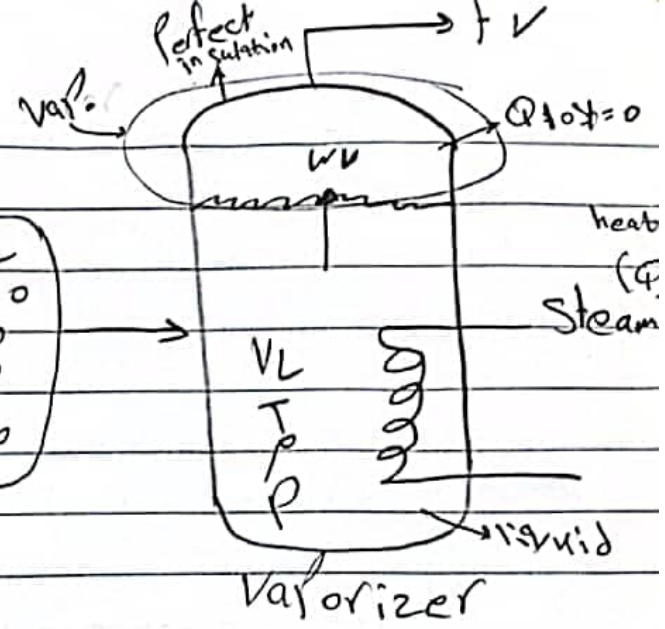
LPG vaporizer



① Perfect mixing

②

Solution

Assume the LPGs behaves as single comp.

Ⓐ Assume No dynamics for gas & liquid

~~No accumulation~~

Mass Balance

○ = mass in - mass out

$$0 = F_0\rho_0 - F_v\rho_v \longrightarrow F_0\rho_0 = F_v\rho_v \quad \text{---①}$$

Energy Balance

$$acc = F_0\rho_0 h_0 - F_v\rho_v H_v + Q$$

h_0: input enthalpy

H_v: output enthalpy

$F_v\rho_v$

$$0 = F_v\rho_v(h_0 - H_v) + Q \quad \text{---②}$$

(B) Neglect the dynamics of vapor Phase

For liquid Phase

M.B

Acc = input − out Put

$$\frac{d}{dt}(M_L) = \dot{m}_{in} - \dot{m}_{out}$$

$$\frac{d}{dt}(\rho V_L) = \rho_o F_o - W_v \qquad W_v = F_v \rho_v$$

$$\rho \frac{dV_L}{dt} = \rho_o F_o - W_v \quad \text{---} (1)$$

Energy Balance

Acc = in − out $\qquad U = C_v \Delta T$

PE + KE + U $\qquad = C_p \Delta T$

$$\frac{d}{dt}(mE) = \dot{m}_{input} E_{in} - \dot{m} E_{out} + Q \qquad C_p = C_v \text{ for incompressible liquid}$$

$$C_{pp} \frac{d}{dt}\left[V_L (T - T_{Ref})\right] = \underbrace{\rho_o F_o}_{\text{input flowrate}} C_{Po} (T_o - T_{ref}) - \underbrace{\rho_v F_v \left[C_p (T - T_{Ref}) + \lambda\right]}_{h_{fg}} + Q \quad \text{---} (2)$$

enthalpy of vap

$$\rho_v = \frac{P_v M_{wt}}{RT} \quad \text{---} (3)$$

$$\ln P = \frac{A}{T} + C \quad \text{---} (4)$$

(C) Consider the dynamics of Both liquid and vap.

liquid Phase

M.B

$$\rho \frac{dV_L}{dt} = F_o \rho_o - W_v \quad \text{---- (1)}$$

$W_v \neq F_v \rho_v$ because we have acc. in the vap.

Energy Balance

$$\rho \frac{\partial}{\partial t}(V_L U_L) = F_o \rho_o h_o - W_v H_{vap} + Q \quad \text{---- (2)}$$

Vaper Phase

M.B

Acc = in - out

$$\frac{\partial}{\partial t}(\rho V_v) = W_v - \rho_v F_v \quad \text{---- (1)}$$

E.B

$$\frac{\partial}{\partial t} \text{Energy Vapor} = E_{vap} - E_{vap\,out}$$

Note : Q is added to the liquid