SUCTION LIMITATIONS

(ANY PUMP)

The importance of keeping within the suction limitations of any pump (centrifugal, rotary, piston) cannot be emphasized too greatly. A pump, by creating a vacuum at the suction (impeller eye on a centrifugal) utilizes atmospheric pressure (14.7# at sea level) to push the liquid into the pump. Because of this, the suction lift is limited theoretically to 33.9 ft. of water maximum (14.7# $\times$ 2.31 $\div$ SG (1.0) = 33.9′ water). Internal pump losses reduce this limitation even more. The dynamic suction lift should be calculated carefully at the required capacity to make sure that it is within the pump's capabilities. Even systems taking suction from a source above the pump can cause trouble when friction losses are too great. *Always keep the pump as close to the liquid source as possible.* Many pump performance curves will show the maximum practical dynamic suction lifts for a given pump or for given capacities from that same pump. Since the limitation is based on internal pump losses also, it can be seen that in any given pump the recommended suction lift is reduced as flow increases.

VAPOR PRESSURE

Another factor that can limit the suction lift is the vapor pressure of the liquid being handled. Vapor pressure denotes the lowest absolute pressure witnessed with a given liquid at a given temperature. If the pressure in a pump system is not equal to or greater than the vapor pressure of the liquid, the liquid will flash into a gas. It is for this same reason that we must have pressure available on the suction side of a pump when handling hot water or volatile liquids such as gasoline. Without sufficient pressure, the liquid will flash into a gas and become, of course, unpumpable.

Many process applications use pressurized vessels on the suction side to overcome vapor pressure of some liquids. The amount of pressure needed depends on the liquid and liquid temperature. The higher the temperature, the higher the vapor pressure. On applications involving an above ground or underground vented tank or a sump, care must be taken when handling volatile liquids to keep within the atmospheric pressure limitations.

Consider, for example a ball of liquid that has a VP of 6# absolute. This means that at least 6# pressure is needed to maintain the liquid state. Since atmospheric pressure is only 14.7# pressure (sea level) we have only 8.7# left to cover suction static lift and friction besides internal pump losses.

NOTE: *Water boils at 212° F. at sea level because its vapor pressure is 14.7# at that temperature. Since atmospheric pressure does not exceed 14.7#, there is no extra pressure to maintain a liquid state.*

NOTE: *V.P. is measured in pounds absolute. Absolute pressure is pressure above a perfect vacuum.*

NET POSITIVE SUCTION HEAD

(NPSH)

NPSH combines all of the factors limiting the suction side of a pump: internal pump losses, static suction lift, friction losses, vapor pressure and atmospheric conditions. It is important to differentiate between *Required NPSH* and *Available NPSH.*

Required NPSH — this refers to internal pump losses and is determined by laboratory test. It varies with each pump and with each pump capacity and speed change. The greater the capacity, the greater the required NPSH. *Required NPSH must always be given by the manufacturer.*

Available NPSH — this is a characteristic of the suction system. It can be calculated, or on an existing installation, it can be determined by field vacuum gauge readings. By definition, it is the net positive suction head above the vapor pressure available at the suction flange of the pump to maintain a liquid state. Since there are also internal pump losses (required NPSH) the available NPSH in a system must exceed the pump required NPSH — otherwise, reduction in capacity, loss of efficiency, noise, vibration and cavitation will result.

AVAILABLE NPSH IN A SYSTEM

Available NPSH = Positive factors (less) negative factors

Positive Factors		Negative Factors
Static Suction Head (if any)		Vapor Pressure—PSIA
Atmospheric Pressure (if open or vented tank or sump)		*All Friction Losses (including velocity head) Total Dynamic Suction Lift
Positive Pressure (if closed pressurized tank)		*Static Suction Lift (if any)
This side	(less)	This Side = Balance or Available NPSH

Note: Always convert all terms to feet taking into consideration the Sp. Gr. of the liquid being handled.

An ideal suction condition pumping from a vented tank would be:

← ATMOSPHERIC PRESSURE →			
Total Dynamic Suction Lift	**Vapor Pressure**	**Required NPSH**	**Safety Factor**

NPSH FORMULAS

PROPOSED INSTALLATION – EXISTING INSTALLATION

To determine the N.P.S.H. available in a proposed application, the following formula is recommended:

$$Hsv = Hp \pm Hz - Hf - Hvp$$

Hsv = Available N.P.S.H. expressed in feet of fluid.

Hp = Absolute pressure on the surface of the liquid where the pump takes suction, expressed in "feet". This could be atmospheric pressure or vessel pressure (pressurized tank).

Hz = Static elevation of the liquid above or below the centerline of the impeller, expressed in feet.

Hf = Friction and velocity head loss in the piping, also expressed in feet.

Hvp = Absolute vapor pressure of the fluid at the pumping temperature, expressed in feet of fluid.

To determine the N.P.S.H. available in an *existing installation*, the preceding formula can be used or the following can be employed in which case it is not necessary to figure elevations and friction losses because the suction gauge reading accounts for these factors.

$$Hsv = Pa \pm Ps - \frac{Vs2}{2g} - Hvp$$

Hsv = N.P.S.H. expressed in feet of fluid.

Pa = Atmospheric pressure for the elevation of the installation, expressed in feet.

Ps = Gauge pressure or vacuum at the suction flange of the pump corrected to the pump centerline and expressed in feet. (+ if pressure or— if vacuum).

$\frac{Vs2}{2g}$ = Velocity head at the point of measurement of Ps.

Hvp = Absolute vapor pressure, expressed in feet.