

Pump Cavitation

Improving Energy Efficiency on Irrigated Australian Cotton Farms

The Improving Energy Efficiency on Irrigated Australian Cotton Farms project aims to deliver an industry-wide awareness campaign that provides tailored energy efficiency information and tools to irrigators and their advisors. This activity received funding from the Department of Industry as part of the Energy Efficiency Information Grants Program.

Cavitation in pumps

Pump cavitation is an unwanted problem that occurs when pumps and associated pipelines are poorly designed and configured. Cavitation is extremely costly because it greatly reduces the life of the pump as well as increases the energy (and cost) required to pump water.

The process of cavitation occurs when the vacuum pressure (also called suction pressure) in the water entering a pump falls below the vacuum pressure at which vapour bubbles form. In other words, the suction pressure at the pump intake is so great that vapour bubbles form in the water. These vapour bubbles move through the pump to the high pressure regions against the pump impeller. The vapour bubbles, which were formed under a vacuum pressure, then collapse, or 'implode' against the impeller. Each bubble implosion will actually eat a small hole in the impeller. Further bubble implosions will occur at these holes and continue to physically scour the impeller causing localised damage (figure 1). These are often referred to as 'worm holes'.



Figure 1 : Cavitation damage to an impellor (Wikicommons – User:Benutzer:Klausbärbel)

Pumps that cavitate even slightly suffer a permanent drop in pump efficiency by 5 to 10% - this means 5 to 10% more diesel. Over time this increases to 40% or more.

Cavitation damage has a different appearance to damage caused by pumping sand or gravel, which will make the entire surface of the impeller evenly worn and shiny, as if it has been cleaned by sand paper. Cavitation does sound like sand or gravel is being pumped.

Impact of cavitation on pump efficiency

Pumps that cavitate even slightly during operation suffer an on-going drop in pump efficiency by 5 to 10% - this means 5 to 10% more diesel. Pumps that cavitate slightly for long periods of time suffer enough physical scouring damage to the impeller to permanently reduce the pump efficiency level by 40% or more. Added to this is the regular replacement cost of impellers and the decreased reliability of the pump.

Impact of cavitation on pump curves

When pumps are cavitating they do not perform according to the pump curve. While increasing pump speed will give marginally more water, pump efficiency falls drastically. In everyday terms this means that significantly more energy (and cost) is added for very small gains in water pumped and the cost of pumping per mega litre skyrockets.

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Cavitation and pump station design

Over the last decade a trend has arisen in large pump station designs in the Australian cotton industry where pumps are placed high above the incoming water surface. This configuration leads to pump cavitation in most cases.

Older pump station designs sensibly placed these large mixed flow pumps at or below the incoming water surface level. These older designs have no potential to cavitate because they are placed close to the incoming water surface level.



Figure 2 : Older style pump station installations in the Australian cotton industry (R.J. Smith).

Pumps that are cavitating sometimes have their discharge reduced by closing a valve on the downstream or discharge side of the pump. Only very rarely in modern pumping station designs in the Australian cotton industry are gate valves installed downstream of large mixed flow

For further information on Pump Cavitation or the Improving Energy Efficiency on Irrigated Australian Cotton Farms project please contact the Cotton Research and Development Corporation on 02 6792 4088 or the CottonInfo Team member in your area.

pumps to allow a reduction in the discharge to stop cavitation.

Complete pump station reconfiguration would also stop the possibility of cavitation when pumps are positioned at or below water surface levels during normal pumping operation. Other types of pumps may be more suitable than those commonly used in the Australian cotton industry.

Typically during flood lifting events, pumps are operated at the extreme right hand side of the pump curve at a high discharge capacity. Pumps operating off this far right hand side of their pump curves will be cavitating under all operating conditions.

Conclusion

Pumping under conditions where cavitation is occurring leads to permanent pump impeller damage. Growers using these pump systems need to be aware that pump cavitation imposes a significant cost. This is due to large reductions in pump efficiency, and this means large increases in the cost of pumping water. Cavitation requires the replacement of worn impellers, which is an expensive exercise. Cavitation also reduces pump reliability.

Recently, the National Centre for Engineering in Agriculture (NCEA) has investigated pumps used in the Australian cotton industry. This work suggests that cavitation, which is known to be costly, is the most common problem with pumps in the Australian cotton industry.

A rigorous pump assessment allows for an economic analysis of pump replacement costs against increased operating costs. Pump assessments are essential for those considering alterations to large pumps in modern pumping stations in the Australian cotton industry.