

# Pump Cavitation

Pump cavitation is a common pumping problem which, if not addressed, leads to impeller surfaces and pump bowls pitting and wearing, and eventually leads to mechanical destruction of the pump.

## What causes cavitation?

When the speed of a liquid increases, the pressure of that liquid decreases. When water enters a pump, its speed increases and this causes a reduction in pressure within the pumping unit. However, if the pressure falls too low, some of the water will vaporize and this forms bubbles in the liquid similar to that seen in boiling water. These bubbles collapse violently as they move to areas of higher pressure and this collapse creates the noise and vibration associated with cavitation. The bubbles formed in a cavitating pump are due to one or more of five basic causes:

1. Vaporisation - A fluid vaporizes when its pressure becomes too low, or its temperature too high. As part of their pump specifications, manufacturers supply a required head (pressure) called Net Positive Suction Head (NPSH) at the suction side of the pump. If, during operation, the pump exceeds the NPSH, vaporization is prevented and thus cavitation won't occur from this cause.
2. Internal recirculation - Water recirculates within the pump which increases its speed. This in turn reduces pressure until the water vaporizes and then collapses in the surrounding higher pressure.
3. Flow turbulence – It is preferable to have liquid flowing through the suction pipe at a constant speed. Corrosion or obstructions can change the speed of the water and consequently its pressure. To help reduce cavitation from this cause, good piping layouts include ten diameters length of pipe between the pump suction and the first elbow.
4. The vane passing syndrome - This type of cavitation is caused when the outside of the pump impeller is too close to the pump cutwater (a section of the pump where the speed of the water is increased due to the close spacing of the impeller and pump bowl). The speed of the liquid increases as it flows through the small passage at the cutwater, lowering the fluid pressure and causing local vaporization. The bubbles then collapse at the higher pressure just beyond the cutwater and this leads to cavitation.
5. Air ingestion (not really cavitation, but has similar symptoms) - A centrifugal pump can handle 0.5% air by volume and, while air ingestion doesn't usually cause damage to the pump, it will reduce pumping capacity.

## Diagnosing cavitation

The symptoms of cavitation can be summarised as:

- A reduction in pump capacity. This happens because bubbles take up space and there can't be bubbles and liquid in the same place at the same time. If the bubble gets big enough at the eye of the impeller, the pump will lose its suction and will require priming.
- A reduction in the pressure produced by the pump. Bubbles, unlike liquid, can be compressed, and when the bubbles compress the pressure produced by the pump is reduced.
- The formation of bubbles in a low pressure area of the pump. The bubbles can only form in a lower pressure area because they collapse in the high pressure areas within the pump.
- A noise that can be heard when the pump is running. As the bubble collapses, the water at the edge of the bubble moves faster than the speed of sound and a sonic boom is created, producing the sounds associated with cavitation. Low level cavitation in pumps may be inaudible, but higher levels generate distinctive sounds. Cavitation is variously described as crackling, sizzling, small steel shot rapidly striking against metal, hissing, rushing, swishing, or a static like sound similar to radio or television static. Recirculation cavitation can produce loud knocking, hammering, or crackling sounds that are distinctive from other cavitation types.
- Damage that can be seen on the pump impeller and pump bowl. As it tries to collapse, the vapor bubble attempts to collapse from all sides. However, if the bubble is lying against a piece of metal such as the

impeller or pump bowl, it can't collapse from that side. This means that the fluid comes in from the opposite side of the bubble at a high speed preceded by a shock wave that can cause damage to pump parts.

### **How to avoid cavitation**

Cavitation can be addressed by the following guidelines:

- The NPSH specified by the pump manufacturer should be taken into account when designing pumping systems.
- Minimise the number of valves and bends in the suction line and use long radius bends.
- Use eccentric not concentric reducers, and ensure the straight side of the eccentric reducer is installed along the top of the suction line.
- Suction length should be as short as possible.
- Ensure the size of valves and pipe work is sufficient to prevent suction losses - suction pipe should be at least the same diameter as the pump inlet connection.
- Don't allow air into the suction line and ensure adequate submergence over the foot valve - at least 5.3 times the suction diameter.
- Centrifugal pumps located less than 4 metres above water level should not experience cavitation.

If pump suction conditions cannot be improved, you should seek expert assistance, as your pumping system may need to be redesigned.

Lex McMullin  
Farm Management System Officer  
Mob: 0400 005 236  
Email: [fms03@ngiq.asn.au](mailto:fms03@ngiq.asn.au)