1. DEFINITIONS

Net Positive Suction Head (NPSH) The pressure exerted on the liquid at the pump suction minus the liquid vapor pressure. The NPSH is the result of the following arithmetic:

- The pressure above the source liquid level
- plus the elevation of the liquid level above the pump's suction inlet nozzle
- minus the elevation of the pump's suction inlet nozzle
- minus the fluid's friction loss in the suction line
- minus the vapor pressure of the liquid fluid.

All the previous values should be consistent in absolute pressure units.

Bubble Point Liquid A liquid at its boiling point (B.P.).

Sub-cooled Liquid A liquid at a temperature less than its boiling point.

Vapor Pressure (V.P.) The pressure exerted by a liquid's molecules at the surface. It is a function of the liquid's temperature. When the V.P. equals the environmental pressure, the liquid is at its boiling point.

Specific Gravity The specific gravity of a liquid is the ratio of its weight density at a specified temperature to that of water at the standard temperature of 60 ^{o}F (62.371 lb/ft^{3}).

2. CONVERSIONS

Pressure, Feet of liquid = (psi) (144 sq. in./sq. ft.) (cu. Ft./62.371 lb) (1/Specific Gravity)
= **(psi) (2.308/ Specific Gravity)**

Flowrate, US gpm = (lb/hr) (hr/60 min) (gal/8.3378 lb)(1/Specific Gravity)
= (lb/hr) / (500.268 * Specific Gravity)
= **(lb/hr) / (500 * Specific Gravity)**

3. CALCULATING THE NPSH

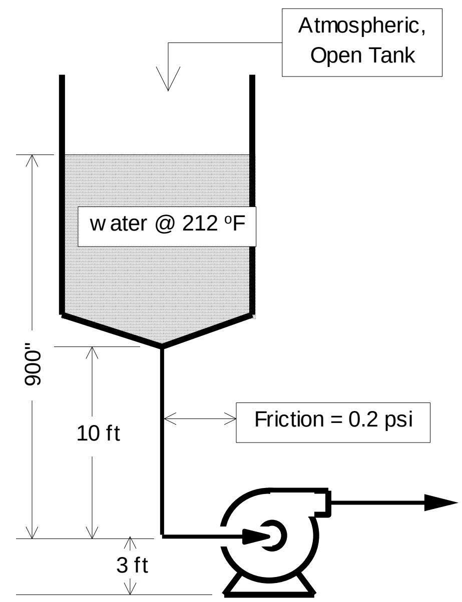
a) Do **not** take credit for liquid levels in tanks, vessels, etc. Pump must be able to work even when the level in the source vessel approaches zero height;
b) Use specific gravities obtained at the pumping temperature. (The specific gravity is a function of temperature);
c) Most pump suctions are 2 - 3 feet above grade if the pump base is at grade;
d) Suction lines are usually sized for 0.1 - 0.2 psi/100 ft. In calculating the NPSH, one can ***usually*** assume 0.2 psi for a suction line pressure drop; and,
e) **Very few** pumps require more than 12 - 15 ft of available NPSH ($NPSH_a$); rarely is more than 20 feet needed. (Exceptions are: multi-stage boiler feed water pumps pumping boiling water over a pressure drop of 200 - 600 psi)

EXAMPLE 1:

A boiling liquid (or "Bubble Point" liquid) pumped out of an open tank:

Pressure existing @ the pump suction is

Pressure above liquid	=	14.7 psia	=	34 ft
Tank bottom elevation	=		=	+10 ft
Pump suction elevation	=		=	- 3 ft
Suction friction loss	=	0.2 psia	=	-0.5 ft
Press. @ pump suction	=		=	40.5 ft
Fluid Vapor Pressure	=	14.7 psia	=	-34 ft
Available NPSH	=		=	**6.5 ft**



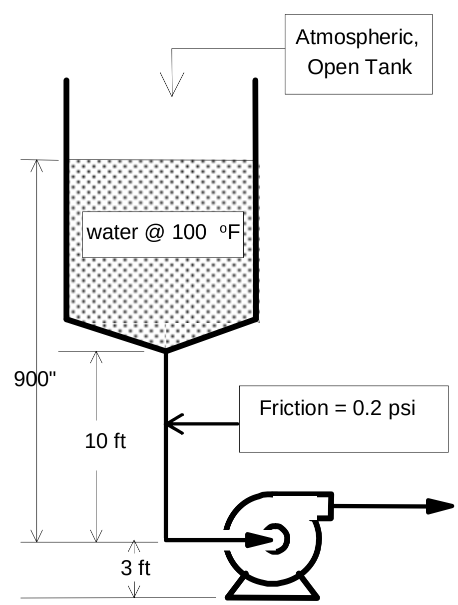
If the pump size or the liquid flow rate requires more available NPSHa, the source tank should be raised until the total NPSHa is in excess of the minimum required.

EXAMPLE 2:

A non-boiling liquid (or "subcooled liquid") pumped out of an open tank:

Pressure existing @ the pump suction is

Pressure above liquid	=	14.7 psia	=	34 ft
Tank bottom elevation	=		=	+10 ft
Pump suction elevation	=		=	- 3 ft
Suction friction loss	=	0.2 psia	=	-0.5 ft
Press. @ pump suction	=		=	40.5 ft
Fluid Vapor Pressure	=	1.0 psia	=	-2.3 ft
Available NPSH	=		=	**38.2 ft**



Specify the NPSHa as **20 ft**

NOTE: Very few pumps need more than 20 ft of NPSHa.

The source tank can be lowered, if desired.
A cooler can be installed on the pump's suction line to lower the suction temperature and, subsequently, the suction Vapor Pressure.

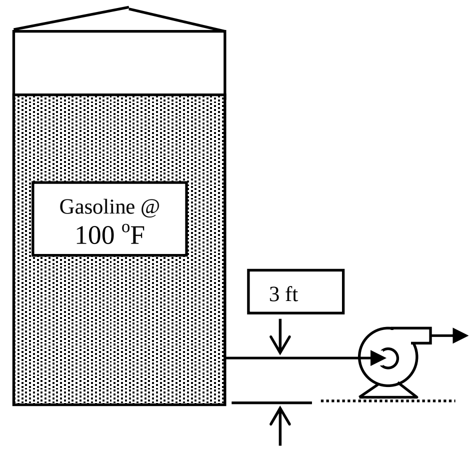
EXAMPLE 3:

A non-boiling liquid (or "subcooled liquid") pumped out of a vented tank:

The vapor pressure of gasoline @ 100 ^oF = 7.0 psia
The Specific Gravity of gasoline @ 100 ^oF = 0.7

Pressure existing @ the pump suction is

Pressure above liquid	=	14.7 psia	=	49 ft
Tank bottom elevation	=		=	+3 ft
Pump suction elevation	=		=	- 3 ft
Suction friction loss	=	0.2 psia	=	-0.7 ft
Press. @ pump suction	=		=	48.3 ft
Fluid Vapor Pressure	=	7.0 psia	=	-23.0 ft
Available NPSH	=		=	**25.3 ft**

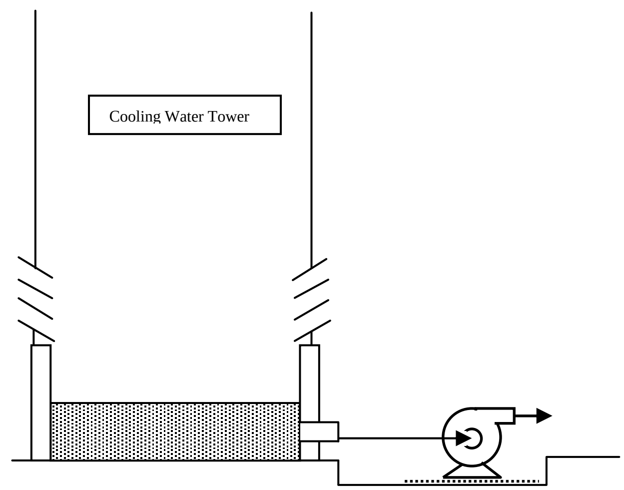


Specify the NPSHa as **20 ft** and state "Flooded Suction".

EXAMPLE 4:

Sub-cooled liquid in a pit or a sump Pressure existing @ the pump suction is

Pressure above liquid	=	14.7 psia	=	34 ft
Tank bottom elevation	=		=	+0 ft
Pump suction elevation	=		=	- 0 ft
Suction friction loss	=	0.2 psia	=	-0.5 ft
Press. @ pump suction	=		=	33.5 ft
Fluid Vapor Pressure	=	1.0 psia	=	-2.3 ft
Available NPSH	=		=	**31.2 ft**



Specify the NPSHa as **20 ft** and state "Flooded Suction".

Design for one of the following conditions:

1. $NPSH_A > NPSH_R$ + 5 feet of head

2. $NPSH_A > (NPSH_R)(1.35)$

…. whichever of the two yields the larger answer.