60 SECONDS WITH SUMMIT™ PUMP, Inc — VOLUME 2-5

VAPOR PRESSURE IS NOT YOUR FRIEND

BY: JIM ELSEY

Be very careful on self-primer lift applications because the liquid temperature directly affects its vapor pressure and that...

…changes the Net Positive Suction Head Available (NPSH$_A$).

$$NPSH_A = Absolute\ Head - Lift\ Head - Vapor\ Head - Friction\ Head$$

Example: Self-Primer - two temperatures… two outcomes:

For the example we will use two versions of the otherwise same application. The applications are identical in both versions except the temperature of the fluid is higher in the second version. The higher temperature signifies the vapor pressure has increased.

Example Constants

SUCTION LIFT: 10 FT

FRICTION LOSS: 3 FT
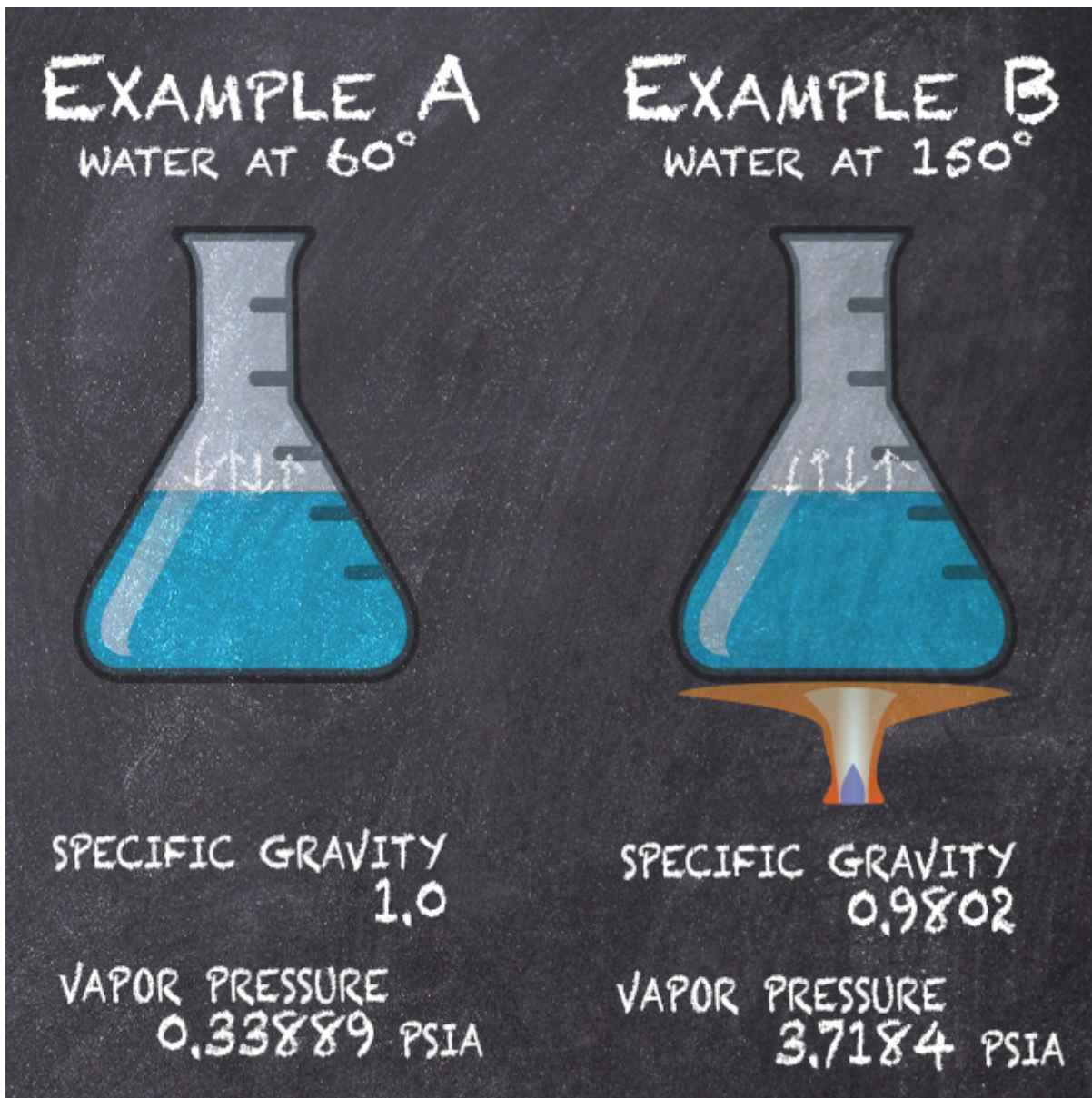
SITE ELEVATION: SEA LEVEL

ABSOLUTE PRESSURE: 34 FT

Note: 14.7 PSI absolute atmospheric pressure x 2.31 divided by the Specific Gravity of 1 = 33.96 feet ≈ 34). Any increase in elevation will reduce your absolute pressure (head) and consequently the $NPSH_A$.

In Example A the fluid is water at 68°F.
In Example B the fluid is water at 150°F.

As you look up the vapor pressure of water for each temperature note it is normally expressed in PSIA (pounds per square inch absolute) and so you need to convert that value to feet (head) then you will have the component value in the proper units needed to do the NPSHA calculation. Remember that to convert PSI (or PSIA) to head, you must multiply by 2.31 and divide by the specific gravity.

EXAMPLE A
WATER AT 60°

SPECIFIC GRAVITY
1.0

VAPOR PRESSURE
0.33889 PSIA

EXAMPLE B
WATER AT 150°

SPECIFIC GRAVITY
0.9802

VAPOR PRESSURE
3.7184 PSIA

You can find these vapor pressure and specific gravity values in several places;
I use the Cameron Hydraulic Data Book or Cranes Technical Publication 410
(There are also several reputable web based sources).

Once you have the conversions then fill in the values for the formula and do the simple math steps (0.33889 X 2.31 = 0.783 ft. and 0.783 divided by 1 is 0.783). Then fill in the values in the $NPSH_A$ formula and complete the steps for the answer. Repeat these steps using the different values for Example B.

Example A (68°F): NPSHA = 34 - 10 - 0.78 - 3 = 20.2 feet

Example B (150°F): NPSHA = 34 - 10 - 8.76 - 3 = 12.24 feet

Note: The _difference_ between the two versions for the value of $NPSH_A$ = 7.98

feet which is approximately 8 feet.

Summary: With all the parameters except temperature (vapor pressure) the same and simply **changing the temperature of the fluid from 68 to 150 degrees we reduced the NPSH$_A$ by 8 feet.** This may not seem like a big deal until you realize that the pump requires 13 feet of NPSH$_R$ at the condition point and now 12.24 feet is all that is available. The pump will not operate correctly and will be in a constant state of cavitation.

Corollary: Most pump manufacturers do not recommend using self–primer pumps on lift applications above 145°F for this reason. The solution for fluid temperatures above 145ºF will likely involve a vertical sump pump or a submersible pump.
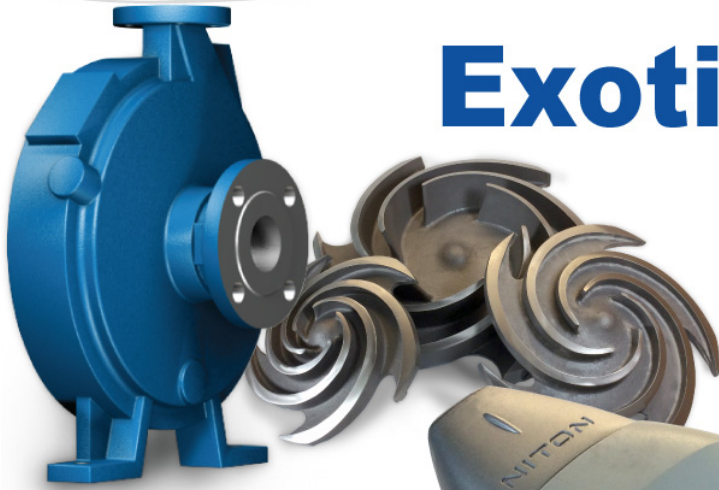
Jim Elsey

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