Folkers Rojas | Mud Gas Separator | 20150814 | pg 1

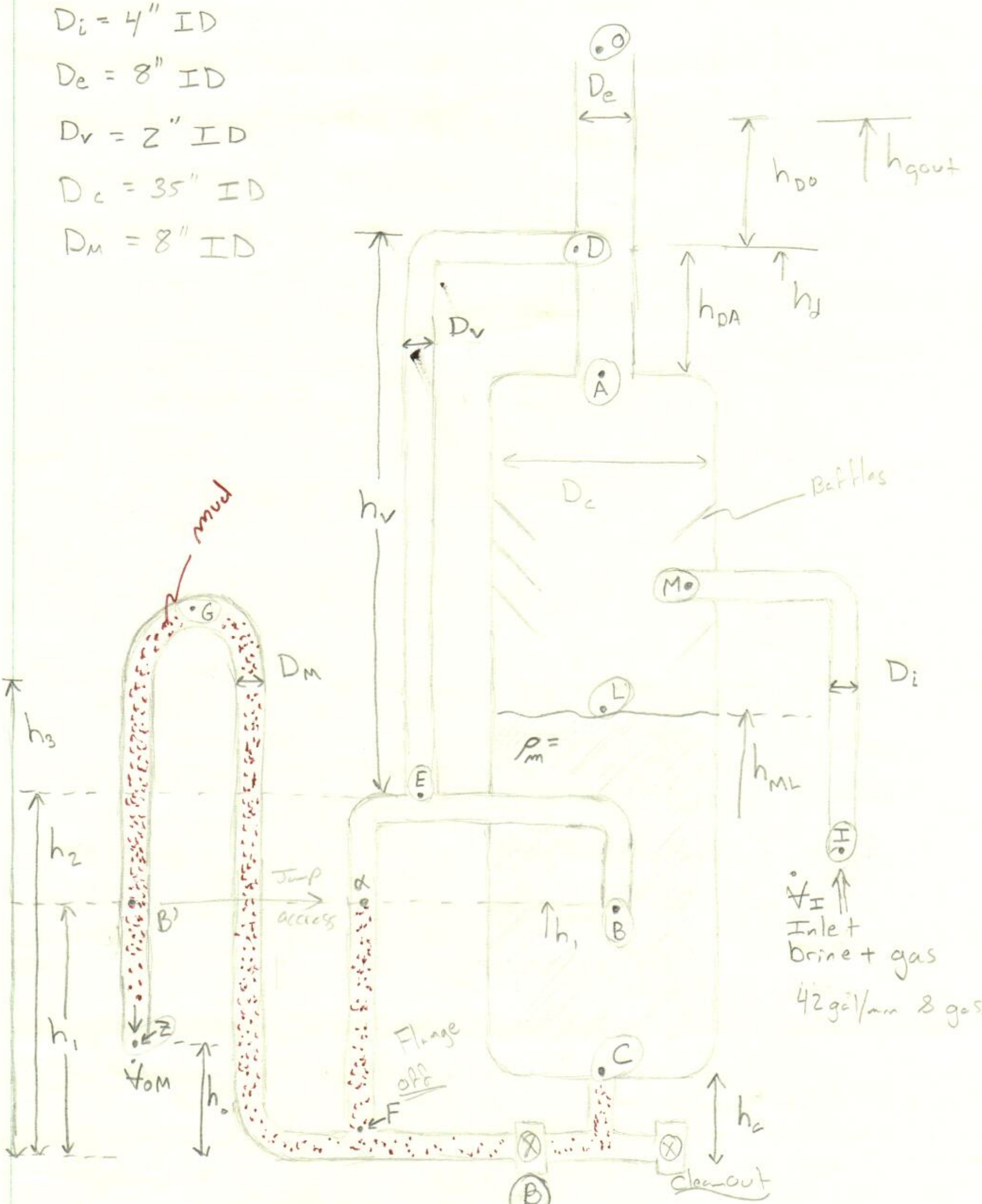
$D_i = 4''$ ID

$D_e = 8''$ ID

$D_v = 2''$ ID

$D_c = 35''$ ID

$D_M = 8''$ ID



$h_v = 12'$

$h_1 = 29''$

$h_2 = 65''$

$h_3 = 77''$

$\rho_m = 9.5$ lb/gal brine

$\dot{V}_{OM} = 42$ gpm

Objective: Analyze Pressures of unit. to identify Source of ~~air~~ gas bubbles in the mud line.

Lets start from the Knowns and move our way thru the problem

Knowns:

Pt. O $\Rightarrow P_o = 1\ atm = 1.013 \times 10^5\ Pa$ (Absolute $\rightarrow$ gauge is zero)

Pt. D $\Rightarrow P_D = ?$ we assumed @ zero in the existing design but we won't in this calculation just yet.

Pt. A $\Rightarrow P_A \approx 100 psi = 6.89 \times 10^5\ Pa$ (Assume Gauge)

Pt. B $\Rightarrow P_B$

Pt. C $\Rightarrow P_C$

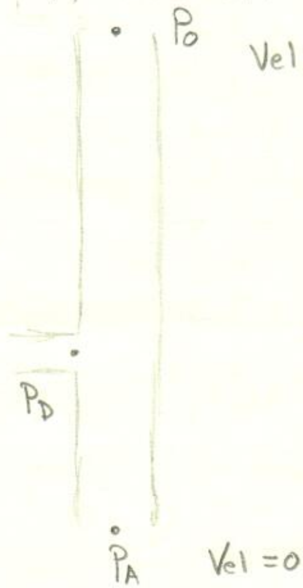
Pt. F $\Rightarrow P_F$

Pt. G $= P_G$

Pt. Z =

*

Ohh let's find P_D with P_o & P_A



Apply Bernoulli's Law

$$P + \tfrac{1}{2}\rho v^2 + \rho g h = [constant]$$

$\therefore$ Assuming $V_A = 0$ then Apply from A to O

$$P_A + \tfrac{1}{2}\rho_g V_A^2 + \rho_g g h_A = P_o + \tfrac{1}{2}\rho_g V_o^2 + \rho_g g h_o$$

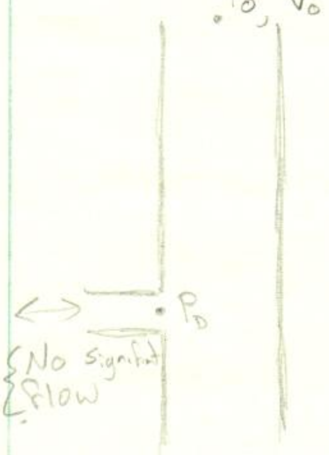
0 0

$\therefore$ In Gauge pressure $P_o = 0$, $P_A = 6.89 \times 10^5\ Pa$

$V_A = 0$

$$\sqrt{\frac{P_A + \rho_g g(h_A - h_o)}{\frac{1}{2}\rho_g}} = V_o \quad \{Eq\ I\}$$

now that I know the outlet velocity I should be able to go from Pt. O to Pt. D



* Assuming No Significant flow escaping gas up.

Apply Bernoulli again

$$\cancelto{0}{P_o} + \frac{1}{2}\rho_g V_o^2 + \rho_g g h_o = P_D + \frac{1}{2}\rho_g V_D^2 + \rho_g g h_D$$

Solve for P_D

$$\boxed{P_D = \frac{1}{2}\rho_g (V_D^2 - V_o^2) + \rho_g g (h_D - h_o)} \quad \{Eq\,2\}$$

this is curious because V_D should be smaller than V_{outlet} and h_D is smaller than h_o therefore it appears using $\{Eq\,2\}$ that P_D is negative therefore creating a small vaccum in the system. I'm not 100% certain so I will continue solving the problem in its current form, and determine implications.

I'm going to assume that $P_L = P_A$ I want to find P_C

$$P_C + \frac{1}{2}\cancel{\rho_M} V_c^2 + \rho_M g h_c = P_L + \frac{1}{2}\cancel{\rho_M} V_L^2 + \rho_M g h_{ML}$$

$V_c = 0$, $V_L = 0$

$$\therefore \boxed{P_C = P_L + \rho_M g (h_{ML} - h_c)} \quad \{Eq\,3\}$$

$$\therefore P_B + \rho_M g h_B = P_C + \rho_M g h_c$$

$$P_B + \rho_M g h_B = P_L + \rho_M g h_{ML} - \cancel{\rho_M g h_c} + \cancel{\rho_M g h_c}$$

$$\therefore \boxed{P_B = P_L + \rho_M g (h_{ML} - h_B)}$$ ✓ this makes sense

Now go from B to Z Ideally it should be filled with Mud.

From P_Z to P_1 (@h_1) we can do no problem.

$$\{Eq\,4\}\quad P_Z + \frac{1}{2}\rho_c V_Z^2 + \rho_c g h_0 = P_B + \frac{1}{2}\rho V_B^2 + \rho g h_1$$

A flow rate of 42 gpm of mud through 8" ID aperture and $\rho_M = 9.5$ lb/gal brine can be converted to a Velocity @ V_Z

$$\dot{V}_{OM} = 42\,\frac{gal}{min} * \frac{3.785\,L}{gal} \times \frac{1\,min}{60\,sec} \times \frac{0.001\,m^3}{1\,Liter} = 0.0026\,\frac{m^3}{sec}$$

$$\dot{V}_{OM} = 0.00265\,m^3/sec$$

Now convert density $\rho_M = 9.5$ lb/gal

$$= \frac{9.5\,\frac{lb}{gal} \times \frac{1\,gal}{3.785\,L} \times \frac{1\,L}{0.001\,m^3} \times \frac{4.448\,N}{1\,lb}}{g\,[m/s^2]}$$

divide by gravity to get units in Kg/m3 for density

$$\{\quad \rho_M = 1139\ Kg/m^3$$

this is in the correct ballpark given that water is ~1000 Kg/m3

$$A_c = \pi R^2 = \pi\,(4 \times 0.0254)^2 \qquad [in \times \frac{m}{in}]$$

$$A_c = 0.0324\,m^2$$

$$\frac{\dot{V}_{OM}\,[m^3/sec]}{A_c\,[m^2]} = V_Z\,[m/sec] = \frac{0.0026\,m^3/sec}{0.0324\,m^2}$$

$$V_Z\,[m/sec] = 0.080\,m/sec$$

$$V_Z = 8\,cm/sec \qquad (\sim 3.15\,inch/sec)$$

Continue w/ {Eq 4}

P_z = 1 atm open (0 gauge)

$$\therefore \quad \cancel{\tfrac{1}{2}\rho_M V_z^2} + \rho_M g h_0 = P_{B'} + \cancel{\tfrac{1}{2}\rho V_{B'}^2} + \rho g h_1$$

assume $V_z \approx V_{B'}$

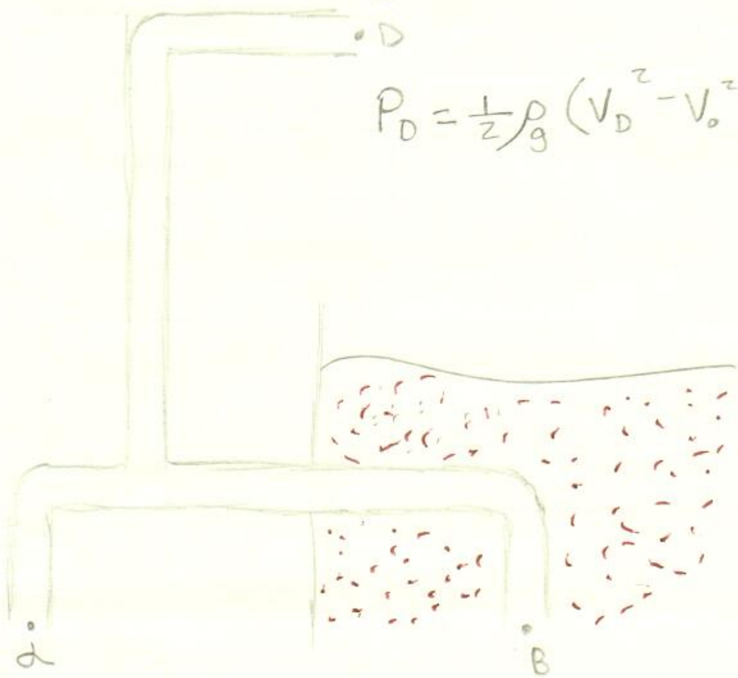
$$\therefore$$

$$P_{B'} = \rho_M g (h_0 - h_1) \qquad \text{if } h_0 > h_1 \quad P_{B'} > 0$$

However $h_0 < h_1$ therefore $P_{B'}$ is negative

Now how does that compare to point α

Now to the Bermudas triangle $\qquad P_{B'} = P_\alpha$



$$P_D = \tfrac{1}{2}\rho_g (V_D^2 - V_0^2) + \rho_g g (h_D - h_0)$$

$$P_\alpha = \rho_M g (h_0 - h_1)$$

$$P_B = P_L + \rho_M g (h_{ML} - h_B)$$

$\uparrow P_L = P_A$ or interior pressure of vessel

Valve β Closed & $h_0 < h_1$

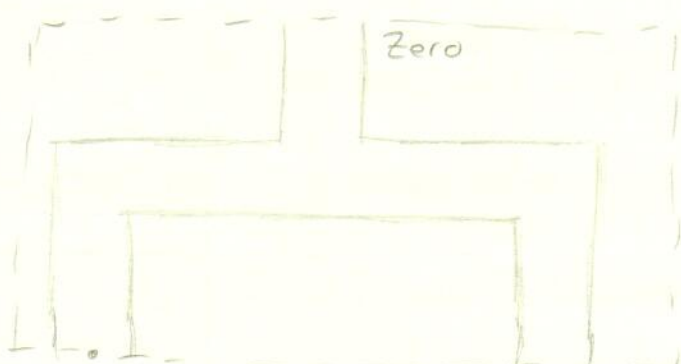
This leads me to believe that air is being sucked in from the anti syphon Valve

$P_B' = P_\alpha = \rho_M g (h_0 - h_1)$
Negative

$P_B = \rho_M g (h_{ML} - h_B) + P_L$
Positive.

Now lets still keep Valve β closed and make $h_0 > h_1$

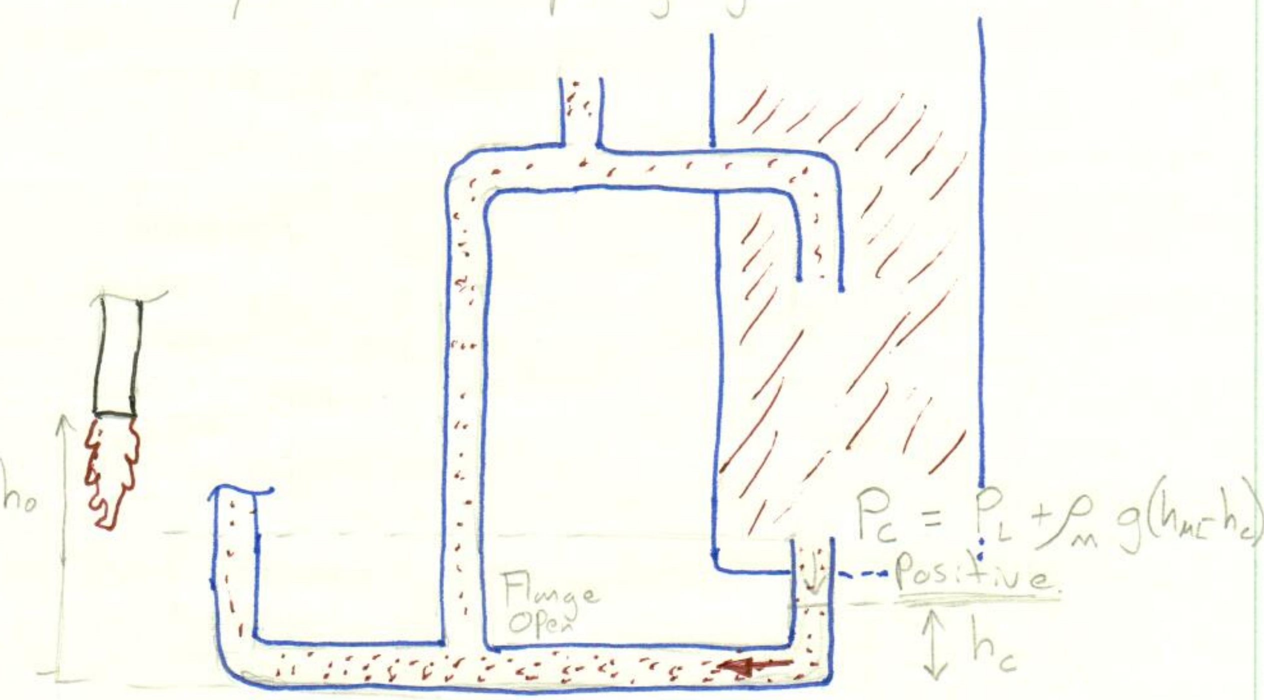
Control Volume



Positive

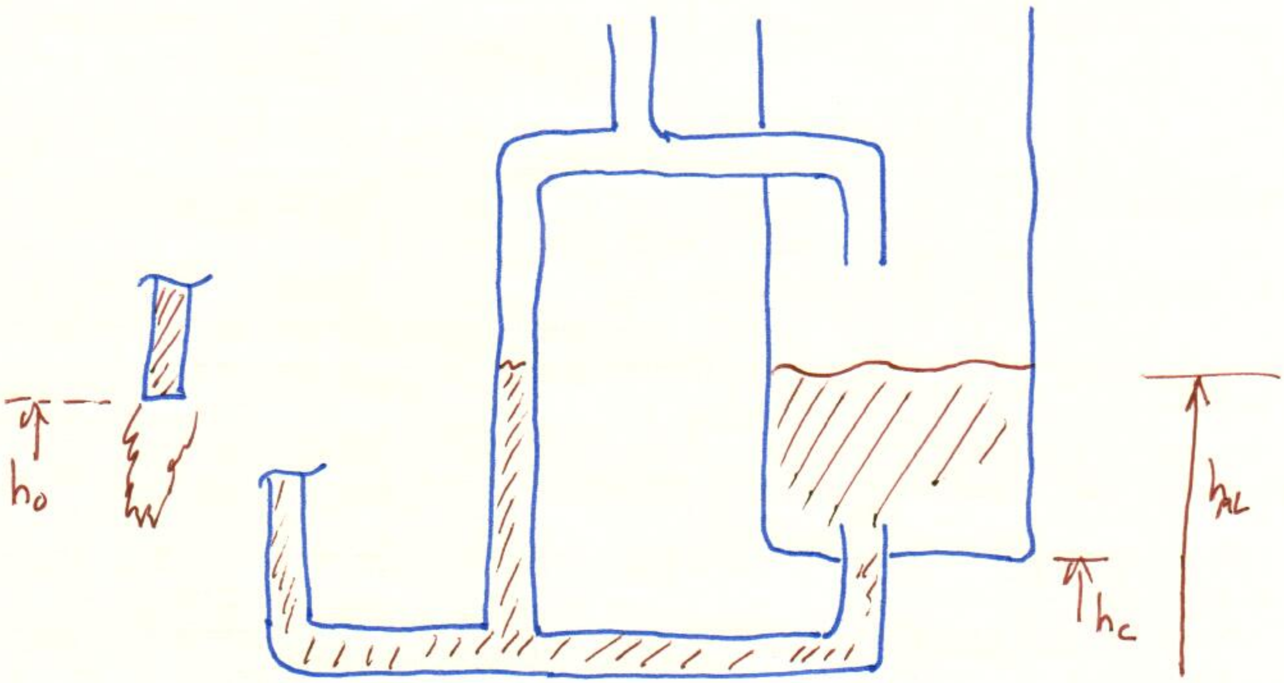
More positive

Now if we were to open Valve β
the $h_c < h_o$ therefore we get to Keep
a mud layer without pulling gas

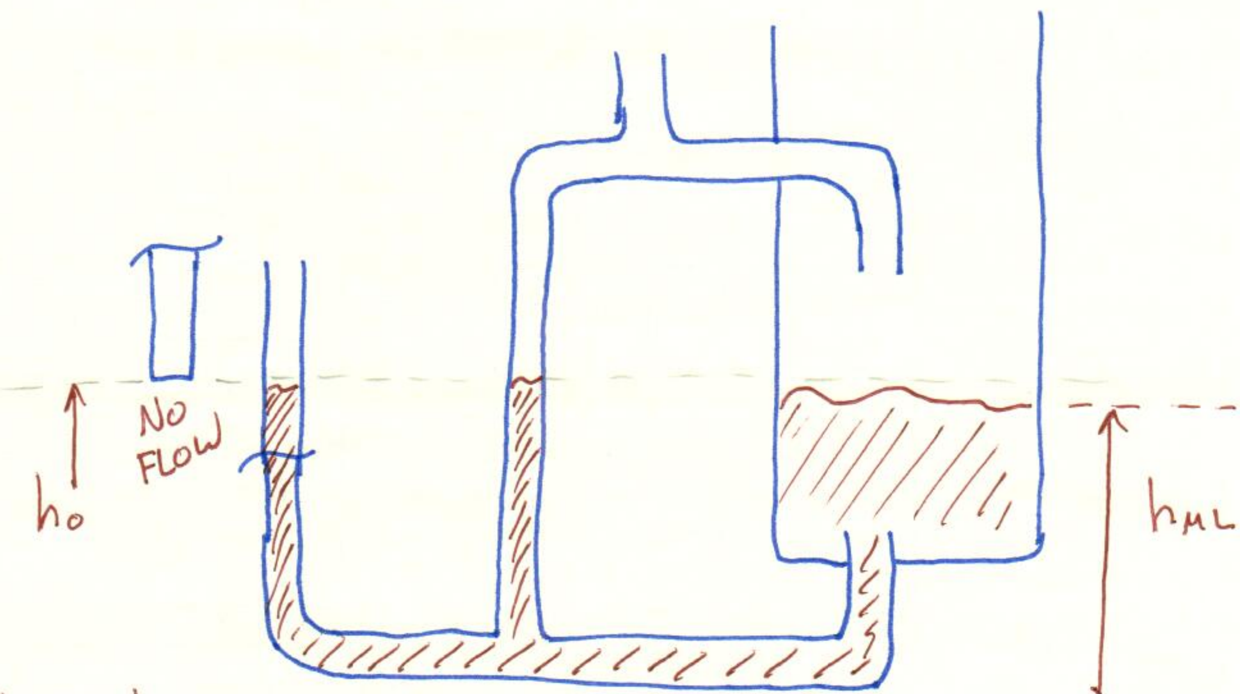


All is Happy just as long as $h_o > h_c$
then Safety mud line is $(h_o - h_c)$

$h_{ML} > h_o > h_c$



All is Happy just as long as $h_{ML} > h_o$



$h_o > h_{ML}$ therefore No Flow Assumes Pressure inside separator is small but use spreadsheet to quantify.