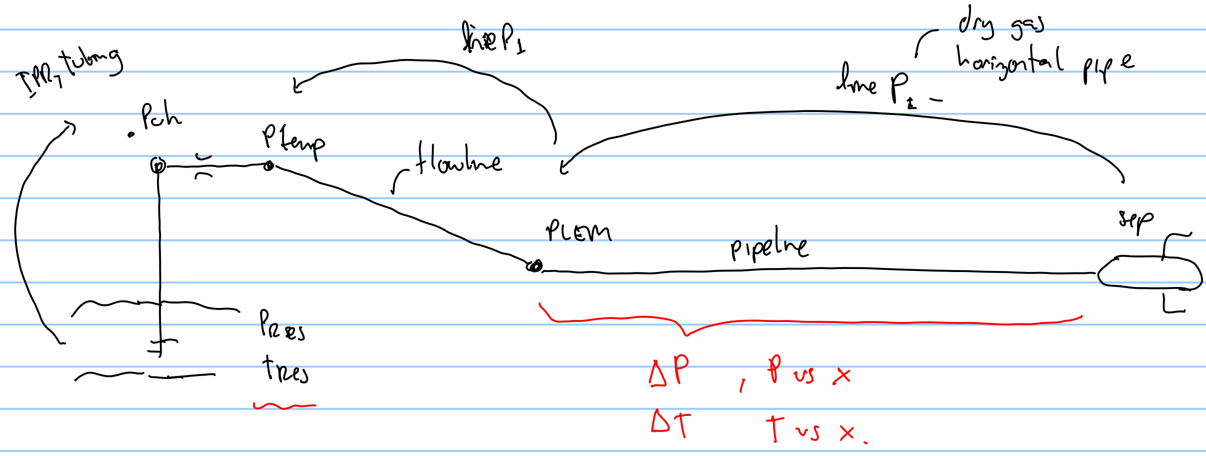
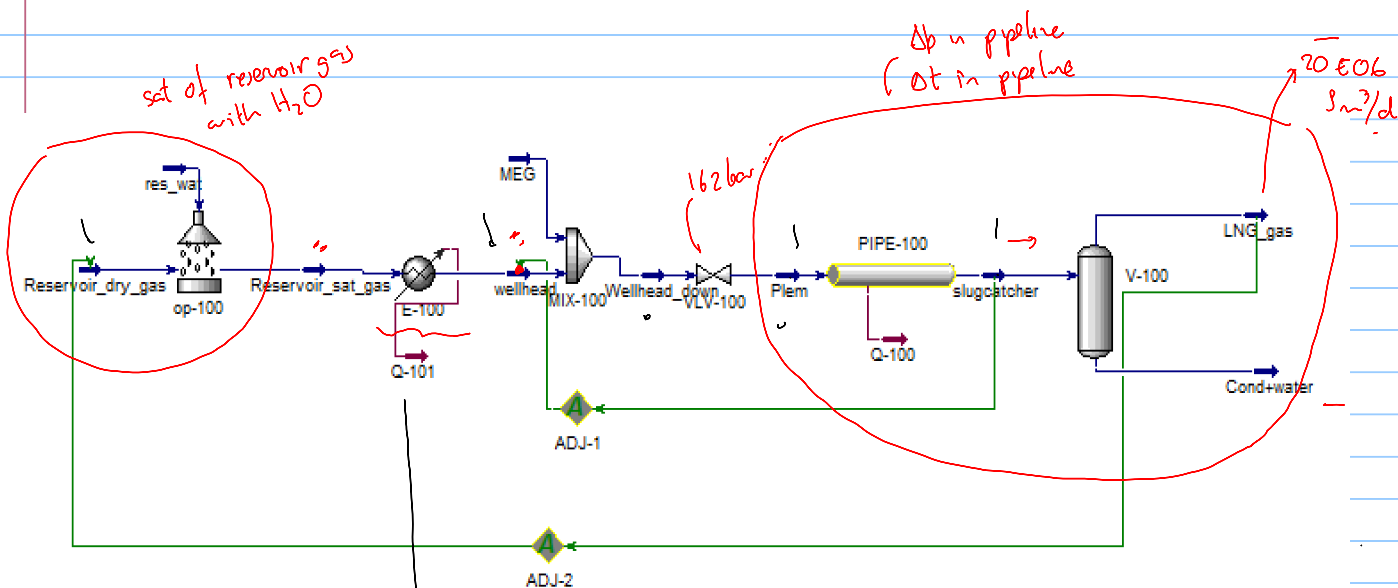
- more comments on problem 1 - ex. set 5
- Δp in Multiphase flow
- work with prob. 1 and prob 2 in class

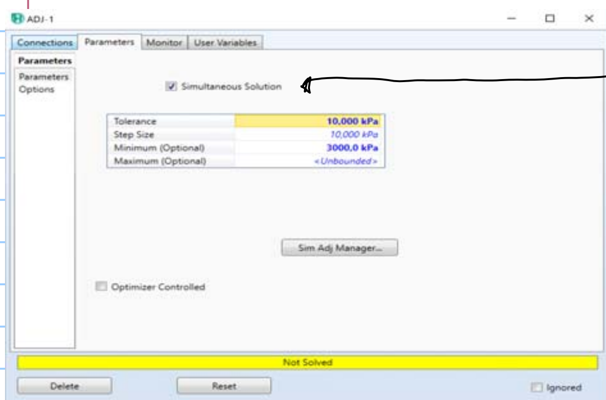




→ cooler ; can provide P_{in}, T_{in}, P_{out}, T_{out} and it will compute Δp, ΔT, $\dot{Q}$

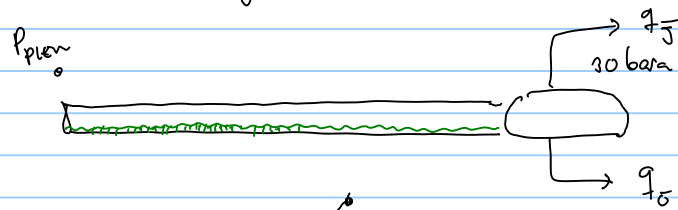
represents the Δp and ΔT a

- if a better model is used for pressure drop calculations in the pipeline it will probably yield:
  - shorter plateau
  - Δp_{choke} smaller →



remember to tick this field

- Multiphase flow in the production system



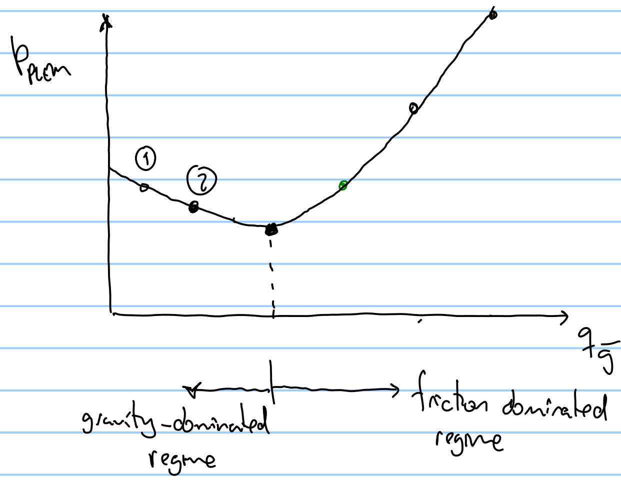
condensate-gas ratio

$$CGR = \frac{q_o}{q_g}$$

$$WGR = \frac{q_w}{q_g}$$

↳ water-gas ratio

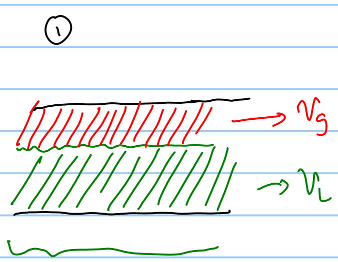
CGR – constant
WGR –

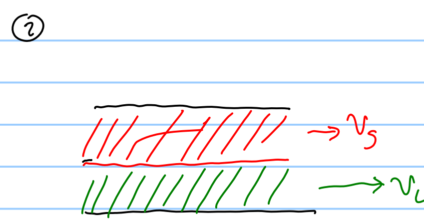


$$\Delta p = \Delta p_{friction} + \Delta p_{hydrostatic}$$

↳ $\rho \cdot g \cdot \Delta z$

↳ ρ_{mix}



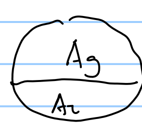


$\rho_{mix} \downarrow$

$$\rho_{mix} = \alpha_L \cdot \rho_L + \alpha_g \cdot \rho_g$$

α volume fraction

$$\alpha_g = \frac{A_g}{A}$$

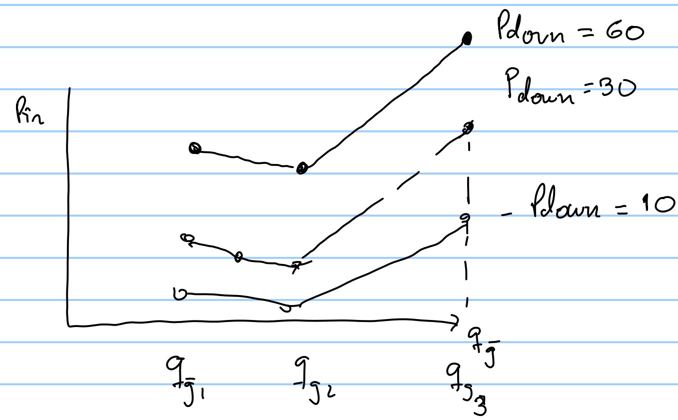


$$\alpha_L = \frac{A_L}{A}$$

Flow tables

Pdown = 30 bara
CGR =
WGR

q_g	Pin
q_{g1}	P_{in1}
q_{g2}	P_{in2}
q_{g3}	P_{in3}

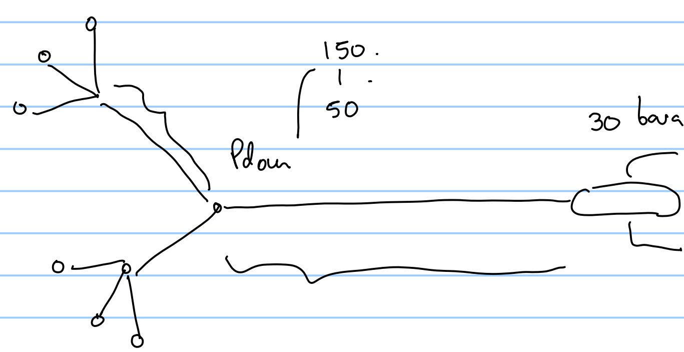


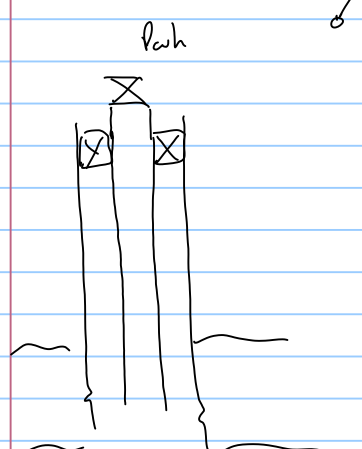
Pdown,man is not known → wells (Pwh)
→ flowline

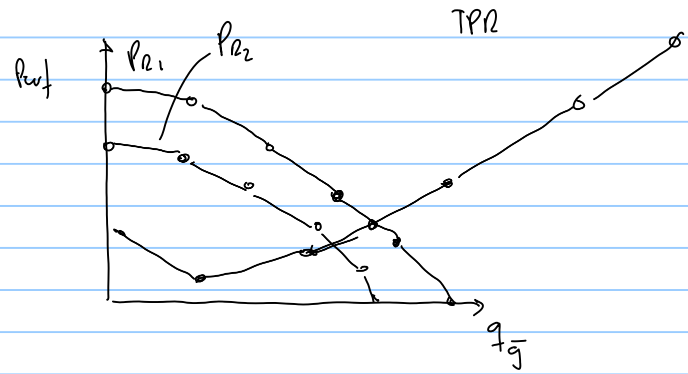
Pdown 1 – Pdown 3

Pdown 1		Pdown 2		Pdown 3	
CGR1, WGR1		CGR1, WGR1		CGR1, WGR1	
q_g	Pin	q_g	Pin	q_g	Pin
x	x	x	x	x	x
x	x	x	x	x	x
x	x	x	x	x	x

Pdown 2 < Pdown < Pdown 3







tables have to be generated for all possible expected variations
IPR : GOR, WC, P_R
TPR → Pwh, GOR, WC, CGR, WGR

TPR with variation in P_{wh}, GOR, WC, q_g

q_g

min, min, min

max, max, max

$N_{P_{wh}} \times N_{GOR} \times N_{WC} \times N_{q_g}$

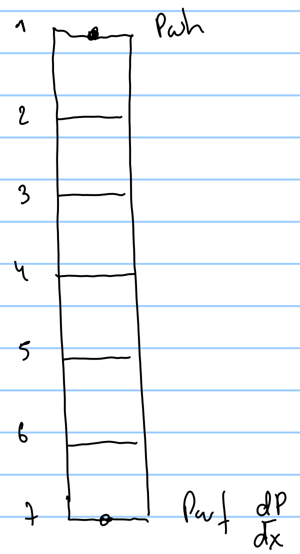
$10 \times 10 \times 10 \times 10 = 10^4$ iterations to compute P_{wf}

How P calculations are made in multiphase flow → ρ_o, ρ_g are changing with P, T along conduit

q_o, q_g, q_w (local rates) → v_o, v_g, v_w

↓

we perform calculation discretizing the pipe!



① depart from a point of "known" pressure, e.g. P_{wh}
temperature

② calculate fluid properties → $\rho_o, \rho_g, \rho_w, \mu_o, \mu_g, \mu_w, \sigma_{og}, \sigma_{ow}$
h_o, h_w, h_g

③ calculate q_o, q_w, q_g → Black oil tables → B_o, B_g, R_s, r_s

→ EOS model → z_i → P, T, $X_v = \frac{\dot{m}_g}{\dot{m}_o + \dot{m}_g}$

↓

$\dot{m}_T$

$\dot{m}_g = X_v \cdot \dot{m}_T$

$\dot{m}_o = (1 - X_v)\, \dot{m}_T$

$q_g = \dot{m}_g / \rho_g$

$q_o = \dot{m}_o / \rho_o$

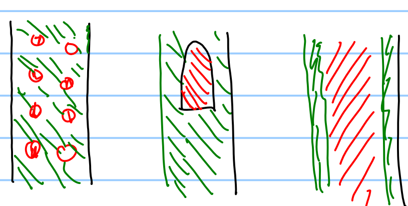
$v_g, v_L, \rho_o, \rho_g, \rho_w, \mu_o, \mu_g, \mu_w$
$\sigma_{og}, \sigma_{ow}, \sigma_{gw}$

④ Compute $\frac{dP}{dx}$ → multiphase flow "expert" (TEP4250)

↳ correlations → Beggs Brill, → Hagedorn Brown

↳ mechanistic model

↳ commercial software



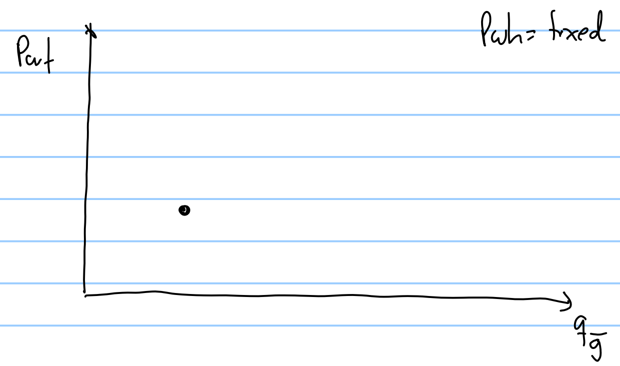
flow pattern

(5) "integrate" the $\frac{dP}{dx}$ to 2

Euler $$\frac{P_2 - P_1}{\Delta L} = \left.\frac{dP}{dx}\right|_{(1)}$$

$$P_2 = \frac{dP}{dx} \cdot \Delta L + P_1$$

(6) P_2, T_2, calculate fluid properties
q_o, q_g, q_w
$\frac{dP}{dx}$
↓
(3)



- Problem 2 . ex. set 5 $q_o = B_o(P,T) \cdot q_{\bar{o}}$ μ f(T)