltage (110/120 Vac, 208/240 or 277/480 Vac), weather data for the area, and the minimum start-up temperature.

WWTP produce flammable gases and vapors. These emissions come mainly from substances that the wastewater could be carrying, such as oils, solvents, or gasoline from accidental spills, and from anaerobic digestion of organic matter. In confined spaces, a high concentration of these gases can build up making the area particularly suspectable to an explosion from an electrical arc. NFPA 820-2020 (Standard for Fire Protection in Wastewater Treatment and Collection Facilities) determined that most pumping stations, spaces, and buildings that make up a WWTP must be considered hazardous locations. In North America, the heat trace cable you specify should be rated for hazardous locations as defined by the National Electrical Code (Article 500), which is broken down into Class, Division, Group, and Zone based on their explosive concentration probabilities. When choosing a heat tracing cable solution for wastewater applications in Europe, ensure it is certified to ATEX, IECEx, CENELEC, EU or other regional hazardous location standards for both metal and non-metal pipes, tanks, and vessels.

Emerson's Solution

Nelson™ Heat Trace Type LT Self-Regulating Heater Cables by Emerson are the field-proven solution to safely maintain fluid flow over a wide range of operating temperatures. They have been relied upon for more than 30 years by the hydrocarbon and chemical industries.

Suitable for use on pipes, tanks, and vessels, Type LT cable maintains process temperatures up to 65°C (150°F) to meet viscosity/fluid requirements as well as for structural anti-icing. In addition, Nelson's HLT cable can provide freeze protection and maintain up to 121 °C (250 °F) of periodically steam-cleaned components. The cables provide a conductive ground path when installed on non-conductive surfaces, such as plastic or painted pipe.

Type LT cables are self-regulating, meaning that they will adjust heat output automatically in response to surrounding temperatures. The heater cable derives its self-regulating characteristic from the inherent properties of the conductive core material. As the core material temperature increases, the number of conductive paths in the core material decreases, automatically decreasing the heat output. As the temperature decreases, the number of conductive paths increases, causing the heat output to increase. This occurs at every point along the length of the cable, adjusting the power output to the varying conditions along the pipe. Straight line runs are the common majority for installation types, however the older practice of spiraled around the pipe installation is also acceptable. Because the cable is self-regulating, it can be overlapped where the installation requires, without creating hot spots or burn out.

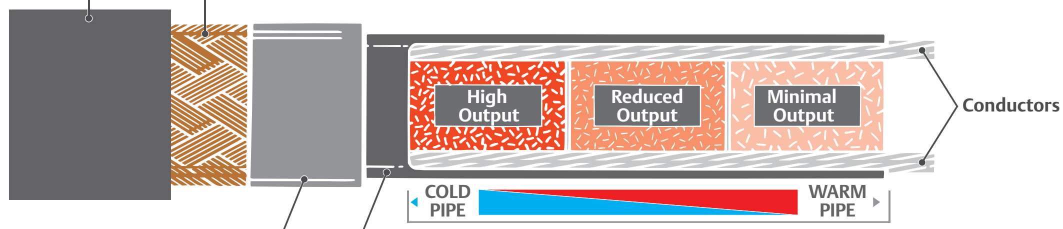
Type LT Self-Regulating Heater Cable

Heat Trace Cable Installation

Before installation, consult with the manufacturer's specific instructions. Failure to do so will likely void warranties and agency approvals. The integrity of the system depends upon how accurately the heat trace cable is installed. Improperly installed systems have resulted in system failure and physical injury.

In general, heat trace cables can be installed in either straight runs (found to be the more standard industry protocol) or spiraled around the pipe. Spiraling is used when a limited

Operating Principle of Self-Regulating Heater Cables



number of cable types are available and has become less common in recent years. In straight tracing, the cable is installed on the lower quadrant of the pipe to prevent physical damage from falling objects or from being walked on. In both spiraling and straight runs, the cable should be applied flat to the pipe.

A power conditioner is another means of harmonics mitigation. It is used for harmonic correction by recreating a smooth, pure sinewave. It also maintains a constant voltage against spikes and sags, while providing electrical isolation when the application requires it.

Attachment of the cable to the pipe can be done with fiberglass tape. The cable should fit snuggly against the pipe and be secured every 12 inches. It is recommended that metal straps, wire, vinyl electrical tape, or duct tape not be used to attach the cable to pipes. If the cable must be cut, do so after it is attached to the pipe, and after confirming allowances for terminations, connections, and heat sinks. Loop the cable around valves, hangers, and other small in-line devices in a manner that allows their removal or access without having to cut the cable.

Moisture penetration of the heat trace system is the single largest source of problems in wastewater treatment facilities. Particular care must be given to the proper sealing of all electrical connections and splices. Cable sealing kits will provide a proper seal for the cable itself, while other electrical connections, including heater to power wiring, thermostat connections, and panel and breaker connections, should be sealed or moisture proofed in an approved fashion.

After installation, it is important you inspect the cable and system components for any possible damage, ensuring the cables are free of nicks, tears, or gouges. Verify that additional cable has been installed at each valve, flange, pipe support, and other devices to allow easy access to the device making sure connections, splices, and end-seals meet code requirements.

The above are only general recommendations. Again, it is very important to consult with the heat trace cable manufacturer's user manual for specific installation instructions.

Thermostats and Controllers

WWTP heat tracing requires the use of temperature control. When selecting the proper thermostat or controller you must consider the voltage and amperage ratings of the device as well as the suitability of its housing for the environment, specifically if the enclosure is explosionproof, raintight, and corrosion resistance.

Temperature Maintenance

Although the application we are addressing in this white paper is freeze protection, it should be noted that many chemicals (aluminum, ferric chloride, sulfates, and polymers) used in sewage treatment are highly aggressive and require process temperature maintenance, a task where electric heating trace cables also excel.

Emerson's Solution
The Nelson Heat Trace CM-1 Microprocessor Based Heater Cable Monitoring System by Emerson continually monitors the supply voltage and current of both series and parallel styles of electric heat trace cables. When used in conjunction with ground fault branch breakers, the CM-1 also serves as an automatic alarm system when the heating system is de-energized due to a tripped breaker. Continuity monitoring for parallel-resistance heating cables can be enabled by adding a passive bus monitor device at the end of each heater circuit. The microprocessor-based scanner systematically compares programmed values with actual data from sensor cards capable of monitoring up to 4 circuits each. The status of each circuit is displayed using high-visibility LEDs. Multiple CM-1 systems throughout a facility can also be connected to a central PC to provide centralized alarm status and acknowledgement. It features a NEMA 4 or 4X powder coated or stainless-steel enclosure for wet environments.

CM-1 Microprocessor Based Heater Cable Monitoring System

Conclusion

Wastewater treatment is one of the most important environmental conservation processes available today to address the growing crisis of water scarcity. WWTP ensure that the sewage discharged from homes, businesses, and industries is properly treated before it is released back into local waterways. During colder months, heat trace cables help maintain efficient system performance and counter seasonal upsets by keeping water and chemicals flowing, therefore preventing facility flooding, the expense of replacement parts and repairs, environmental damage, and plant downtime.

Emerson's Nelson Heat Trace brand offers a broad range of heat trace cables, controls, monitors, and accessories to serve the most demanding industrial environments including the hazardous and non-hazardous areas of wastewater treatment facilities, while addressing issues of wet and highly corrosive atmospheres. Emerson's engineering team will optimize the most efficient, reliable, and cost-effective heat trace system possible based on your plant's individual requirements, including the design of custom solutions for extreme weather.

Learn more at www.nelsonheaters.com.

About Nelson

Nelson heat trace products and systems utilize the latest design philosophies and innovative technology to provide the highest level of efficiency and reliability for industrial pipelines. With the broadest range of heating cables, controls, monitors and accessories, along with the world's most advanced heat trace management software, the Nelson brand is known for ensuring optimum control and cost-efficient operation of pipelines in the most severe climates around the world.

About Emerson

Emerson (NYSE: EMR), headquartered in St. Louis, Missouri (USA), is a global technology and engineering company providing innovative solutions for customers in industrial, commercial and residential markets. Our Automation Solutions business helps process, hybrid and discrete manufacturers maximize production, protect personnel and the environment while optimizing their energy and operating costs. Our Commercial & Residential Solutions business helps ensure human comfort and health, protect food quality and safety, advance energy efficiency and create sustainable infrastructure.

Footnotes

1. UNICEF. Water scarcity: Addressing the growing lack of available water to meet children's needs.

2. EPA. History of the Clean Water Act

3. "Reducing the Costs of Water and Wastewater Treatment Pipelines" April 2, 2021, Fluence

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