

TECHNICAL ASSESSMENT

Open Channel Vertical Pumps

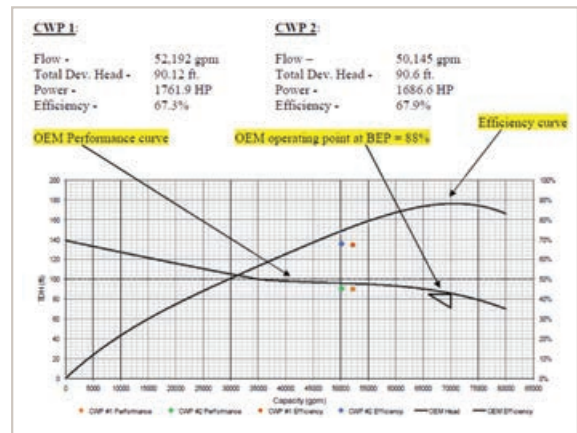
Flowserve offers the ability to measure and assess open channel vertical pump hydraulic performance, capturing data that is historically difficult to obtain through traditional methods. Using this information, we generate a comprehensive technical report with recommendations supported by a life cycle cost analysis that enables plant operators to achieve their uptime and reliability goals.



Large open channel vertical pumps typically operate at flow rates upward of 200 000 gallons per minute, with the suction inlet located greater than 30 feet below grade within river channel inlets. There they distribute water to a power plant condensing system. If these pumps are not running, power plants run the risk of being de-rated, which is very costly to the utility, especially during the summer months when the potential loss can reach \$500 000 per day. In most of these types of installations, there are no permanent flow meters installed and installing temporary ones is typically not feasible. As a result, plant operators are largely unaware of equipment performance levels until a unit starts showing signs of stress.

Flowserve is now able to provide a technical assessment of this critical equipment. Using a sensor mechanism designed to capture an inlet's velocity profile, Flowserve can accurately calculate the pump's flow rate based on the channel's geometry.

Combined with discharge pressure, suction pressure, speed, vibration and electrical power supplied to the motor, Flowserve is able to deliver a comprehensive technical assessment and performance analysis of a vertical pump system. The detailed report includes a graph plotting the recorded data points and each pump's recommended Best Efficiency Point (BEP) of operation.



Actionable Recommendations Prevent Costly Downtime

This technical assessment for open channel vertical pumps identifies immediate reliability concerns and provides actionable recommendations to reduce energy consumption, the rate of mechanical degradation, and the frequency of costly downtime due to unplanned pump failures. Thirty percent of abrupt pump failures in extreme working conditions result in significant downtime that equates to a 20 percent decrease in productivity. This analysis allows critical applications to maintain optimum



performance, preventing pumps from going offline and potentially de-rating the plant. Flowserve provides a final report with recommendations to meet system demand and improve the hydraulic performance of the pump, including (but not limited to):

- Resizing the diameter of impellers
- Making necessary impeller stage adjustments
- Providing additional vibration analysis as needed (e.g., modal resonance testing, ODS analysis, etc.)

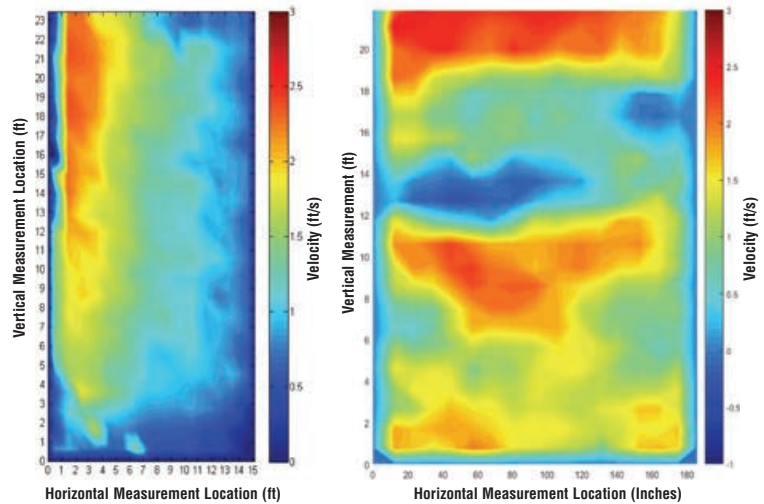
Because this comprehensive technical assessment is designed to bring pumps back to their BEP, uptime is maximized and the need to replace pumps—which can be costly to plant operators—is diminished. This also allows plants to schedule pump maintenance on an as-needed basis rather than the typical practice of time-based maintenance (e.g., every two to five years).

Flow Measurement Technique

To measure the flow rate across the inlet bay, Flowserve designed a mechanical frame with multiple flow meters located side-by-side. Velocity measurements are achieved by incrementally lowering the frame into the channel and recording data at each position.

The rig is designed to utilize the lateral guides in the inlet bays, and the individual sensors measure velocity (or intake) at different locations.

The end result of the measurement is a velocity profile of the channel. The two color charts pictured illustrate example measurements.



Total volumetric flow is then obtained by calculating the velocity data with the area of the channel.

Testing Methodology

Flowserve captures the following data to evaluate hydraulic performance of open channel vertical pumps:

- Measure discharge pressure using instrumentation nearest the pump discharge
- Calculate suction pressure using the sump water level
- Verify motor speed (RPM) with a handheld strobe device
- Determine individual pump flow by recording sump inlet flow velocities and accurately mapping the channel's velocity profile
- Collect and analyze pump and overall motor vibration levels

With this data, Flowserve can plot the performance data against “as new” design conditions. This detailed hydraulic performance analysis is compiled in a comprehensive report with recommendations for plant operators to help achieve their operational and reliability goals.

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