CALCULATE NPSH FOR A SUCTION LIFT APPLICATION

In this issue of **flow** we return to the topic of Net Positive Suction Head and specifically calculating it accurately in a high suction lift application. *Pav Vatani*, Regional Sales Manager for UK & Ireland at Varisco, gave us his explanation of the steps involved in the calculation.

flow: What are the considerations when calculating Net Positive Suction Head (NPSH) in a high suction lift application?

Pav Vatani: One of the first fascinating facts I ever learnt about pump related physics is that the term 'suction' is rather misleading. When I discovered that a pump must create an area of low pressure at the inlet to allow the atmospheric pressure to 'push' the liquid to the pump, it changed everything I thought I understood about physics.

This explains why it is so important to ensure that there is enough NPSH available in the pump system to push a liquid to the inlet of the pump, without dropping below the required NPSH of the pump. If the NPSHa (available) drops below the NPSHr (required) value of the pump, then cavitation will occur.

Most engineers are aware of the risks of cavitation due to high flow, or high-pressure conditions, which is why we always try to make a pump selection at the BEP (Best Efficiency Point) on a pump's curve. And, one would be forgiven for overlooking the fact that cavitation can be induced due to insufficient NPSHa. However, in my opinion, although a selection can be made mid-curve, the NPSHr can easily exceed the NPSHa in a high suction lift application.

For instance, if a suction lift of 6m is required at a given flow rate, it would be conceivable that although relatively mid-point in the pump's performance curve, the NPSHr of the pump could be 5m. Even before you consider vapour pressure, density and friction losses, you would already exceed the available atmospheric pressure of 10.33m. The pump would still produce a flow rate and head, but would sound very noisy and would likely experience a drop in performance. If allowed to run for an extended period in such a condition, it would likely suffer premature wear and potential failure, the most common of course being a leaking mechanical seal.

flow: How do you ensure you are making the right calculation?

PV: In order to understand how we accurately calculate the NPSHa of a pump system it is important to understand the formula.

For a systems' NPSHa, expressed in metres, the formula is:

$$\frac{(\text{Atmospheric Pressure} - \text{Vapour Pressure})}{(\text{Density x Gravity})} - \text{Suction Lift} - \text{Friction Loss} = \text{NPSHa}$$

First, we need to take the atmospheric pressure in Pascals minus the vapour pressure of the liquid, also in Pascals. This figure is then divided by the density of the liquid in Kg/m^3 multiplied by the acceleration of gravity ($9.81m/s^2$). From the resulting figure we minus the suction lift height in metres, and then minus the suction friction losses, which is also expressed in metres

Using the following sample application data, let us work through the formula.

Liquid	Dirty Rain Water
Viscosity	1cP
Density	1000 kg/m^3
pH	Assumed neutral
Liquid Temp.	Ambient
Solids	10mm
Flow Rate	$20m^3/hr$
Suction Lift	4m
Suction Friction Losses	1m
Discharge Static Head	6m
Discharge Friction Losses	4m
Total Dynamic Head	15m
Electrical Supply	3-Phase
Atex	Safe Area

((101,325 – 2,337) / (1000 x 9.81)) – 4m – 1m
(98,988 / 9,810) – 4m – 1m
10.09m – 4m – 1m = **5m NPSHa**

Using a Varisco J2-120 pump in this example, figure 1 shows that, to prevent cavitation, it requires 3m NPSH at the given duty point. This is a function of the pump.

Above we calculated that there would be 5m NPSHa in the proposed pump system. So, the proposed duty point would be a good selection for this size of pump on this application.

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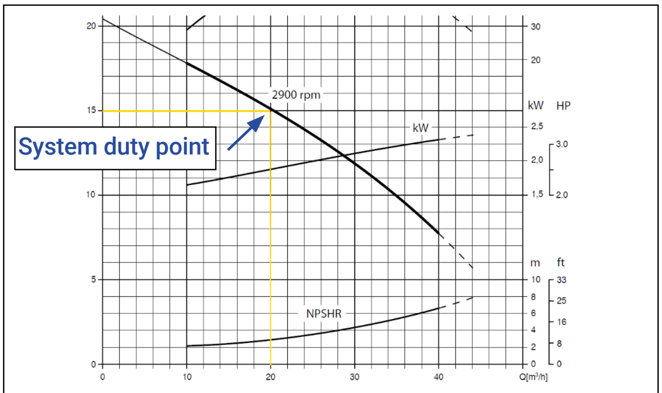

Figure 1: J2-J120 performance curve

NOTE: Always allow 0.5m margin between NPSHa and NPSHr.
1 Atm = 1.01 Bar = 101,325 Pascals = 101Kpa = 10.33m Column of Water at sea level.
Vapour Pressure of Water is 2337 Pascals at 20°C at sea level.
Density of Water is $1000kg/m^3$ (This is also the reference point when referring to relative density)
It will be necessary to calculate the friction losses in the suction pipework prior to using this formula.