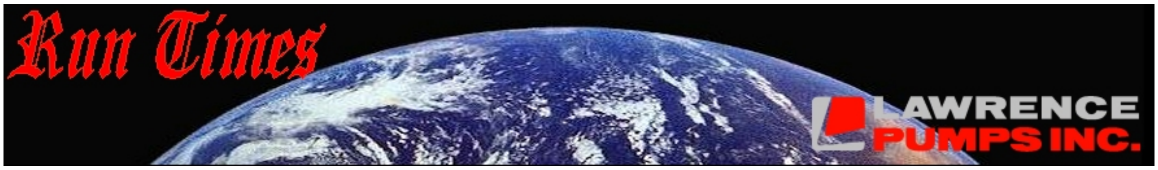

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We'll start off the new year with an old problem that can have many causes. In this issue we'll present some of the most common reasons why centrifugal pumps can exhibit insufficient discharge pressure.

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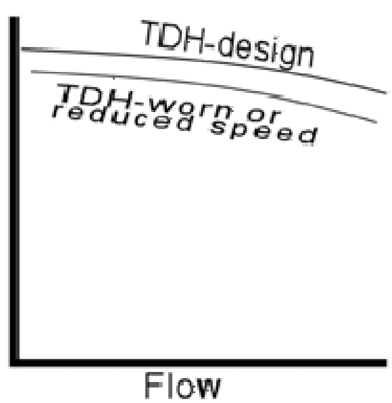
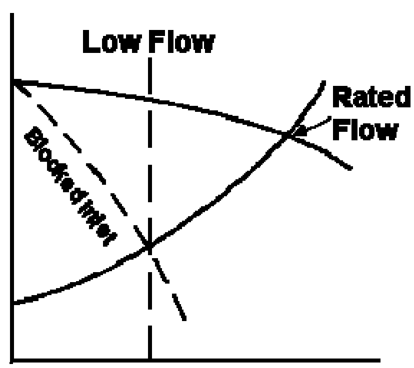
Like many pump problems, troubleshooting discharge pressure issues is best done methodically. Insufficient discharge pressure may be related to either mechanical or hydraulic root causes. Mechanical problems include reverse rotation, low rotative speed, a worn or incorrect diameter impeller, or blockage of flow pathways. Hydraulic possibilities include a reduction in suction pressure, cavitation, gas entrainment, run-out operation, or fluid property changes. Each of these possibilities should be looked at and eliminated where possible; starting with whatever is the easiest and least expensive to check.

Reverse rotation problems almost always follow some maintenance or installation procedure that involved electrical work where the motor phase leads became reversed. Pump discharge pressure will be near 100% at shut-off but will degrade rapidly as the discharge valve is opened. Pump discharge pressure at the best efficiency point is generally reduced to one-half to two-thirds that of the pressure developed with correct rotation.

Reduced rotative speed will also reduce discharge pressure. Discharge pressure will vary as the square of any speed change. For variable speed or belt driven pumps check the rotational speed of the unit. A pump operating at reduced speed will exhibit a characteristic curve that more or less parallels the curve at design operating conditions. Rotative speed can be easily checked with a hand held strobe or a vibration monitor. The predominant vibration frequency is usually the rotative speed. Reduced rotative speed will also be accompanied by a reduction in power that approximates the cube of the ratio of the speed reduction.



Similar to speed reduction, a pump with an **incorrect diameter impeller** will exhibit low discharge pressure at shut-off and at all points along the curve. With a **worn impeller** the loss in discharge pressure is associated with a loss of pump efficiency, therefore the power consumed by the pump will either remain the same, or increase as wear occurs. With wear, operational records will indicate gradual change in performance over some period of time, whereas a change in rotative speed, or incorrect diameter, is generally a sudden occurrence related to a man-made event.



Partially blocked pathways will usually be evidenced by a pump that delivers full discharge pressure at shut-off, with a sharp drop in discharge pressure as flow is increased. The drop in discharge pressure is often accompanied by increased vibration as the flow restriction starts to cause cavitation. If vibration is also present at shut-off the blockage may be in the impeller causing a physical imbalance. It is not uncommon to have construction debris present in piping following outages or in new installations. In vertical pump installations that handle solids, pumps that have been idle for long periods may become silted in, preventing flow into the pump.

Any **reduction in suction pressure** will result in a change in discharge pressure. A centrifugal pump impeller generates a differential head between suction and discharge. Discharge pressure readings will vary directly with changes in suction pressure or with changes in sump liquid levels.

Cavitation will behave similarly to a pump with partially blocked pathways and should always be suspect where the net positive suction head available (NPSHA) is limited. NPSH problems come about due to design errors that are manifested at start up or are due to changes to the physical system or process parameters. NPSHA is easy to estimate[1] and should be compared to the manufacture's NPSHR data if NPSH is suspect.

Gas entrainment is tougher to troubleshoot. Symptoms of gas entrainment are similar to partially blocked passageways and cavitation[2]. Often the best way to establish gas entrainment is to eliminate cavitation or blockage as a possibility.

Run-out operation occurs when a pump is over-sized for a system, or when a downstream restriction to flow has been eliminated. As pump flow increases, pressure decreases. This is usually accompanied by an increase in power consumption for radial flow impellers and a decrease in power consumption for axial flow impellers. Vibration and noise often increase

[1] See our August 2006 newsletter for a guide to determining NPSHA

[2] Our December 2007 newsletter discusses gas entrainment in greater detail

significantly at high flows. Run-out operation may be an instantaneous event such as when an oversized pump is installed, or it may occur gradually as a result of erosive wear to downstream equipment such as nozzles. Run-out operation can be very difficult to verify unless a means of flow measurement is available, as symptoms may closely resemble those for cavitation or gas entrainment. If a flow measurement can be made, taking flow and pressure data at several flow rates will show whether the pump is following its design curve.

A change in process conditions may also affect discharge pressure. Discharge pressure is a direct linear function of fluid density, and a non-linear function of viscosity. A change in either of these parameters will change the discharge pressure characteristics of the pump. Fluid density changes will be evidenced by a pressure change at shut-off and at design that is directly proportional to the change in fluid density. A change in viscosity alone will be evidenced by a change in discharge pressure at design but not at shut-off. Horsepower at shut-off will be affected by viscosity.

One final note: pump curves affected by changes in pump speed, impeller diameter, or fluid density usually run more or less parallel to the original pump curve. Pump curves that are affected by reverse rotation, blocked pathways, cavitation, and viscosity generally have curves that sharply diverge from the pump's water performance curve as flow is increased.