PUMP HYDRAULIC CALCULATIONS
API-14E,GPSA and PEM

Ahmed Gamal
Jr. Process Engineer

ahmedgamalmetwaly3@gmail.com

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Net positive suction head available (NPSHa)

NPSHa definition

- It is the suction head present at the pump suction over and above the vapor pressure of the liquid.
- It is a function of the suction system and is **independent of the type of pump in the system.**
- It is calculated by the engineer or pump user, and supplied to the pump manufacturer as part of the pump specification.

NPSHa general formula

- **$NPSHa = P \pm H - H_f - H_{vp} - H_a$**

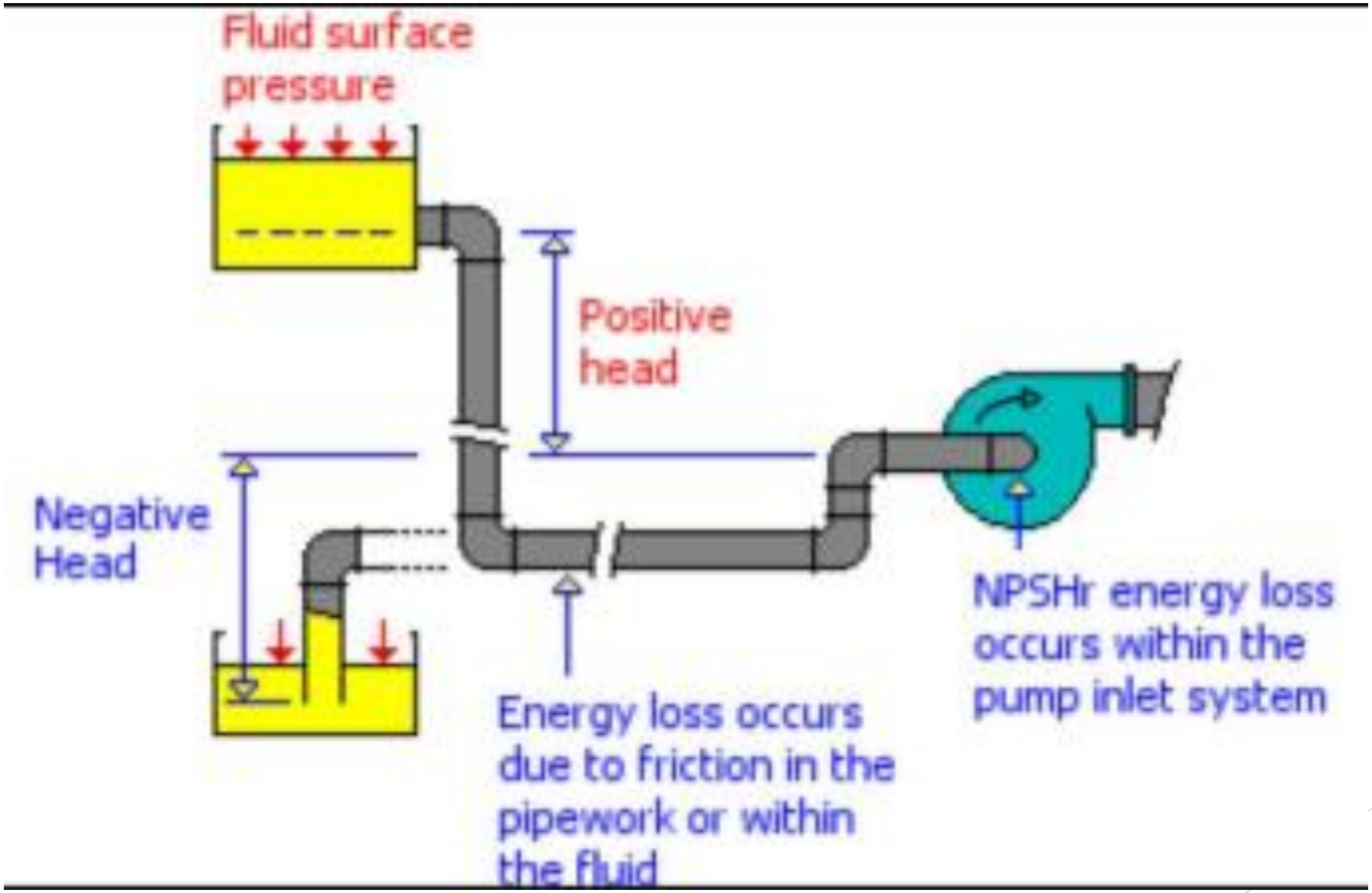
- **Where :-**

- **P :-** absolute pressure on the surface of the liquid in the suction vessel, expressed in meter of liquid.

- **H_f** = friction loss in the suction line, including all piping, valves, fittings, filters, etc., expressed in meter of liquid; this term varies with flow, so NPSHa must be calculated based on a particular flow rate.

NPSHa general formula cont..

- **H** = static distance from the surface of the liquid in the supply vessel to the centerline of the pump impeller, in meter; the term is positive if the pump has a static suction head, and negative if the pump has a static suction lift. For the purpose of NPSHa calculations, both the static suction head and the static suction lift should be considered at the “minimum operating liquid level” of the suction vessel.
- H_{vp} = vapor pressure of the liquid at the pumping temperature, expressed in meter of liquid.
- H_a = Acceleration head Acceleration head needs to be considered only for reciprocating pumps. For centrifugal pumps and rotary pumps the acceleration head is zero.


Fluid surface pressure
Positive head
Negative Head
NPSHr energy loss occurs within the pump inlet system
Energy loss occurs due to friction in the pipework or within the fluid

Suction Head

- It is also called suction pressure.
- Its formula as follow
- **H_s = NPSHa + Hvp = P ± H - Hf - Ha**
- Hs = Suction Head in meter at the pump suction.

Discharge Head

- This is the pressure measured at the discharge connection of the pump.

- **Hdis = Pdest + Hf (dis) ± H(dis)**
- Hdis = Discharge pressure expressed in meter of liquid
- Pdest = Destination pressure of destination vessel expressed in meter of liquid
- H(dis) = Static distance from pump discharge nozzle to the inlet connection at the destination vessel, expressed in meter of liquid; the term is positive if the inlet connection to the destination vessel is at a height above the pump discharge nozzle and negative if the inlet connection to the destination vessel is at a height below the pump discharge nozzle.

Differential head

- It is the difference between the discharge head and the suction head. Expressed as an equation it is: **Pd = Hdis – Hs**

- Pd = differential head expressed in (meter of liquid).

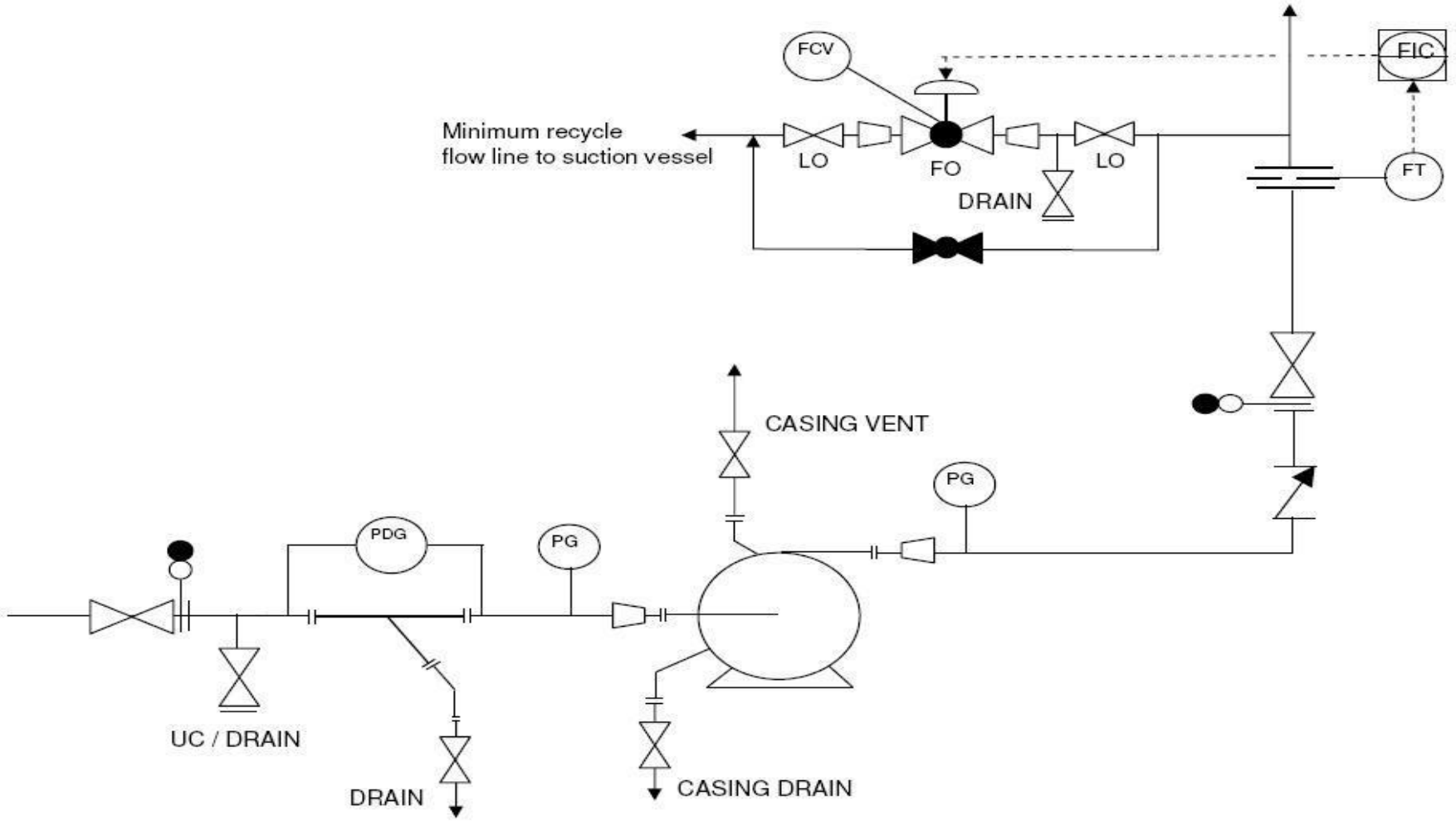
Conversion between head (m) to pressure (bar)

- Head in Meters to Pressure in Bar
  - P = h x S.G. / 10.2
- Pressure in Bar to Head in Meters
  - h = P x 10.2 / SG
- Where
- SG = specific gravity of liquid = (density of liquid in kg/m3)/ (1000)

Aspen plus

- If you have the eagerness to master pumps simulation in aspen plus, please watch the below video
- Link : https://eiepd.com/pressure-change-in-aspen-plus/

P&ID sample


FCV
FIC
Minimum recycle
flow line to suction vessel
LO
FO
LO
DRAIN
FT
CASING VENT
PG
PDG
PG
UC / DRAIN
DRAIN
CASING DRAIN

API-14E Recommendations

API-14E Recommendations-velocities

TYPICAL FLOW VELOCITIES

	Suction Velocity (feet per second)	Discharge Velocity (feet per second)
Reciprocating Pumps		
Speeds up to 250 RPM	2	6
Speeds 251–330 RPM	1½	4½
Speeds above 330 RPM	1	3
Centrifugal Pumps	2–3	6–9

API-14E Recommendations-suction piping

- Suction piping should be one or two pipe sizes larger than the pump inlet connection.
- Suction lines should be short with a minimum number of elbows and fittings
- Eccentric reducers should be used near the pump, with the flat side u % keep the top of the line level. This eYirninates the possibility of gas pockets being formed in the suction i in. If poten- tial for accumulation orcfebris is a con- cern, means for removal is recommended.
- For reciprocating pumps, provide a suitable pulsation dampener (or make provisions for adding a dampener at a later date) as close to the pump cylin- der as possible.

API-14E Recommendations-discharge piping

- Discharge piping should be as short and direct as possible.
- Discharge piping should be one or two pipe sizes larger than pump discharge connection.
- Velocity in discharge piping should not exceed three times the velocity in the .suction piping. This velocity will nor- mally result in an economical line size for all pumps, and will minimize pulsations in RC pumps.
- For reciprocating pumps, include a suitable pulsation dampener (or make provisions for adding a dampener at a later date) as close to the pump cylin- der as possible.

Thank you

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