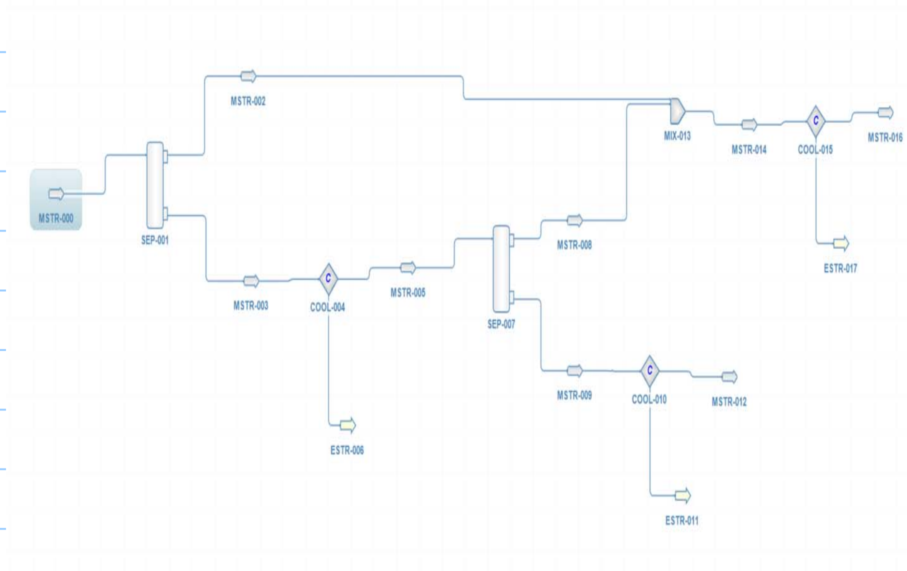
Note Title 09.11.2018

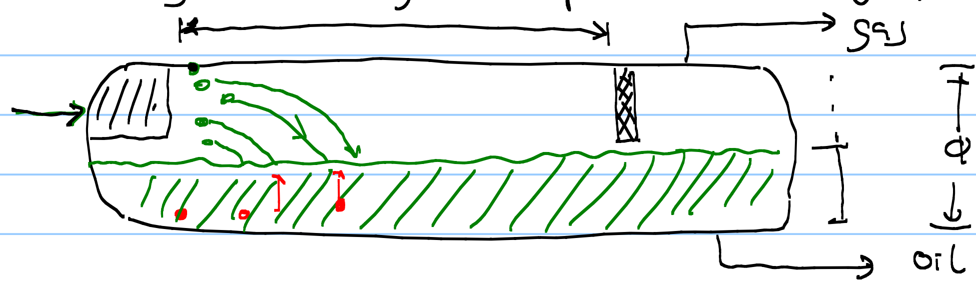
for Dwsim $\dot{m} = (q_{\bar{o}} \rho_{\bar{o}} + q_{\bar{g}} \cdot \rho_{\bar{g}})$



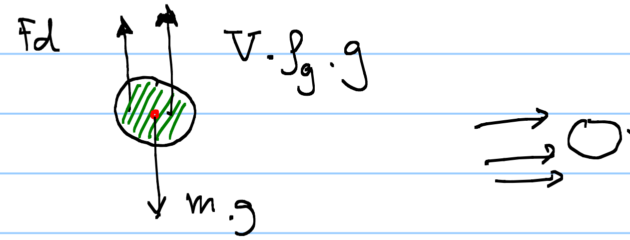
Gas rate	[m^3/h]	737.995
Oil rate	[m^3/h]	4.22543
GOR	[Sm^3/Sm^3]	174.6556

FLASH CALCULATIONS									
p	[bara]	35							
T	[C]	50					Fv	0.054942	
		fv	0.153093				DWSIM		
Comp	zi	Ki (T)	RR_term	xi	yi		yi	xi	Ki
C1	0.18047	12.75386	7.58E-01	0.06447	0.82220		0.8528045	0.141384	6.031849
C3	0.24173	0.69867	-7.64E-02	0.25342	0.17705		0.14647848	0.247263	0.5924
N-C10	0.57780	0.00109	-6.81E-01	0.68212	0.00075		0.000717026	0.611354	0.001173
		SUM=	-5.22E-07	1.00000	1.00000				

- Separator sizing → Horizontal separator (oil + gas)



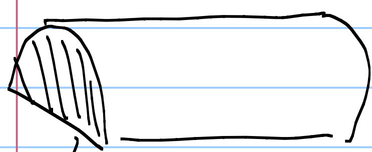
$$t_{res} = \frac{\phi}{2\, v_{droplet}}$$



$$t_{res\,gas} = \frac{L_{eff}}{v_g} = \frac{L_{eff} \cdot \pi \phi^2}{q_g \cdot 8}$$

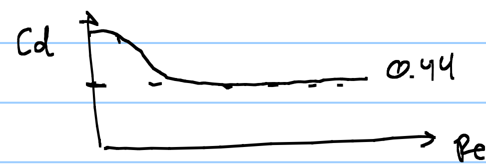
$$v_g = \frac{q_g\, 8}{\pi \phi^2}$$

$$v_{droplet} = \sqrt{\frac{4}{3}\frac{d \cdot g}{C_d}\frac{(\rho_o - \rho_g)}{\rho_g}}$$



$$\left(\frac{\pi \phi^2}{4}\right)\frac{1}{2}$$

assuming 1/2 separator is liquid and 1/2 is gas



$$C_d = \frac{24}{Re} + \frac{3}{Re^{0.5}} + 0.34$$

$$Re = \frac{d\, \rho_g\, V_{droplet}}{\mu_g}$$

$$t_{res\,gas} \geq t_{res\,droplet}$$

$$\frac{L_{eff}\, \pi \phi^2}{q_g\, 8} \geq \frac{\phi}{2\, V_{droplet}}$$

$$L_{eff} \cdot \phi \geq \frac{q_g\, 4}{V_{droplet}\, \pi}$$

trying to define L_{eff}, ϕ

for construction purposes

$$\frac{L}{\phi} \leq 4 \quad (2-3)$$

$$t_{res\,liquid} = \frac{L_{eff}}{v_o} \quad \text{depends on API}$$

$$v_o = \frac{q_o\, 8}{\pi \phi^2}$$

$$t_{res\,liq} = \frac{L_{eff}\, \pi\, \phi^2}{q_o\, 8}$$

Crude API	Retention Time (min)
>30	1
20 - 30	1 - 2
10 - 20	2 - 4

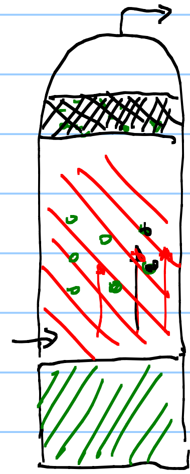
Assume L_{eff}, Φ and verify:

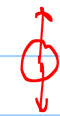
- $\frac{L}{\Phi} < 4$
- $t_{res,liquid} = 1, 1\text{-}2, 3\text{-}4$ min $(f(API))$
- $t_{res,gas} \geq t_{droplet\ fall}$

$$\underbrace{L_{eff} \cdot \Phi}_{min} \geq \frac{q_g \, 4}{\underbrace{V_{droplet}}_{min} \, \pi}$$

psep	[bara]	50
Tsep	[C]	70
qo	[Sm^3/d]	8333
qg	[Sm^3/d]	1.03E+06
gammag	[-]	0.85
Bo	[m^3/Sm^3]	1.05
deno	[kg/m^3]	870
API	[kg/m^3]	31
Z	[-]	0.8893
deng	[kg/m^3]	48.5
viscg	[cp]	0.121
Bg	[m^3/Sm^3]	0.0214
qg	[m^3/d]	2.21E+04
qo	[m^3/d]	8750
Vdroplet_assumed	[m/s]	0.0639
ddroplet	[m]	0.00015
Re	[-]	3.8
Cd	[-]	8.12
Vdroplet	[m/s]	0.0639
L*D_min	[m^2]	5.102
L	[m]	5.5
D	[m]	1.7
L*D	[m^2]	9.4
L/D max	[-]	4.0
L/D	[-]	3.2
tres_liq	[min]	1.03

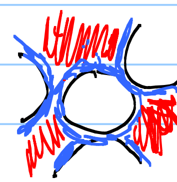
Vertical separators

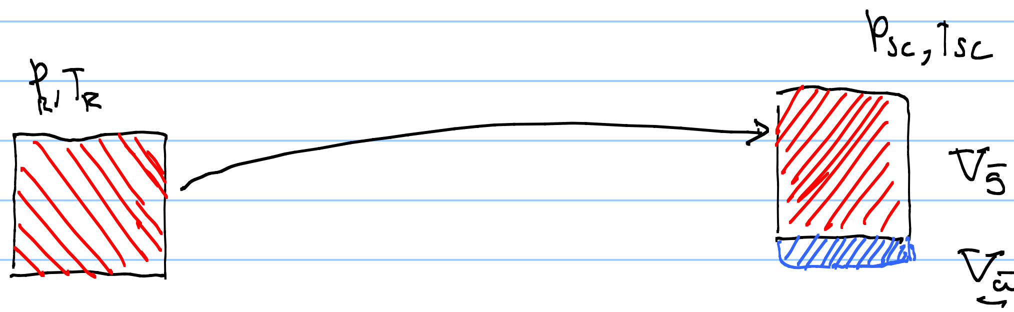




$\Sigma F = 0$

Water content in Natural gas





r_{sw} Solution water gas ratio

similar to R_s, r_s

$\frac{V_w'}{V_g}$ [stb/mmscf] [Sm^3/mm Sm^3] [kg/mm Sm^3] [lb/mmscf]

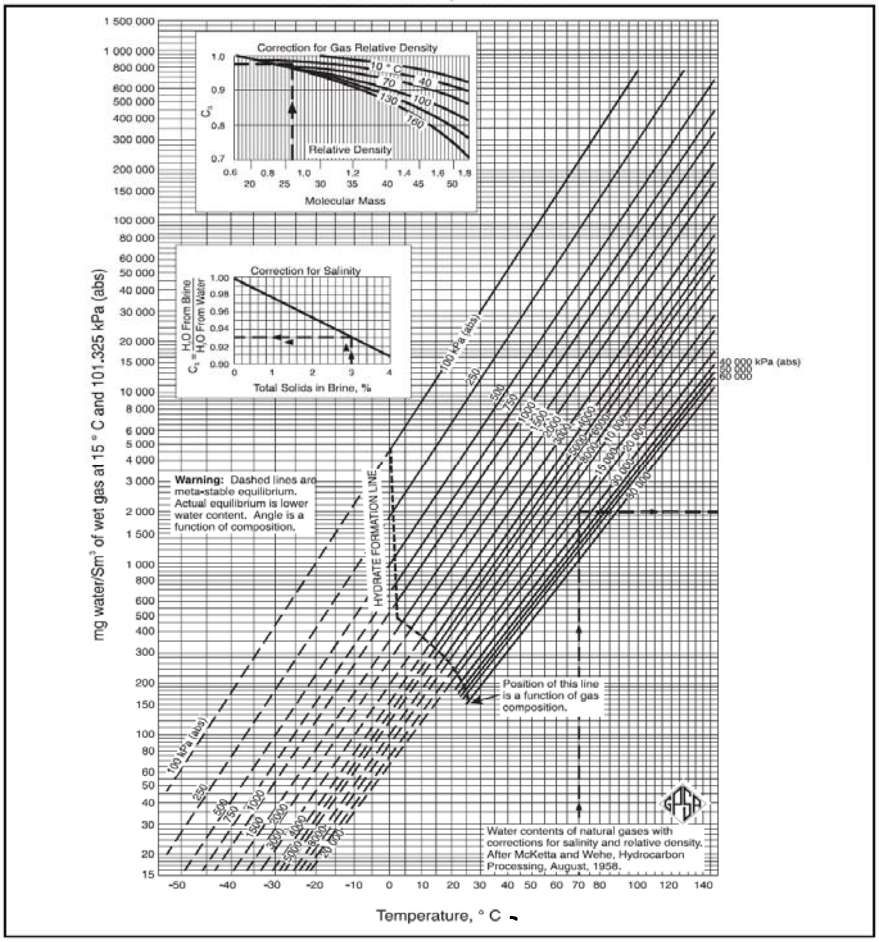
r_{sw} ~> correlations { brine, H_2S, CO_2

↳ EOS Peng Robinson (PR)

Soave Redlich Kwong (SRK)

FIG. 20-4

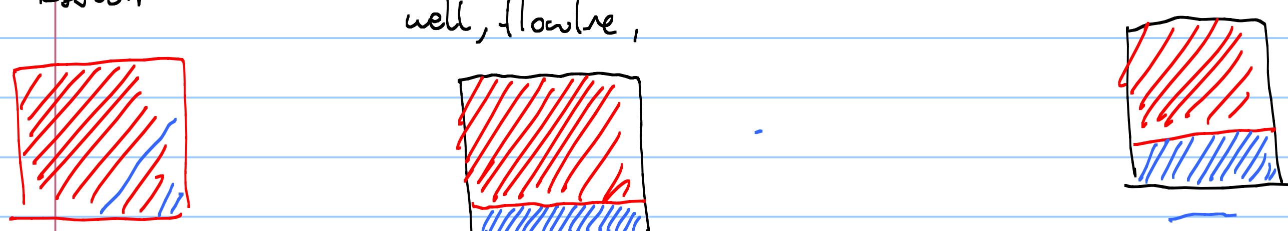
Water Content of Hydrocarbon Gas



20-5

P_R, T_R → P, T → P_{sc}, T_{sc}

Reservoir — well, flowline, — s.c



Example

1. $P_R = 250$ bara

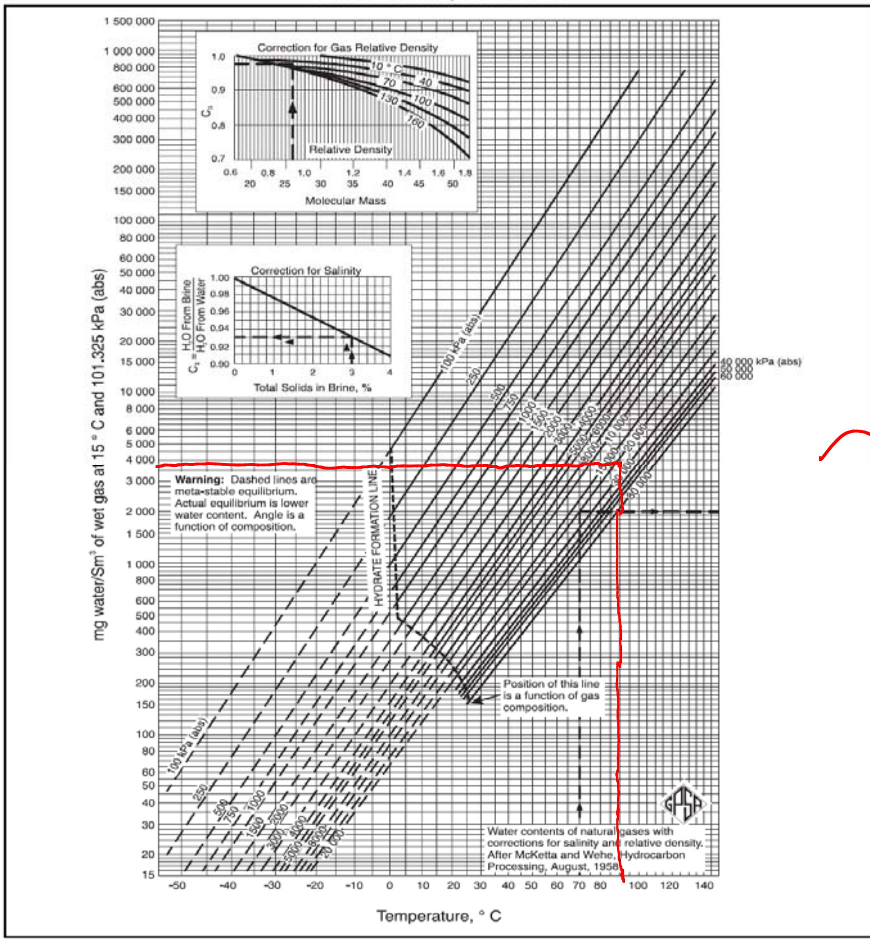
$\gamma_g = 0.8$

$T_R = 90°C$

$q_g = 20$ E6 Sm^3/d

$q_w = ?$

FIG. 20-4
Water Content of Hydrocarbon Gas



$r_{sw} = 3500 \text{ mg}/Sm^3$

$q_g = 20E6 \; Sm^3$

$q_w = ?$ water comes only from condensation from gas

$q_w = q_g \, r_{sw}$

$q_w = 20E6 \; Sm^3/d \cdot 3500 \text{ mg}/Sm^3$

$q_w = 7E9 \text{ mg}/d$

1 mg → g 1/1000

1 g → kg 1/100

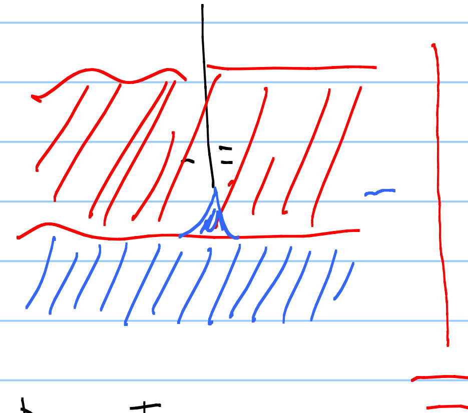
$q_w = 70E9 \cdot 10^{-6} \text{ kg}/d$

$q_w = 70000 \text{ kg}/d$

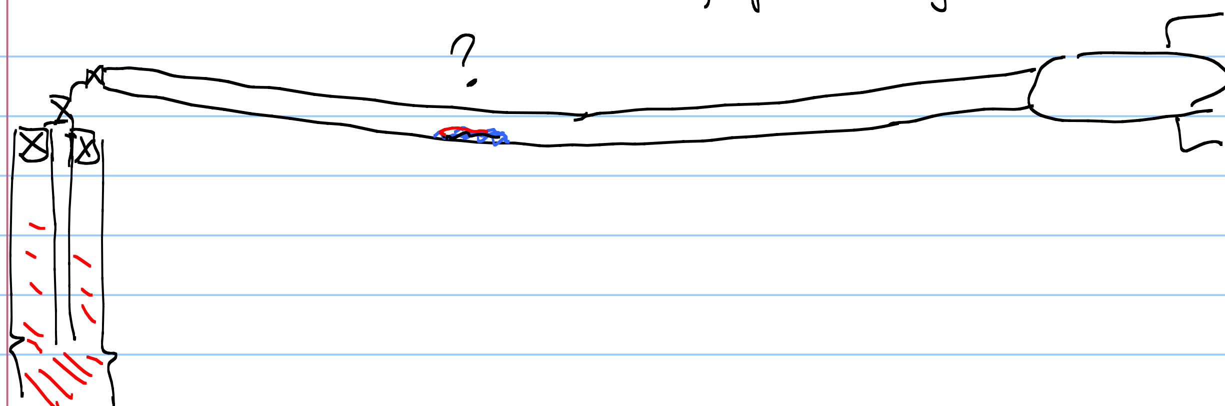
$\rho_w \simeq 1000 \text{ kg}/m^3$

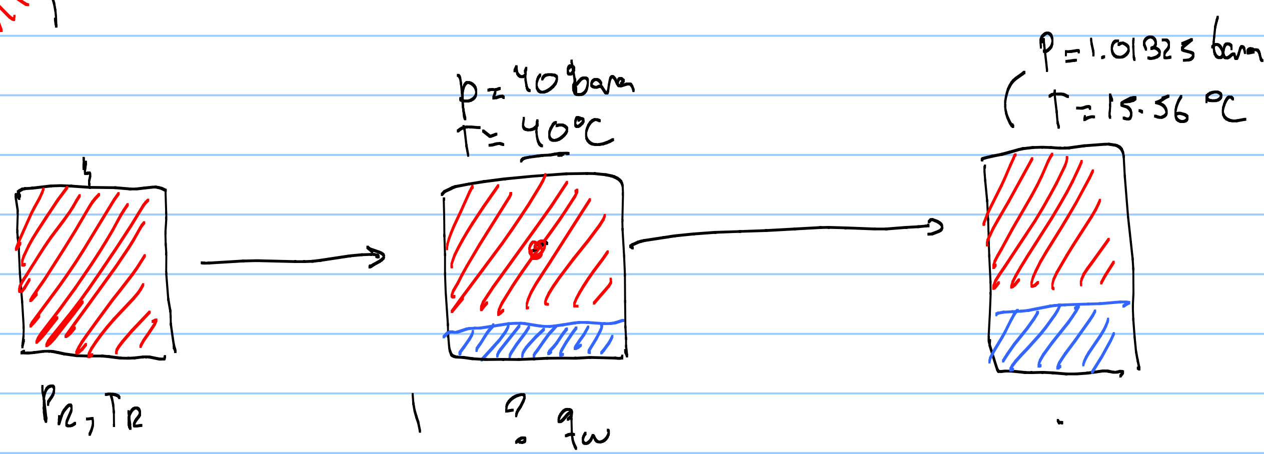
$1 \; Sm^3 = 6.28 \text{ bbl}$ $q_w = 70 \; Sm^3/d$

use to size surface facility → $q_w \simeq 420$ stb/d to determine if there aquifer coning.



to determine water flow in location of production system





r_{sw} @ p_R, T_R

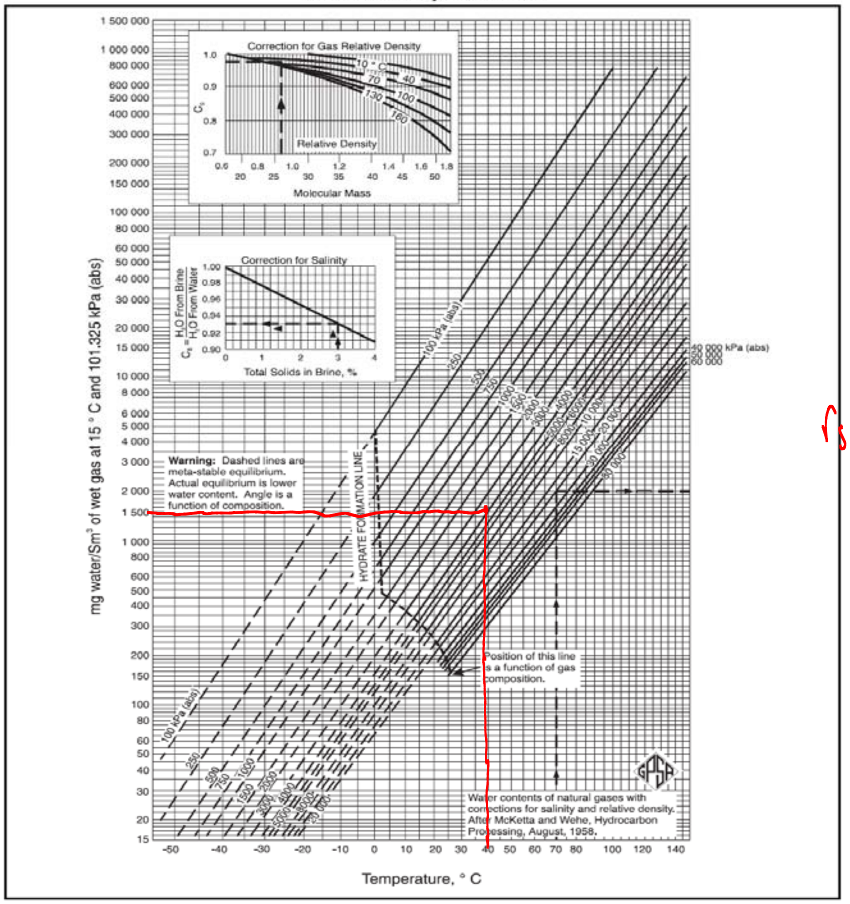
$$q_{\bar{w}} = \left(r_{sw@p_R,T_R} - r_{s@p,T}\right) q_{\bar{g}}$$

$$B_w = \frac{q_w}{q_{\bar{w}}}$$

$B_w \approx 1.0\ldots$

$$q_w = B_w \cdot q_{\bar{w}}$$

FIG. 20-4
Water Content of Hydrocarbon Gas



20-5

ρ_w 1500 mg/Sm^3

$$q_w = 70\,E6\ Sm^3/d \cdot \underbrace{(3500 - 1500)}_{2000}$$

$$= 40\,E9\ mg/d$$

$$q_w = 40\,000\ kg/d = 40\ Sm^3/d$$

$$q_w = 40\ B_w = 40\ Sm^3/d \rightsquigarrow \frac{u_{sw}}{u_{sg}}$$

- Layout of production systems, wells interface and production manifold.
- Flow equilibrium (Nodal Analysis).
- Gas PVT behavior. Real Gas Equation.
- Pressure drop calculations for single phase gas, the tubing equation. Tubing flow considerations, liquid loading and erosion problems in wells. — Backpressure equation $q_{g} = C(P_R^2 - P_{wf}^2)^n$
- Effect of tubing size, reservoir pressure and wellhead pressure in flow equilibrium.
- Pressure traverse calculations along the tubing for gas.
- Pressure drop calculations in pipelines, design considerations, Hydrates.
- IPR for single phase liquid, gas and under saturated oil
- Pressure drop calculations across restrictions (choke) for liquid and gas. Choke performance
- Pressure drop calculations for liquid. Example for ESP flow calculations. Comments on oil-water emulsions.
- Multiphase flow theory.
- Black oil properties. Oil viscosity behaviour with temperature
- Pressure drop calculations for multiphase flow. Tubing tables. Tubing performance relationship
- Pressure traverse curves
- Pressure traverse calculations along the tubing for multiphase flow.
- Gas oil processing — IPR for undersaturated oil
- Flash calculations, Rachford Rice
- gas liquid separation
- Sizing of horizontal separator
- water content in natural gas — separator sizing

  Δp calculation

  hydrate & corrosion.

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THE END.
THANK YOU FOR YOUR ACTIVE PARTICIPATION.