

Wet balancing cuts vibration up to 70% in Grundfos S-tube® wastewater pump impeller

By Bryan Orchard

Wet balancing solution

Closed impellers have been around for decades, but until now, they have had issues with vibration, clogging and inefficiency in wastewater applications.

When Grundfos engineers developed the S-tube® impeller, they looked at three main issues:
– efficiency – clogging – vibration –

They began by conquering the first two concerns, says Flemming Lykholt-Ustrup, Head of Mechanics and Hydraulics at Grundfos. The Grundfos S-tube® impellers not only allowed a non-compromised, free spherical passage throughout the pump, but they also improved the efficiency over traditional channel impellers by 20%.

The final issue to tackle was thus vibration.

“With a multi-vane impeller, fluid and pressure are more evenly distributed around the complete circumference of the impeller, whereas the pressure distribution is asymmetrical around a single channel impeller,” explains Flemming Lykholt-Ustrup. “The traditional and well-known single channel impeller has the strong advantage of offering high hydraulic efficiency, but it is well known for potential problems with vibration.”

Searching for an cure to vibration

Vibration has always been an issue with impellers – and it challenged the new Grundfos S-tube® in the beginning. In early lab tests, the impeller was efficient and robust, but it vibrated excessively. Vibration can cause premature wear of components, damage to mechanical shaft seals, copper windings, loss of power and even pump failure.

Typically, the acceptable vibration levels for pump impellers vary between 3-7 mm/sec. These standards apply to multi-vane impellers and pumps using clean water, however. There are no standards for wastewater single-channel impeller pumps. Therefore, there are often higher vibration levels in wastewater pumps. This is due to the hydrodynamic characteristics of a single channel pump and the varying solids and air content of wastewater together with variations in the incoming flow. Although not ideal, the wastewater treatment industry has largely tolerated higher levels of vibration.

Grundfos set out to change these standards by reducing vibration to levels lower than those of wastewater pumps with multi-vane impellers, says Flemming Lykholt-Ustrup.

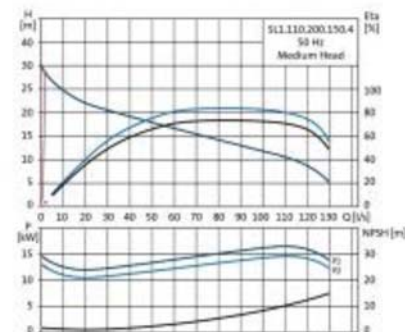
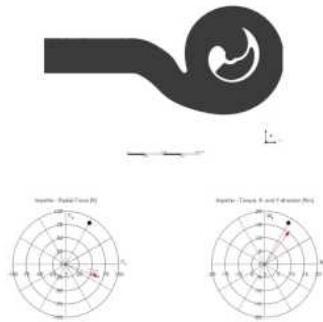


FIGURE 1: S-tube® performance in a Grundfos SL1 15 kW wastewater pump. More than half of the pump's flow range is above 75% hydraulic efficiency. Source: Grundfos



Video: Optimization of hydraulic forces and torque in the Grundfos S-tube® impeller.

Wet balancing brings the answer

One specific type of vibration is imbalance, or the vibration caused by rotating machinery. One of the main tasks of the Grundfos S-tube® is to reduce the vibration level and consequently the noise level to a minimum in order to ensure the longest life for vital components such as bearings and the shaft seal faces.

components and thereby avoid vibration,” says Flemming Lykholt-Ustrup. “But this is not sufficient due to the unsteady pressure forces.”

“The traditional approach to reducing imbalance and running the motor smoothly is to minimize the imbalance in the rotating

Grundfos took another approach to reduce imbalance in pumps: wet balancing.

“Wet balancing is a statically and dynamically balancing method similar to that we use when we balance the tires on our cars,” he explains. “The difference is that for wet balancing, the impeller is in perfect balance when the pump housing and the impeller are submerged in or filled with water. Being in perfect balance under water, we ensure the optimum operating conditions. In some cases we meet vibration levels below those known for standard norm motors.” He adds that the pump industry has previously attempted similar methods of wet balancing without success.

Wet balancing involves introducing a deliberate mechanical unbalance to counteract the unsteady dynamic forces originating from pressure fluctuations within the pump. This approach cannot address the full spectrum of unsteady forces, he says, but does deal with a major source of excitation.

To reduce the basic excitation in the pump, Grundfos combined the unsteady hydraulic forces with the unsteady mechanical forces that come from wet balancing in order to obtain a state of equilibrium, he explains. “We calculate the forces acting on the impeller when it is pumping – the direct force and the torque – and those obviously change, depending on how much flow is going through the pump,” he says. “We cannot make all these forces go to zero. This is something we need to balance out. So we have made our own little cookbook in how to do it – how to put the impeller off balance.”

Tests showed a significant reduction in vibration. By introducing wet balancing in its single-channel S-tube® impellers, Grundfos reduced vibration levels by 50-70%, says Flemming Lykholt-Ustrup.

These results mean sturdier and more reliable pumps for Grundfos, he adds, because the dynamic balancing of the impellers and rotors is essential to prolonging the reliability and functioning of the pump system.

References: API Standard 670; Europump Vibration Standards First Edition July 2013; ANSI/HI 9.6.4. -2009

Find out more at: www.grundfos.us

