Vibration Monitoring of Water Treatment Plants

Purpose

This application note is intended to communicate how the rotating machinery at a Water 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 water treatment facilities. It allows for early detection of equipment issues, optimized processes, and overall, more sustainable, and reliable plant operations.

Water Treatment Plant Overview

Water Treatment Plants are facilities that treat water to make it safe for human consumption and other uses. The process of water treatment involves several steps that remove impurities and contaminants from the water. Usually, gravity is used to help convey the water to the treatment plant, in many cases lift pumps need to be used to move the water from a lake or river to where the water can be treated in a treatment facility. The size of the lift pumps is determined by the flow volume and the pressure head necessary to deliver the water. The bearings for the lift pumps are either going to be Rolling Element Bearings or Fluid Film Bearings depending upon the size of the pump. Large pumps, over 1 megawatt, usually have Fluid Film Bearings.

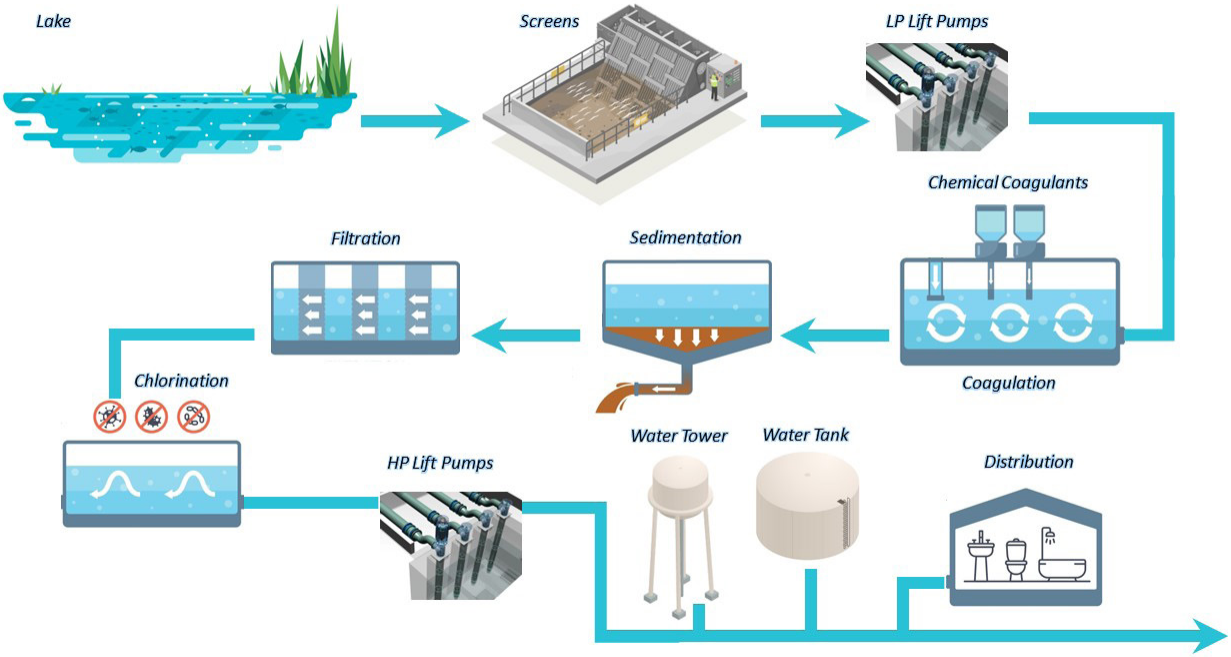

Figure - Typical Water Treatment Plant

In the water treatment process, the first step is to remove any physical objects and large particles from the stream. This starts in a screening process, and may involve conveyors. The conveyor motors should be monitored with velocity transmitters on the load side bearing to help ensure that the debris does not cause a problem with the conveyor. The next step is to remove the dissolved solids suspended in the water. To speed up the settling and removal process, chemicals called coagulants are added to the water. The most common coagulant is aluminum sulfate, but this varies by the Water Treatment Plant. Essentially this chemical has the opposite charge from the suspended solids, like clays or silts, which then neutralizes the charge and allows for the particles to stick together. In the coagulation basin the solids in the water begin sticking together, the mixture is slowly mixed and moves to the flocculation basin in order to continue to form what are called floc particles. The motors for the coagulation and the flocculation mixers are slow moving, usually, rolling element bearing machines. These machines should be monitored per the Hydraulic Institutes Guidelines 9.6.4 for machines operating less than 600 rpm, using seismic velocity transmitters measuring vibration velocity and integrated displacement.

Monitoring the vibration allows for any degradation to be noticed, and maintenance to be planned in advance of machine failure (see the tables below for monitoring recommendations). The floc particles then settle out of the mixture in a sedimentation basin, and cleaner water flows overtop a weir. This process is only the first step, and it has mainly removed larger particles in the water, but some smaller particles may remain, as well as chemicals and bacteria. Following sedimentation, the next step is typically filtration through a sand filter. Sand filters have been used

					Monitoring System		Recommended Sensors			Minimum Sensor / Transmitters			Vibration Switch
Rotating Equipment	**Bearing Type**	**Typically Spared**	**Essential Machines**	**Balance of Plant Machines**	**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)**
Intake Pumps	Rolling Element Bearings[1]	Y		Y	SCADA[2]	SCADA		Y			Y		SW5484E
Intake 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
Low Pressure (LP) Lift Pumps	Rolling Element Bearings	Y		Y	SCADA	SCADA		Y			Y		SW5484E
Low Pressure (LP) Lift Pumps	Sleeve Bearing	Y	Y		SCADA	SCADA	Y		Y	Y		Y	SW5580
Coagulator / Fluocculation Mixing Motors	Rolling Element Bearings	Y	Y		SCADA	SCADA		Y			Y		SW5484E
High Pressure (HP) Lift Pumps	Rolling Element Bearings	Y		Y	SCADA	SCADA		Y			Y		SW5484E
High Pressure (HP) Lift Pumps	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 Protecton 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 – Water Treatment Rotating Machine Monitoring Recommendations

since the beginning of water treatment, and they are required most everywhere to be included in the treatment process to assure a standard level of clarity.

Sand filters are used as a step in the water treatment process of water purification. There are three main types; rapid (gravity) sand filters, upward flow sand filters and slow sand filters. All three methods are used extensively in the water industry throughout the world. Sand filtration works by using multiple layers of specialized sand and gravitational fluid pressure to retain solid particles suspended in liquids, resulting in a cleaner product. As fluids pass slowly though layered sand and gravel beds, natural physical, biological, and chemical processes combine to provide treatment. Gravity is often used to move the water through the sand filter beds, however, is some higher flow or demand situations, pumps are often used to force the flow through the beds. Pumps are also used to force water to back flush the beds to clean them and allow for their continued use. These pumps are usually employing rolling element bearings and are monitored with velocity transmitters. On larger pumps, greater than 1 megawatt, fluid film bearings are used necessitating the need for proximity sensors for proper monitoring.

It should be noted that, anthracite is a type of coal that is used in water filtration systems. It is used as a filter medium in dual media filters with sand as the other medium. Anthracite is used to remove smaller particles from water than sand alone can remove. At the end of the process chlorine is added as a disinfectant, it kills any organisms that have not been

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

removed in the filtration process.

Why is vibration monitoring of water treatment plants needed?

Vibration monitoring is crucial in Water Treatment Plants for several reasons. These plants house equipment and machinery that are essential for the treatment and processing of water. Monitoring vibration helps ensure the smooth and efficient operation of these facilities, as well as the safety of personnel and the environment. Here are some key reasons why vibration monitoring is essential:

Equipment Health and Condition Monitoring: Water 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 water 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: Water 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: Water 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 water industries?

Vibration monitoring plays a crucial role in the water 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 Water 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 water 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.

Mixing and Agitation Equipment: In various water 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: Water 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 water plants?

While vibration monitoring offers numerous benefits in water 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: Water 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 water 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 water 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, water 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 water plants?

Some general solutions that are commonly advocated for vibration monitoring in water 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 water 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 water 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 water 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 water 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 water plant.

In conclusion, vibration monitoring is a proactive approach to maintain the operational efficiency, safety, and environmental integrity of Water 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