RESEARCH ON THE VIBRATION OF A VERTICAL HYDROPOWER PLANT

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Abstract. *This thesis explores the phenomenon of vibration vertical hydropower plants units, analyzing its causes, impacts and prevention strategies. Vibration in hydropower plants can significantly reduce operational reliability, decrease efficiency and lead to early wear or failure of mechanical components. The study highlights common sources of vibration and presents modern monitoring and mitigation techniques to ensure stable and safe operation of hydroelectric power plants.*

Key words: *hydropower plants, vibration, monitoring, balancing, hydrodynamics, bearings, prevention, diagnostics.*

Main content. Hydropower plants play an important role in hydropower systems. Vertical hydropower plants are used in many hydroelectric power plants, and their reliable operation affects the efficiency of the entire system. Vibrations that occur during the operation of hydropower plants can negatively affect their structural elements. Therefore, it is important to measure, control and study the level of vibration in hydroturbines.

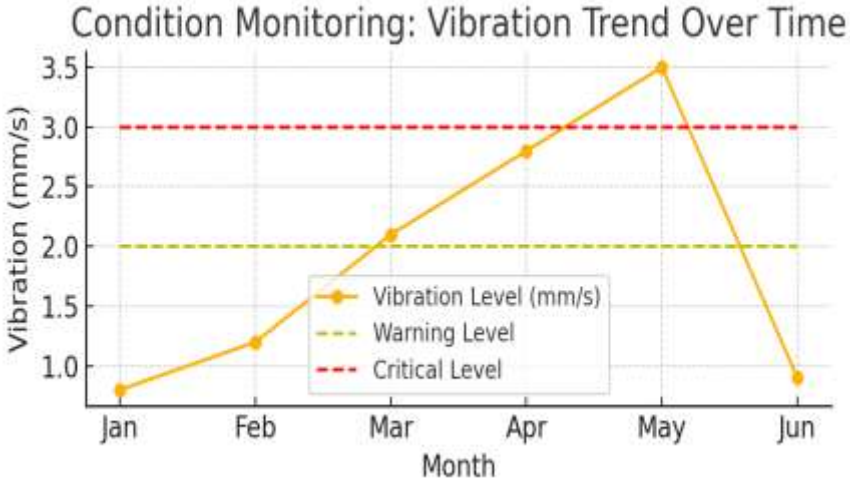
A vertical hydro turbine is a type of hydraulic machine that converts the energy of flowing or falling water into mechanical rotational energy, where the turbine shaft is arranged in a vertical orientation. Vertical hydro turbines are commonly used in hydroelectric power plants, especially in medium and high under pressure. The key feature of these turbines is that the turbine runner is located below, submerged in water, while the generator is mounted above.

During operation, these units are subject to various types of vibrations caused by:

- Hydrodynamic instabilities, such an uneven flow and cavitation;
- Rotor-stator misalignment;
- Imbalanced masses or rotor deformations;
- Wear or failure of bearings;
- Installation or operational errors;

Unchecked vibrations can lead to critical failures, making early detection and prevention essential. The following preventive measures are key:

Condition Monitoring Systems – real-time vibration monitoring using sensors and control software. Condition monitoring systems help detect early signs of abnormal vibrations in vertiacal hydro units. For example, at the Bo'zsuv HPP, vibration sensors, detected increased vibration trends over six months, leading to preventive maintenance before any major damage occurred.



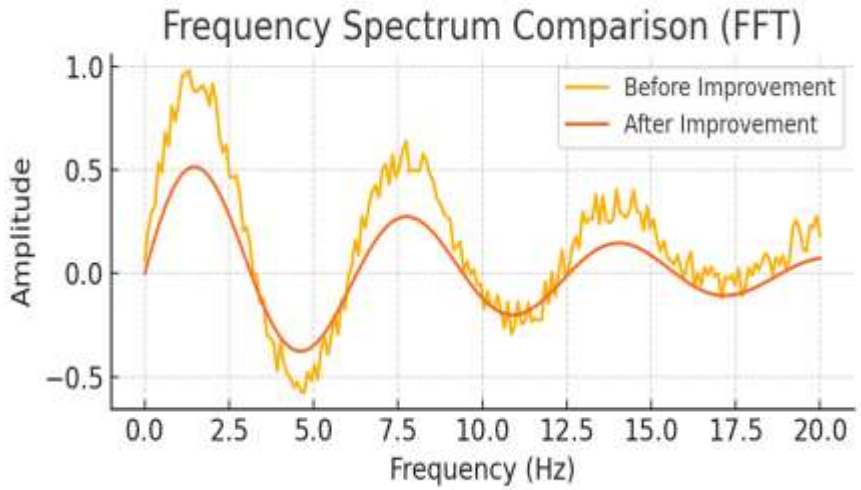
Vibration trend chart sowing increasing vibration followed by maintenance action.

1. Dynamic Balancing – the process of balancing rotating components (such as the rotor and runner) to minimize unbalanced forces and reduce vibration during operation. This ensures smoother rotation, decreases mechanical stress on bearings, and prolongs equipment life.

2. Routine Maintenance – scheduled inspections and timely replacement of worn parts. At unit 1 of the Bo'zsuv HPP, the bearing temperature and vibration amplitude are measured quarterly. During a scheduled maintenance in the spring of 2024, early wear was detected in the lower bearing, which was subsequently replaced. This preventive action helped avoid unexpected shutdowns.

3. Design Improvements – use of advanced damping elements and high-quality bearings. This method involves modifying the design of the existing hydro power plant to reduce vibrations.

- Use of dampers (vibration-absorbing elements);
- Reinforcing weak joints;
- Installing high-quality bearings and fasteners;



4. Numerical Modeling and Simulation – predictive analysis using computer-aided engineering tools. Creating computer models of the hydro power plant and analyzing potential vibrations under various conditions using simulation software. Benfits: Identifying problem areas during the design phase; Reducing experimental costs; Assisting in selecting optimal operating modes.

Conclusion. Vibration in vertical hydro power plants is a complex issue influenced by multiple factors. To ensure the longevity and reliability of hydro equipment, a combination of technical solutions, regular diagnostics, and structural enhancements must be implemented. Modern vibration analysis and predictive maintenance technologies are crucial in mitigating these risks and improving overall performance.

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