

Pumping Liquids with Entrained Gas

Pump applications may involve handling liquid and gas mixtures either as part of the process or as a result of unwanted application conditions or upsets. Although symptoms may be similar to cavitation, the process of is a little different.

Cavitation is the formation and subsequent collapse of vapour bubbles that are formed when pressure within the pump drops below the vapour pressure of the pumped product. As pressure increases within the pump, the vapour bubbles re-condense (implode) resulting in shock waves that cause damage to pump components.

The pumping of entrained gas is different in that the gas is non condensable. Centrifugal action tends to cause a separation between the liquid and gas due to differences in density. This centrifugal action moves the liquid to the outside and concentrates the gas in the eye of the impeller. This restricts the flow area for the liquid causing significant pressure drop and hence cavitation even though NPSH calculations will indicate that cavitation should not occur.

Some industries introduce air into products as part of the process. An example is the Pulp and Paper industry where air in the range of 4-10% is introduced into pulp slurry as part of the ink removal process in paper recycling plants. Some processes also involve pumping a two-phase flow. Excess agitation in suction vessels or vortex formation due to inadequate submergence or incorrect sump designs may result in introduction of undesirable gas entrainment.

The proper selection of a centrifugal pump for liquid and gas (two-phase) mixtures is highly dependent on the amount of gas and the characteristics of the liquid. The presence of entrained gases will reduce hydraulic performance of centrifugal pumps and can potentially cause loss of prime. Standard centrifugal pumps' pump designs can be used for entrained gases up to 4% by volume.

For gas entrainment values above 4%, specifically modified impellers can be used effectively. Pump performance corrections are required in all cases with gas content from around 2%. Gas concentrations above 10% can be handled, however pumps designed with specific gas handling characteristics are required e.g. vortex impeller pumps, side channel pumps and regenerative turbine pumps.

Most centrifugal pump can handle low concentrations of entrained gas. As detailed earlier, the gas will accumulate in the eye of the impeller restricting flow and head generation. Continued gas accumulation may cause the pump to vapour lock and lose prime. Fig. 1 below shows performance variation as gas concentrations vary form 0% to 10%. At concentrations up to 2%, the impact is relatively insignificant. Impact on performance is still reasonably acceptable up to 4%.

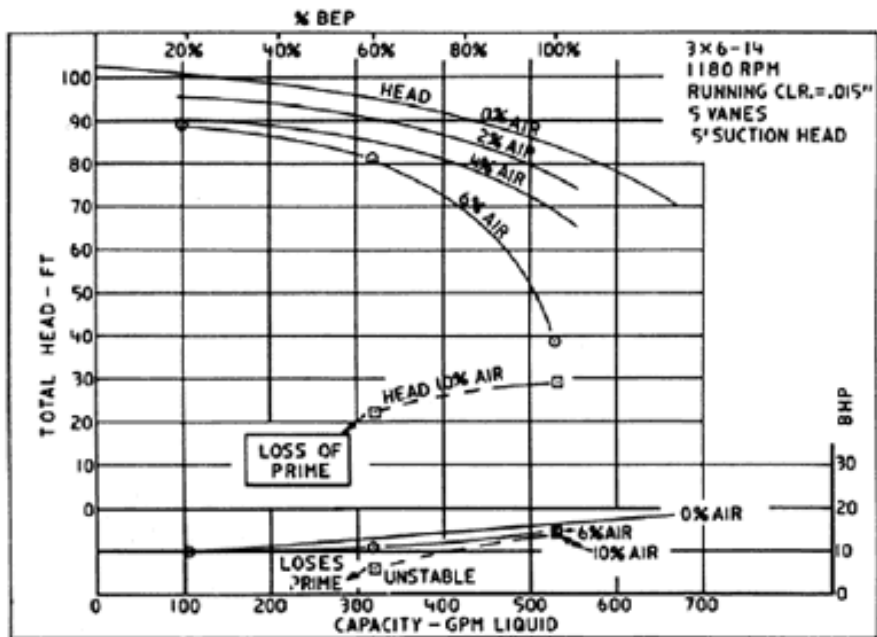


Fig. 1 Head and Power vs Capacity Zero to Ten Percent Air by Volume for Normal Running Clearance

As the percentage of gas increases further, the performance begins to quickly deteriorate (Fig. 1) until the pump becomes unstable and loses prime. Increasing the running clearances between the impeller and pump casing (.004 to .008 mm) allows for additional leakage and this may assist in preventing loss of prime at the higher gas concentrations.

Much testing has been done by various manufacturers, however the many variables impacting on the effect of gas entrainment does not allow for presenting specific selection information.

Manufacturers should be contacted for detailed selections on applications where gas entrainment is an issue.