The Magazine For Pump Users Worldwide

Reprinted from July 2006

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...TEMPERATURE RISING IN LIQUID RING VACUUM PUMPS

PACKAGED PUMPING SYSTEMS SHOWCASE

Temperature Rising

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Reduction of flow in liquid ring vacuum pumps when water temperature increases.

The liquid ring vacuum pump (LRVP) is the best solution for vacuum applications where wet, or extremely humid, and slightly contaminated gases are ingested. For several of these applications, water is the best media that can be used for the liquid ring.

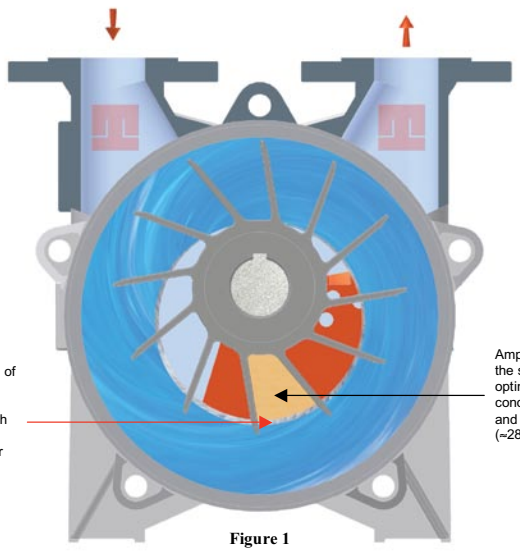

Figure 1

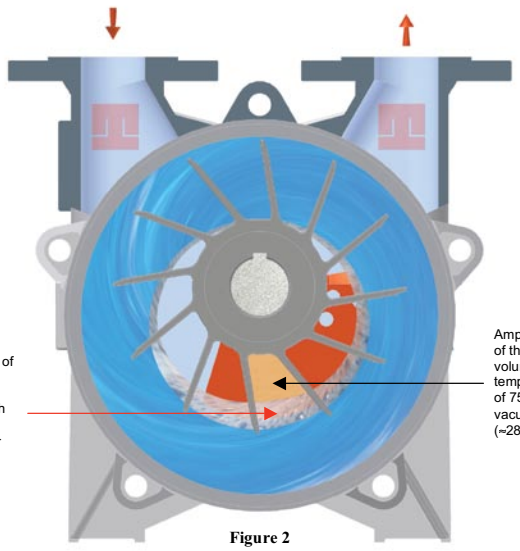

Figure 2

The liquid ring pump, while running, absorbs the heat of compression and leaves the ingested gas inlet temperature unchanged (isothermal compression). In other vacuum pump technologies, the heat generated by compression is transferred to the ingested gas which exits the pump at a higher temperature.

Even at an ambient temperature of 59-deg F, the water tends to vaporize because it contains heat energy. This is called *vapor pressure* and increases with the temperature. The normal atmospheric pressure acting on the fluid can be seen as a counterforce reducing the ability of water to become vapor.

On a high mountain, water boils at a lower temperature since the atmospheric pressure is less than at sea level, therefore water has less resistance to become vapor. Water at sea level, where standard atmospheric pressure is 14.7-psi (0-in HgV), starts to boil when its vapor pressure reaches a temperature around 212-deg F.

In Aspen, CO, where elevation is about 11,000-ft, the atmospheric pressure is 9.8-psi (9.9-in HgV), causing the water to boil when its vapor tension is equal or slightly higher then the pressure requirements at these altitudes. The water will boil at an approximate temperature of 192-deg F (20-deg F less than at sea level).

This is necessary to understand because when water is used as a sealing liquid (i.e. as the liquid ring) inside a LRVP, a capacity reduction will occur since the pump's available volume is partially occupied from the vapor generated from the water sealing fluid. This flow reduction is then directly related to the sealing fluid water temperature and pump vacuum level. To achieve a better vacuum you must have colder water.

To better understand this concept, consider Diagram 1 for a single stage and Diagram 2 for a double stage LRVP.

It is possible to calculate the change of flow knowing the sealing water temperature and the maximum operating vacuum. The diagrams showing a multiplier, when used with the flow value from the standard pump curve, will give the approximate expected flow at the designed liquid ring temperature.

Consider the following example: The flow of 60 ACFM at an absolute pressure of 45 Torr (28.14-in HgV) with the sealing water temperature of 75-deg F for a double stage pump (Diagram 2), indicates a multiplier of 0.8 and therefore a 20 percent flow reduction, hence the real flow of the pump is 48 ACFM.

With a single stage pump (Diagram 1), the flow reduction is 30 percent (multiplier 0.7), hence the real flow of the pump is 42 ACFM, which is about 12 percent less than the double stage.

This example shows how important it is to determine the most economical LRVP solution. First, verify whether to use a double stage LRVP or a single stage pump. The double stage LRVP is more expensive than the single stage LRVP, but has better capacity at a deeper range of vacuum, and it is less affected by the sealing fluid temperature. The single stage LRVP has a wider range of vacuum levels that are used in applications where the vacuum is constantly changing during operation.

From the diagrams, the maximum level of vacuum can be determined at various water temperatures. The higher the water temperature, the sooner cavitation can occur in the vacuum pump. Extreme cavitation can reduce the life of the pump.

Also, examine the better performance of the double stage versus the single stage LRVP when the water temperature rises. The same concept applies on all service fluids depending on their own vapor pressure characteristics.

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Diagram 1: SINGLE STAGE PUMP

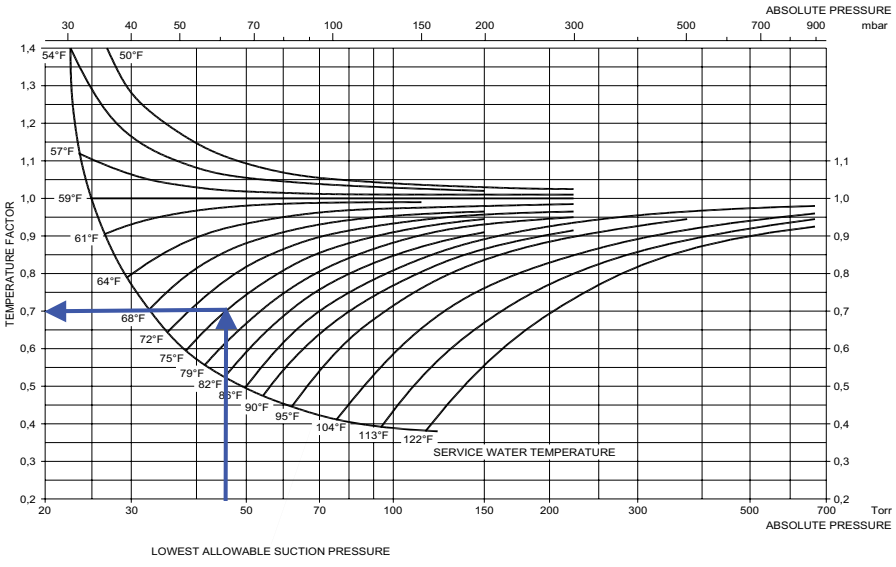
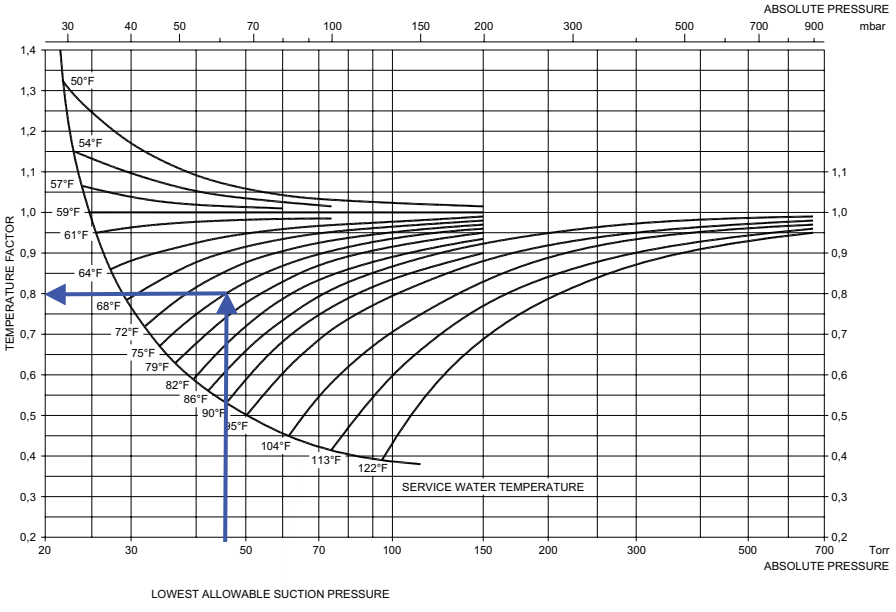


Diagram 2: DOUBLE STAGE PUMP



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