

Vibration Monitoring of Wastewater Treatment Plants

Purpose

This application note is intended to communicate how the rotating machinery at a Wastewater Treatment Plant should be monitored to enable proactive maintenance, reduce downtime, increase equipment lifespan, and improve operational efficiency by identifying potential issues before they escalate into major problems. This document outlines how vibration monitoring can help you take a proactive approach to maintain the operational efficiency, safety, and environmental integrity of wastewater treatment facilities. It allows for early detection of equipment issues, optimized processes, and overall, more sustainable, and reliable plant operations.

Wastewater Treatment Plant Overview

Wastewater treatment plants clean sewage and water so that they can be returned to the environment. These plants remove solids and pollutants, break down organic matter and restore the oxygen content of treated water. They achieve these results through four sets of operations: preliminary, primary, secondary and sludge treatments all of which can involve motor driven pumps and blowers. The size of the pumps is determined by the flow volume and the pressure head necessary to deliver the wastewater. The size of the air blowers are determined by the flow volume and the amount of oxygen needed in the wastewater treatment process. The bearings for the pumps and blowers are either going to be Rolling Element Bearings or Fluid Film

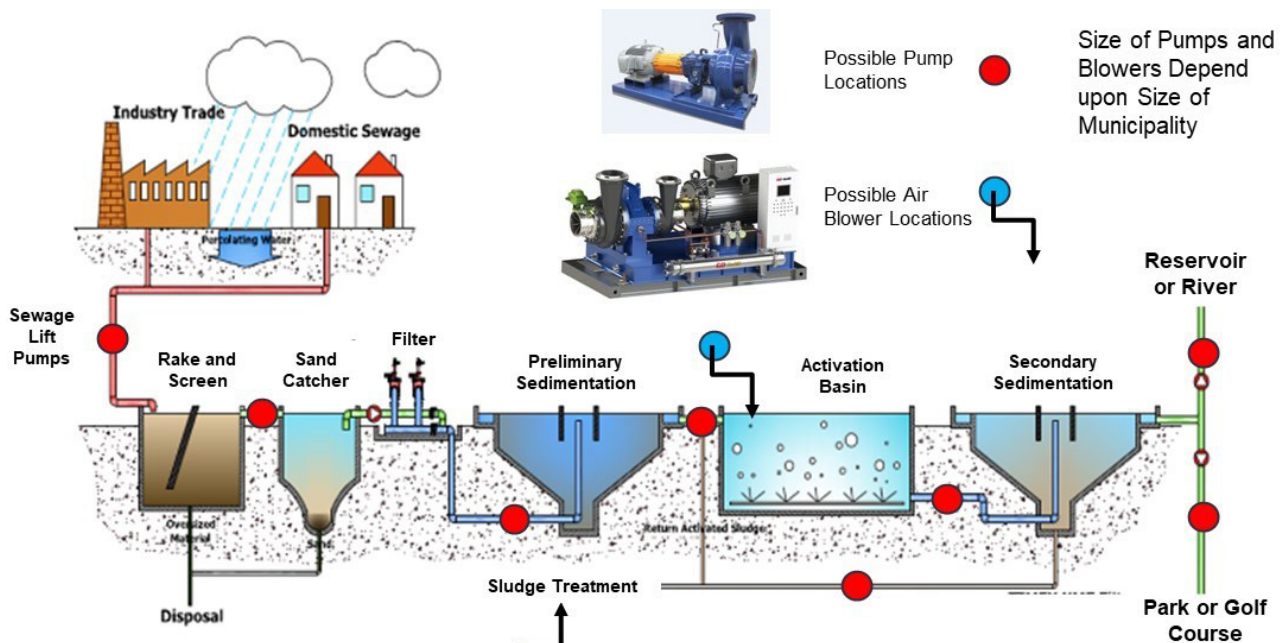


Figure – Typical Wastewater Treatment Plant

Bearings depending upon their size. Large pumps and blowers, over 1 megawatt, usually have Fluid Film Bearings.

Normally, a network of sewers connected to homes, commercial buildings, schools and street grates delivers wastewater and solids to a treatment plant's collection tanks and basins in a never-ending flow. In many locations, due to elevation differences within a municipality, lift pumps are used to get the sewage where it needs to go. The first phase is the pretreatment phase where wastewater plants remove the large debris. A set of bar screens rakes away large items such as tree limbs, garbage, leaves, cans, rags, plastic bottles, diapers and other waste materials. In many plants, equalization basins and grit chambers of various types regulate the rate of water inflow so that stones, sand and glass settle out. The basins hold sewage until it is ready for treatment and handle

overflows due to heavy rains. Some plants skim grease and fats off the surface of the water during pretreatment.

After pretreatment, the wastewater collects in primary sedimentation clarifiers which are large basins and sedimentation tanks. Gravity allows smaller particles to settle out. Mechanically driven scrapers collect solid matter and direct it to hoppers connected to the sludge treatment equipment. If the plant didn't remove grease and oil during pretreatment, it does so in this phase using surface skimmers.

In the next phase called secondary treatment, plants aerate and agitate the wastewater before it flows to the secondary sedimentation basins adding beneficial microorganisms to break down organic matter into sludge. If not gravity fed, or to increase flow, pumps

Rotating Equipment	Bearing Type	Typically Spared	Essential Machines	Balance of Plant Machines	Monitoring System		Recommended Sensors			Minimum Sensor / Transmitters		Vibration Switch	
					Recommended Monitoring & Protection	Minimum Monitoring & Protection	XY Probes @ 45° from C/L w/ Proximity Transmitter	Vertical (V) and or Horizontal Velocity Transmitter	Thrust Probes w/ Proximity Transmitter	XY Probes @ 45° from C/L with Transmitter	Vertical (V) and or Horizontal Velocity Transmitter	Thrust Probes w/ Transmitter	For minimum Protection (Electrical or Mechanical)
Sewage Lift Pumps	Rolling Element Bearings ¹	Y		Y	SCADA ²	SCADA		Y			Y		SW5484E
Sewage Lift Pumps	Sleeve Bearing ³	Y	Y		SCADA	SCADA	Y		Y	Y		Y	SW5580
Conveyor Belt Screens	Rolling Element Bearings	Y	Y		SCADA	SCADA		Y			Y		SW5484E
Process (LP) Low Pressure Pumps	Rolling Element Bearings	Y		Y	SCADA	SCADA		Y			Y		SW5484E
Process (LP) Low Pressure Pumps	Sleeve Bearing	Y	Y		SCADA	SCADA	Y		Y	Y		Y	SW5580
Skimmer Motors	Rolling Element Bearings	Y	Y		SCADA	SCADA		Y			Y		SW5484E
Air Blower	Rolling Element Bearings	Y		Y	SCADA	SCADA		Y			Y		SW5484E
Rotary Screw Air Blower	Sleeve Bearing	Y	Y		SCADA	SCADA	Y		Y	Y		Y	SW5580

1. For Seismic Monitoring of Rolling Element Bearings, monitor the Rotor Related Region (1 / 4X to 3X) and the Prime Spike Region (1 to 6 times the Ball Pass Frequency Outer Race (BPFO))
2. Supervisory Control and Data Acquisition (SCADA) System
3. Sleeve Bearings are also known as Fluid Film Bearings and Journal Bearings are monitored with Proximity Probe Transducers (Drivers or Transmitters)

Sensor Type	At Each Bearing on Each Side of Coupling	Typically Spared	Essential Machines	Balance of Plant Machines	Vibration Sensors Connected to Monitors (SW5580 or other VMS)	Vibration Transmitters Connected to SCADA System	Minimum Protection Switches
Casing Vibration	Rolling Element Bearings	Y		Y	SA6200A Accelerometers on each side of the coupling.	ST5484E Velocity Transmitter on each side of coupling (Primary - Load Side)	SW5580, SW5484E, 440, SW6000, SM6100
Casing Vibration	Rolling Element Bearings	Y		Y	SA6200A Accelerometers on each side of the coupling.	ST5491 Indicating Velocity Transmitters on each side of coupling (Primary - Load Side).	SW5580, 440, SW6000, SM6100
Casing Vibration	Rolling Element Bearings	Y		Y	Walk Around Data Collection	Use permanent Velocity Transmitters for Difficult to Reach Locations	

For low speed machines (600 rpm or less), monitor both velocity and displacement with a SA6200A Accelerometer and a 5580 or SW5580 Monitor (Per Hydraulic Institute 9.6.4)

Sensor Type	At Each Bearing	Typically Spared	Essential Machines	Balance of Plant Machines	Transducers
XY Probes @ 45° from C/L w/ Transmitter	Sleeve - Radial Vibration	Y	Y		(2) MX8030 Proximity Probes, MX8031 Extension Cables, MX2034 Transmitters and Necessary Accessories
Thrust Probes w/ Transmitter	Thrust Collar	Y	Y		(1 or 2) MX8030 Proximity Probes, MX8031 Extension Cables, MX2034 Transmitters and Necessary Accessories
Casing Vibration	Sleeve - Radial Vibration	Y	Y		ST5484E Velocity Transmitter on each side of the coupling (Primary - Load Side)

Tables - Wastewater Treatment Rotating Machine Monitoring Recommendations

may be used to transfer water from one basin to the next. Blowers are used to add air / oxygen to the process to increase the biological activity and breakdown or digest the biological contaminants in the wastewater. For vibration monitoring recommendations, see the pictured tables. The water from the secondary treatment is returned to the environment usually through a river, lake, and or park or golf course watering. If the reclaimed water is going to be consumed by people or animals it is put through a Water Treatment process, as described above, called Tertiary Treatment.

Plants also employ a number of alternative strategies to break down sludge. For example, plants can culture a mass of microbes and pass the waste material over biofilm (a film of microorganisms that aid in

the digestion of biological contaminants). Other plants mix the biomass with waste material creating activated sludge that can be recycled for reuse. Air blowers can be used in the sludge process to increase the biological breakdown activity. The resulting biological floc removes carbon and nitrogen from organic wastes.

Why is vibration monitoring of wastewater plants needed?

Vibration monitoring is crucial in wastewater plants for several reasons. These plants house equipment and machinery that are essential for the treatment and processing of wastewater. Monitoring vibration helps ensure the smooth and efficient operation of these facilities, as well as the safety of personnel and

Why Monitor...	Realized Business Value
Avoid Catastrophic Failure	Reduce Capital & Maintenance Spend
Manage & Plan Maintenance	Reduce Maintenance Spend & Meet Budget
Decrease Unplanned Downtime	Meet Production & Revenue Targets
Improve Machine Efficiency	Reduce Energy Costs
Optimize Work Tasks	Deploy Resources on Value-Added Tasks



Figure – Why Vibration Monitoring

the environment. Here are some key reasons why vibration monitoring is essential:

Equipment Health and Condition Monitoring:

Wastewater plants typically rely on a variety of rotating machinery, such as pumps, motors, blowers, and mixers. Continuous vibration monitoring allows operators and maintenance personnel to assess the health of these machines. Unusual levels of vibration can indicate wear and tear, misalignment, unbalance, or other issues that might lead to equipment failure. Detecting problems early enables proactive maintenance and reduces the risk of costly breakdowns.

Early Fault Detection: Monitoring vibrations helps identify potential faults or malfunctions before they cause severe damage to the equipment. Early detection allows for timely repairs or replacements, minimizing downtime and avoiding more extensive and expensive repairs.

Energy Efficiency: Unwanted vibrations in equipment can result in energy inefficiencies.

Monitoring vibration levels enables operators to optimize equipment performance, reducing energy consumption and operating costs.

Process Optimization: The efficiency of wastewater treatment processes can be affected by vibration-related issues. Monitoring vibrations can help identify process inefficiencies caused by equipment problems, allowing for adjustments and improvements to maintain optimal treatment performance.

Environmental Protection: Wastewater treatment plants play a vital role in protecting the environment. Vibration monitoring helps prevent potential environmental hazards by identifying equipment problems that could lead to leaks, spills, or other incidents that might harm the surrounding environment.

Personnel Safety: Excessive vibrations in equipment can pose safety risks to plant personnel. Vibrations can lead to equipment failure, which might result in accidents and injuries. By monitoring and addressing vibration-related issues promptly, the safety of plant

workers can be significantly improved.

Regulatory Compliance: Wastewater treatment plants often need to adhere to strict regulations and guidelines. Vibration monitoring may be a requirement in some regulatory frameworks to ensure the proper functioning and maintenance of critical equipment.

Asset Management and Longevity: Monitoring vibrations provides valuable data for asset management. Understanding the condition of equipment helps in planning maintenance schedules and replacement cycles, extending the life of the machinery and avoiding unplanned downtime.

How is vibration monitoring used in wastewater industries?

Vibration monitoring plays a crucial role in the wastewater industries by helping to ensure the reliable and efficient operation of equipment and infrastructure. Here are some ways in which vibration monitoring is used in these industries:

Pump and Motor Monitoring: Pumps and motors are extensively used in wastewater treatment plants. Vibration monitoring helps in detecting abnormalities in the rotating equipment, such as misalignment, bearing wear, unbalance, and mechanical looseness. By monitoring vibration levels, plant operators can identify potential failures and schedule maintenance proactively, minimizing downtime and reducing repair costs.

Pipe and Valve Monitoring: Vibration monitoring is employed to detect pipe and valve failures in wastewater systems. Excessive vibration can indicate issues like water hammer, fluid flow problems, or structural weaknesses in the piping network. Continuous monitoring allows for early detection of leaks, pipe bursts, or valve malfunctions, enabling prompt repairs and preventing water loss or environmental contamination.

Blower and Compressor Monitoring: Blowers and compressors are vital components in aeration systems used in wastewater treatment. Vibration monitoring helps to identify issues such as worn bearings, unbalance, and alignment problems in these machines. By detecting these problems early on, maintenance can be scheduled to avoid costly breakdowns and optimize energy efficiency.

Mixing and Agitation Equipment: In various wastewater treatment processes, mixing and agitation equipment are used to ensure proper blending of chemicals and facilitate solid-liquid separation. Vibration monitoring assists in identifying problems like impeller damage, bearing wear, or mechanical faults in mixers and agitators. Timely maintenance based on vibration data helps to prevent equipment failure and optimize process performance.

Structural Monitoring: Wastewater infrastructure often includes large structures like reservoirs, tanks, and dams. Vibration monitoring is employed to assess the structural integrity of these assets. By monitoring vibration levels and frequencies, engineers can detect any abnormal vibrations that may indicate structural damage, settling, or excessive loads. This information helps in evaluating the safety of the structures and planning necessary repairs or reinforcements.

What are the challenges in vibration monitoring of wastewater plants?

While vibration monitoring offers numerous benefits in wastewater plants, there are also several challenges that need to be addressed. Here are some common challenges associated with vibration monitoring in these industries:

Harsh Environment: Wastewater Treatment Plants often have harsh and corrosive environments, with high humidity, chemical exposure, and elevated temperatures. These conditions can affect the performance and lifespan of vibration monitoring equipment, such as sensors and data acquisition

systems. Specialized vibration monitoring equipment with robust construction and suitable materials is required to withstand these environments.

Sensor and or Transmitter Placement: Proper sensor placement is crucial for effective vibration monitoring. However, in wastewater plants, it can be challenging to identify the optimal locations for vibration transducers due to limited accessibility, crowded equipment layouts, and complex piping networks. It may require careful planning and consideration of factors such as vibration transmission paths, potential sources of vibration, and critical equipment locations. Metrix can be relied upon to help with proper vibration transducer placement.

Data Interpretation: Vibration monitoring generates a significant amount of data, and interpreting this data correctly can be challenging, that is why people have relied upon Metrix Vibration for their simple 4-20 milliamp output for trending purposes for decades. This simple tool allows plant operators to easily see changes in vibration levels. After early warning is provided, plant operators and maintenance personnel can focus on the machines that need attention. This allows experts that have a good understanding of vibration analysis techniques and interpretation methods to identify problems and avoid impending failures. Training and expertise in vibration analysis are useful for effective decision-making based on the collected data.

Integration with Maintenance Strategies: Vibration monitoring should be integrated into a comprehensive maintenance strategy to be effective. The challenge lies in establishing an effective system that connects the vibration monitoring data with maintenance planning and scheduling. This integration involves setting up thresholds and alarms, establishing protocols for action based on vibration data, and ensuring timely follow-up on identified issues to prevent failures or breakdowns.

Cost Considerations: Implementing a vibration monitoring program requires an investment in

equipment, software, and training. Small and medium-sized wastewater plants with limited budgets may face challenges in allocating resources for vibration monitoring. Cost-effective solutions and prioritization of critical equipment are important considerations to overcome this challenge. Metrix provides solutions that are economical, easy to install and that are modular to fit within any budget. Addressing these challenges requires a combination of appropriate technology, expertise, and effective implementation strategies. By overcoming these obstacles, wastewater plants can optimize their maintenance practices, improve equipment reliability, and ensure the efficient operation of their facilities.

What solutions do we advocate for vibration monitoring of wastewater plants?

Some general solutions that are commonly advocated for vibration monitoring in wastewater plants are noted below. These solutions can help optimize the vibration monitoring process:

Robust Vibration Sensors and Transmitters: High-quality vibration sensors and transmitters specifically designed for harsh environments are crucial for accurate and reliable monitoring. These sensors are capable of withstanding the corrosive and demanding conditions found in wastewater plants. They are adequate protection against moisture, chemicals, and temperature variations.

Wireless Monitoring Systems: For Balance of Plant rotating machines, implementing wireless vibration monitoring systems can simplify installation and reduce the complexity of cable routing in wastewater plants. Wireless systems enable flexible transducer placement and provide data transmission to central monitoring stations. This allows for easier access to vibration data, efficient data management, and timely analysis.

Advanced Signal Processing and Analysis: Vibration monitoring systems should incorporate advanced signal processing algorithms and analysis techniques to filter out background noise and extract meaningful

information. These techniques help in accurately identifying vibration patterns, detecting anomalies, and providing early warning indications of potential equipment failures.

Remote Monitoring and Analytics: Cloud-based or remote monitoring platforms allow plant operators and maintenance personnel to access vibration data and analysis remotely. This provides the convenience of real-time monitoring, data visualization, and trend analysis from any location. It facilitates proactive decision-making, immediate response to critical alerts, and comprehensive data-driven maintenance strategies.

Integration with Maintenance Management Systems: Integrating vibration monitoring systems with existing maintenance management systems or computerized maintenance management systems (CMMS) streamlines the workflow and enhances maintenance planning. By connecting vibration data with work order generation, scheduling, and asset management, it ensures seamless coordination between vibration analysis results and maintenance activities.

Expert Support and Training: Vibration monitoring in wastewater plants can benefit from expert support and training. Metrix offers technical assistance, training programs, and consultation services to help plant personnel understand the vibration monitoring

process, interpret data accurately, and make informed maintenance decisions.

Conclusion

Overall, vibration monitoring in the wastewater industries enables proactive maintenance, reduces downtime, increases equipment lifespan, and improves operational efficiency by identifying potential issues before they escalate into major failures.

It's advisable to consult with vibration monitoring solution providers, such as Metrix Vibration or other reputable companies in the industry, to understand their specific offerings and how they align with the unique requirements of your wastewater plant.

In conclusion, vibration monitoring is a proactive approach to maintain the operational efficiency, safety, and environmental integrity of wastewater treatment plants. It allows for early detection of equipment issues, optimized processes, and overall, more sustainable, and reliable plant operations.

Why Metrix...	Impact to Business Value
Application Expertise	An Investment in Metrix Includes Consultation on Applications and Proven Monitoring Strategies
Scalable Monitoring	Pay for Solutions to Address Current Needs & Expand Monitoring if Needs Evolve
Decreased Investment	Metrix Leverages Your Existing Control System – No Standalone Monitoring System Needed
Minimized Complexity	Metrix Provides Intuitive Monitoring Instruments & Tools To Enable You To Install & Maintain
Best In Class Delivery & Lead Time	On Time Delivery and Short Lead Times Reduce Machinery Down Time



Figure – Why Metrix for Vibration Monitoring