PUMP CAVITATION

Pump cavitation, why cavitation occurs, and the reasons why a pump cavitates will be revealed.

Before we cover cavitation, we need to understand properties of water. Pressure and temperature affect water just like it would a refrigerant (water is a recognized refrigerant R718, refrigerants are covered in depth later). Water changes to steam at a lower temperature with a reduced pressure. More heat is required to change water to steam at a higher pressure. For example, at sea level (14.7 psia) water boils/changes state at 212˚F, but in Denver Co (5280 ft. above sea level), water boils/changes states at 202˚F. The reason is the lower pressure of 12 psia at 5280', versus the pressure of 14.7 psia at sea level (*Figure 1*). When you drop in pressure, it requires a lower temperature to boil and change state of water. This is important to know when talking about pump cavitation.

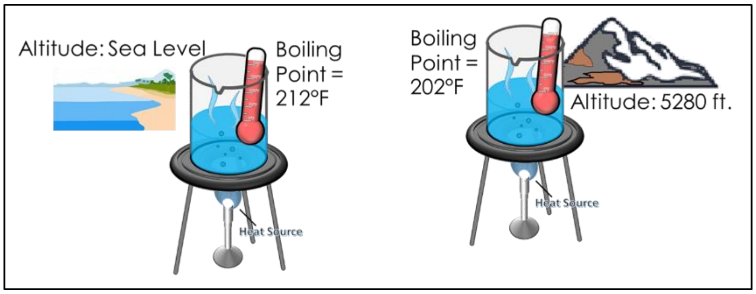

Figure 1

Then next thing to think about is the pump construction. In a typical hydronic pump, you have the pump impeller and impeller housing (*Figure 2*). The pump impeller is typically made of an alloy metal, which has little elasticity. The pump impeller sits in a housing. This housing serves a couple functions, it separates the suction side of the pump from the discharge side of the pump. It also directs the water out of the impeller into which is usually a pipe. This housing is characteristically made of cast iron so again there is no elasticity in this material. Most pump motors are usually at 1750 RPM (revolutions per minute) to 3500 RPM. Most pump impellers are directly driven or connected directly to the motor shaft.

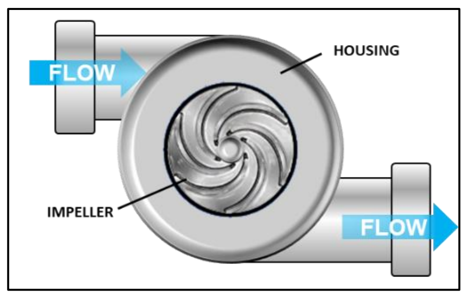

Figure 2

In simple terms, pump cavitation is when water turns to vapor around the pump impeller. How can water turn to vapor or steam at 50˚F? In a hydronic system where the fluid is being moved by a pump the lowest pressure in the system is directly at the inlet of the impeller or what is known as the eye of the impeller. If water is restricted somehow coming into the impeller or out of the impeller of the pump, then it just sits on the impeller and spins at a low pressure. With friction between the water, pump impeller and pump impeller housing this creates heat which causes the water to get warm or to boil and change states. (*Figure 3*) This will cause one of two things to happen or both. When water starts to get

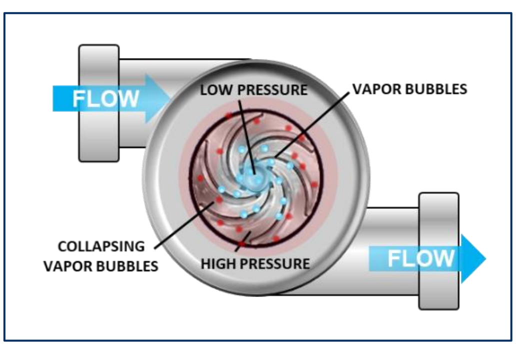

Figure 3

warm it expands with nowhere to go and cause damage (remember the construction of the pump). Some may think this would take a while to achieve. It doesn't, remember the speed of the impeller (RPM). This will only take a few seconds. The next thing that can happen is when the water gets warmed up and due to the friction, the water will boil and change state, also known as steam. When steam is created and then suddenly cooled it creates a vacuum, that vacuum will suck water in at an extreme speed causing a major "hammer" effect on the pump impeller and housing (google steam explosion NYC). Again, with the construction of the pump, and no elasticity in components, this will cause damage to the components.

So, what to look for and avoid with pump cavitation. Thinking back to the pump curve. (*Figure 4*) Anytime you are extreme right or extreme left on the curve you have the potential for cavitation. Anything on the suction of the pump or the discharge of the pump can and will cause a pump to cavitate. Maybe the pump is oversized or under sized for the application. Look for discharge or suction valves that are not functioning properly or maybe they are closed. Dirty strainers, strainers are typically on the suction side of the pump however they will be found on the discharge of the pump as well, especially on a water-cooled chillers condenser loop. Poor piping/system design, maybe the pipes are undersized. On an open loop, maybe the water level is dropping causing the pump to suck air. Suction pressure is too low, make sure the expansion tank is functioning properly, make sure there is proper system pressure and the expansion tank is set up for that proper system pressure. Most bladder type expansion tanks are set with 12 psig on them. Very rarely is the pressure set for proper net suction pressure of the pumps or the system.

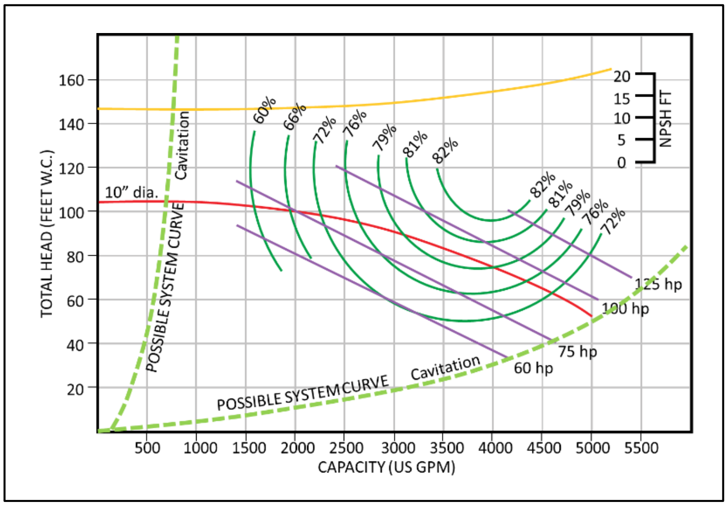

Figure 4

Pump cavitation will destroy a pump and destroy them fast. You can hear when a pump cavitates or starts to cavitate as the sound pitch of the pump will change dramatically. It will sound like the pump is chewing on gravel. If you know the system has 50˚F suction water and you feel the pump impeller housing and it is warm that pump is or has been cavitating. Try to avoid pump cavitation at all costs.

Good luck!!

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