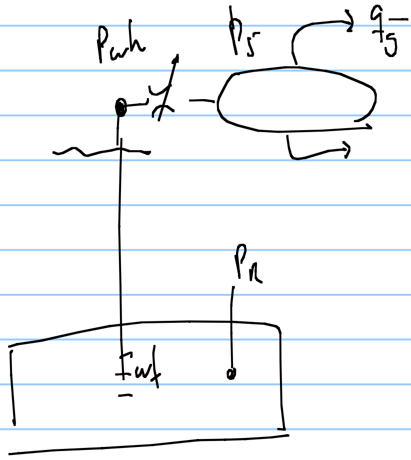
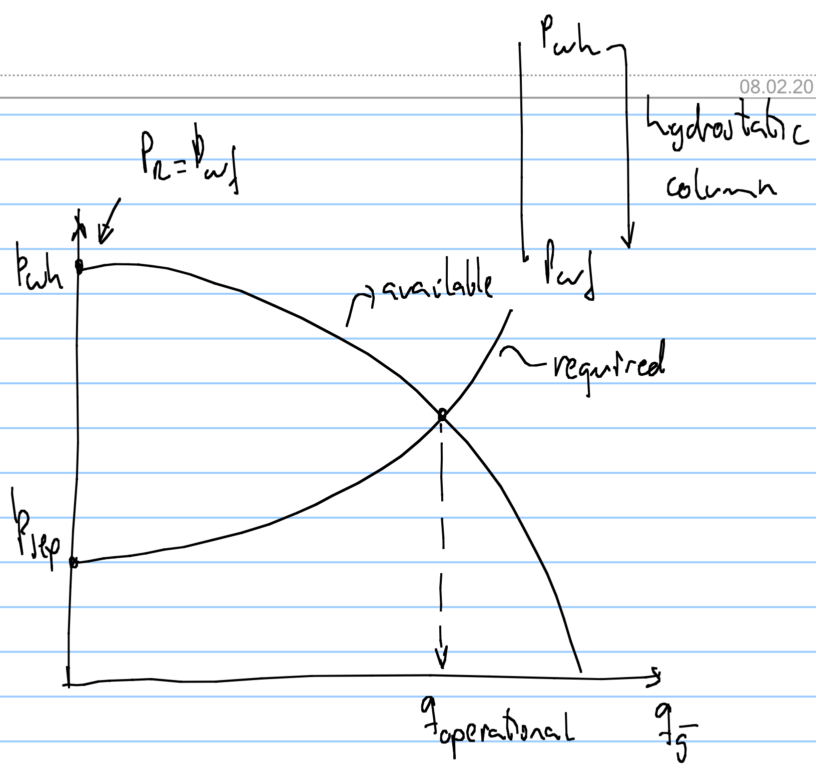
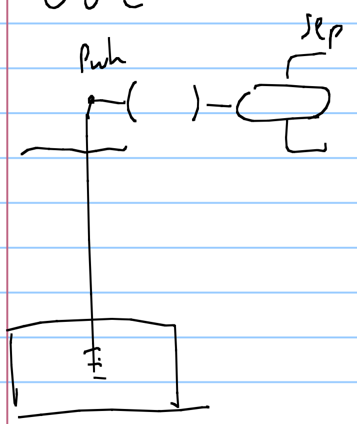
- Flow equilibrium calculations

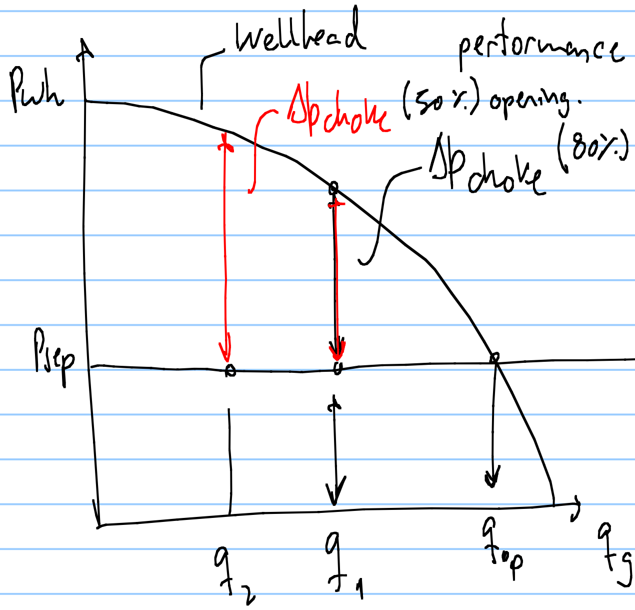


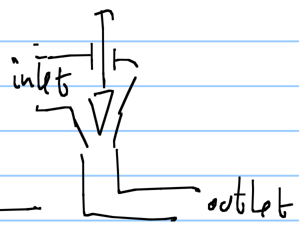


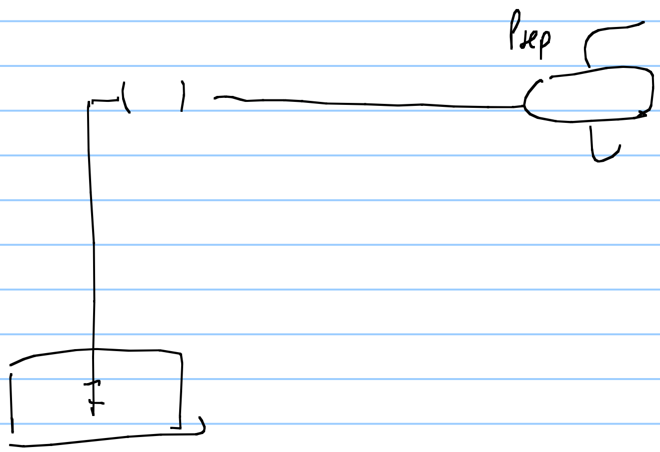
- for design of choke, boosting we could remove the element from the system an execute the flow equilibrium analysis.

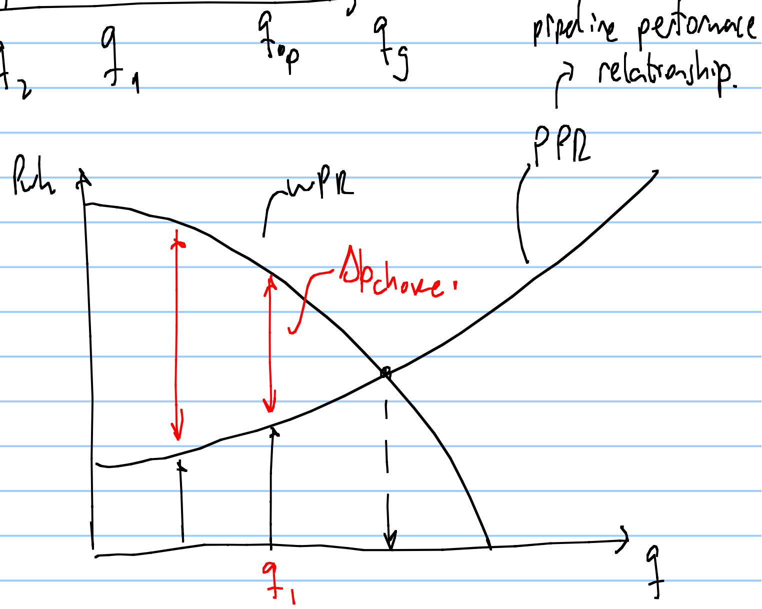
choke



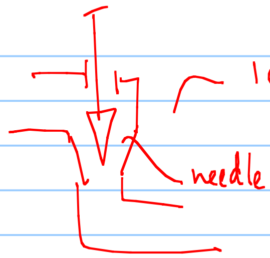






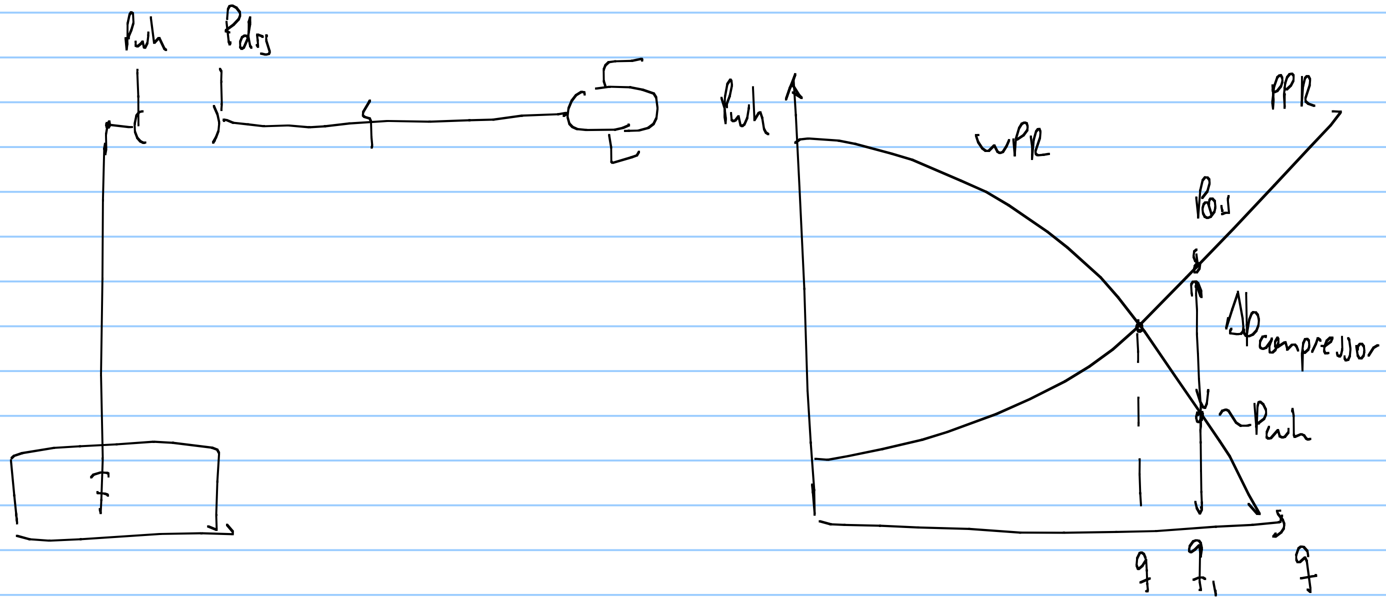


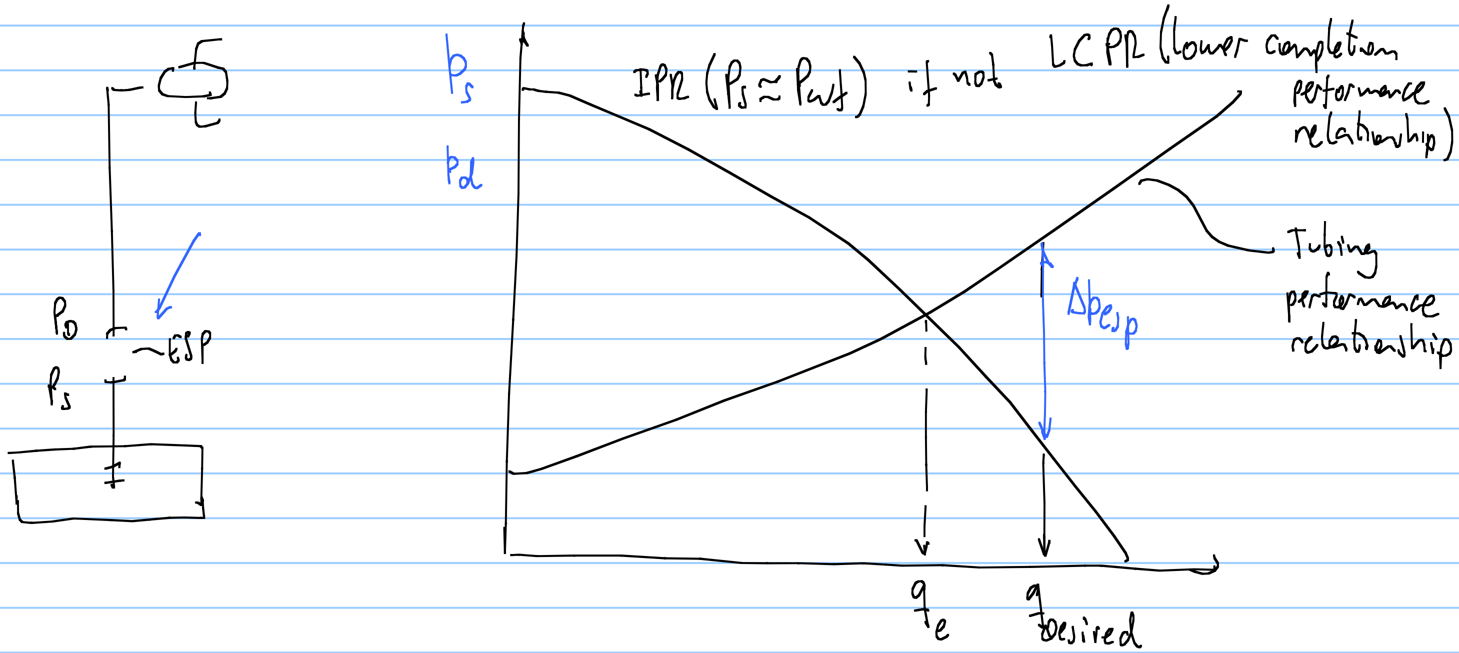
$(\Delta p_{choke1}, q_1)$



100% open $\Delta p_{choke} < \Delta p_{choke\ desired}$

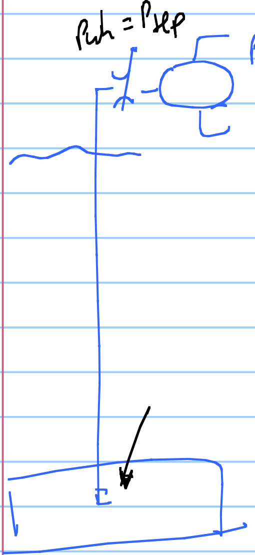
• Boosting equipment : compressor (surface), ESP (electrip submersible pump),

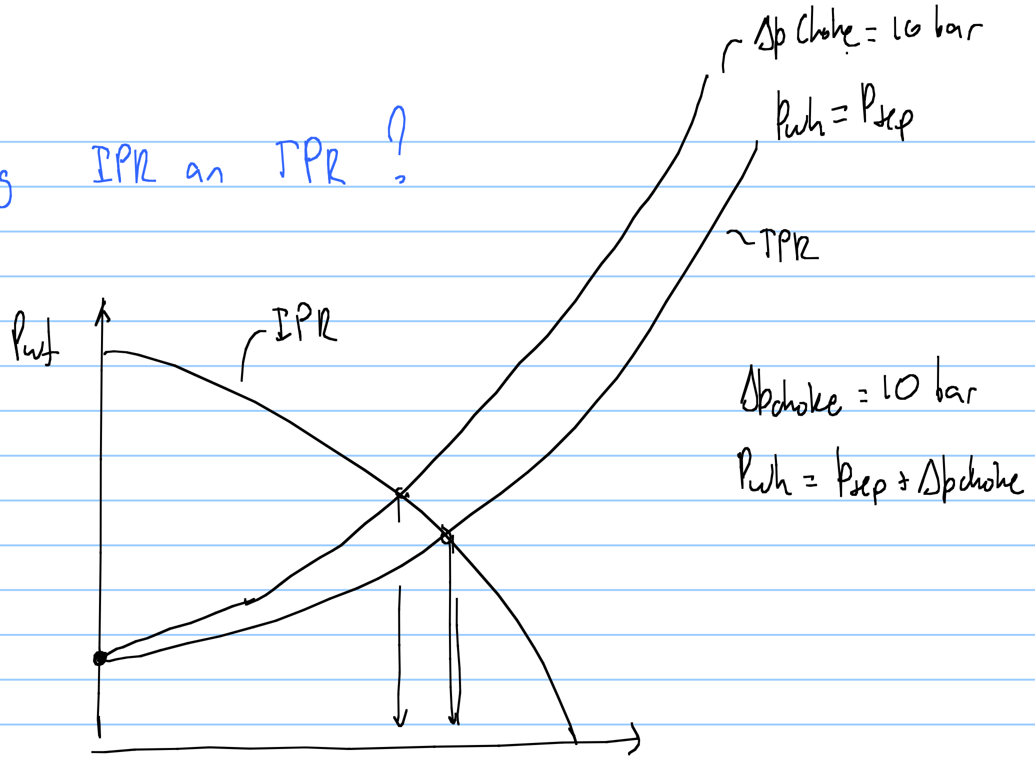


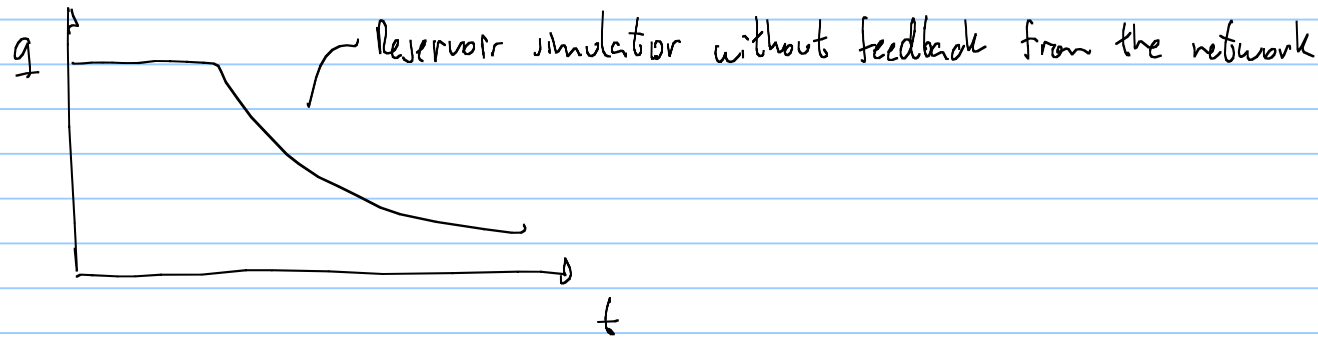


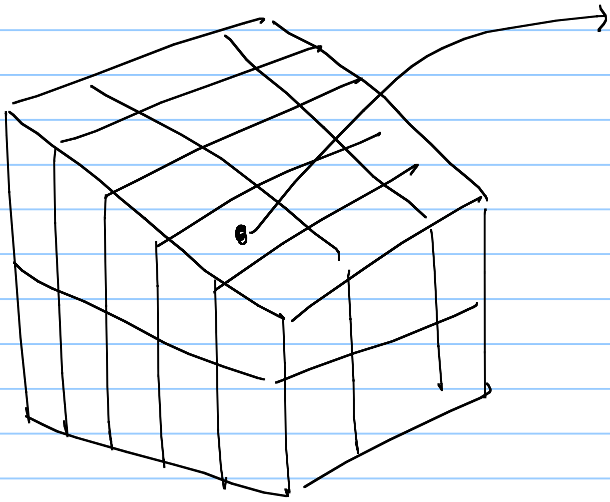
$(q_{desired}, \Delta p_{esp}) \rightsquigarrow$

Choke design using IPR an TPR ?





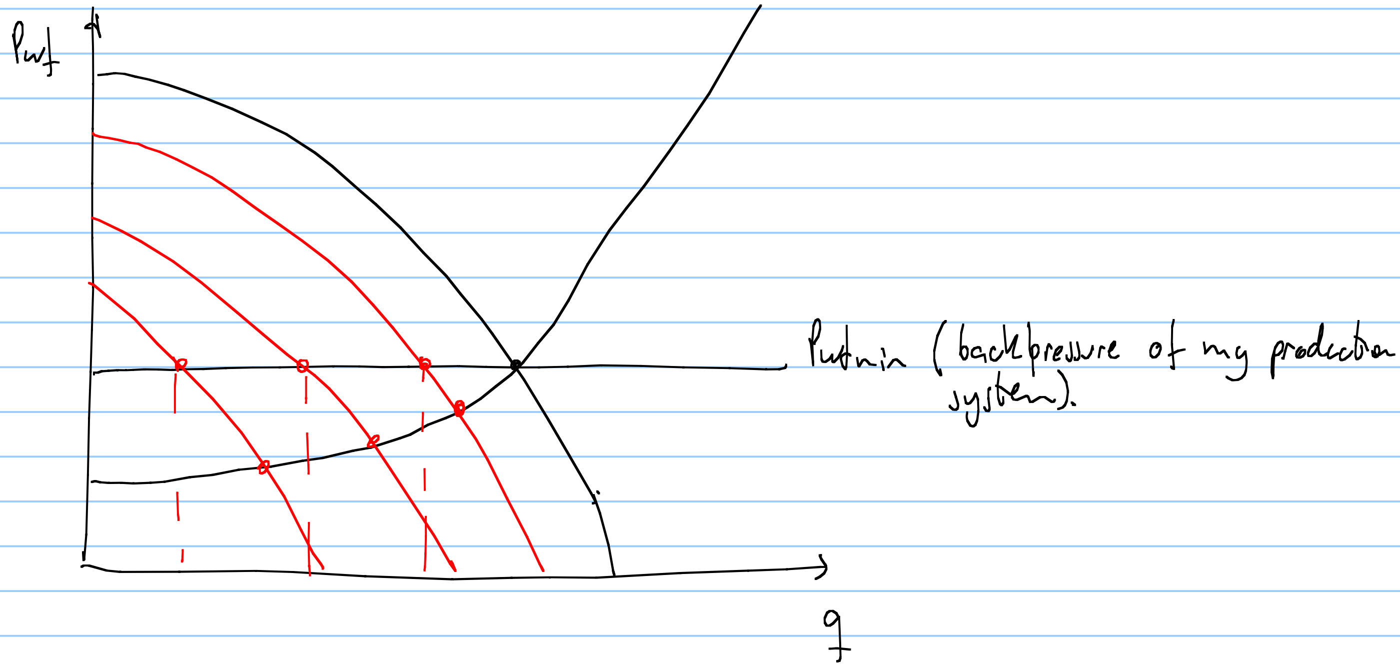


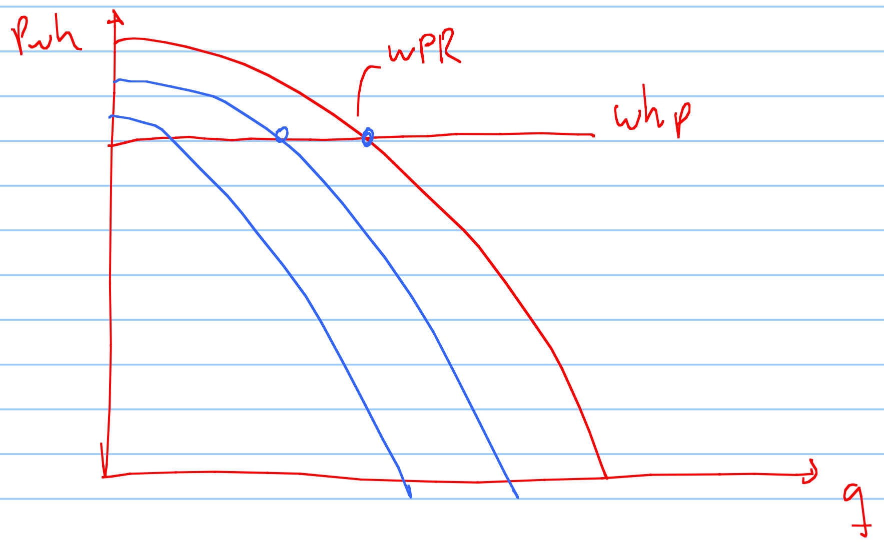


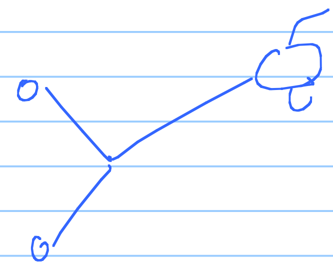
q_{target}, $P_{wf\,min}$

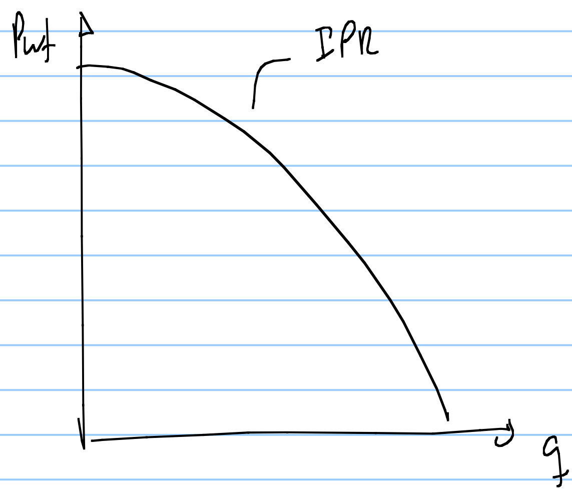
for every timestep, the reservoir simulator

- impose $P_{wf\,min}$ at the well boundary
- calculate q_{well}
- check if $q_{well} \geq q_{target}$
  - YES: increase P_{wf} until $q_{well} = q_{target}$
  - NO: produce q_{well} because q_{target} is unfeasible.







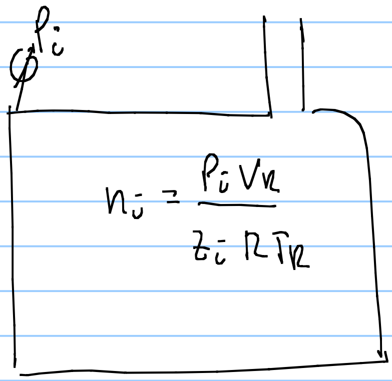


$q = C_R \left(P_R^2 - P_{wf}^2\right)^n$ C_R, n constant with time

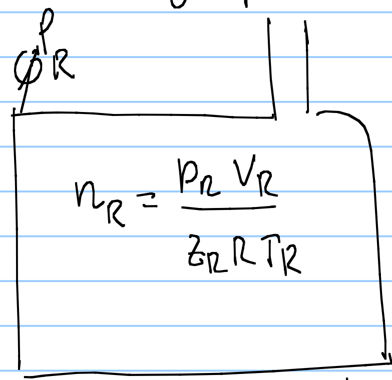
to compute IPR for different times I just need P_R

Dry gas material balance $P_r = f(G_p) = f\left(\int_0^t q_g \, dt\right)$

any depletion state



$T_R = \text{const.}$



Real gas Equation of state $PV = znRT$

universal gas constant

Temperature

moles

- Single phase gas
- No condensation in the reservoir
- No rock compressibility
- Neglect connate water expansion
- No injection

proportional

$\propto (G - G_p)$

$P . V = z n R T$

CT.

constant

Constant

$$\left(\frac{G - G_p}{G}\right) = \left(\frac{n_i - n_p}{n_i}\right)$$

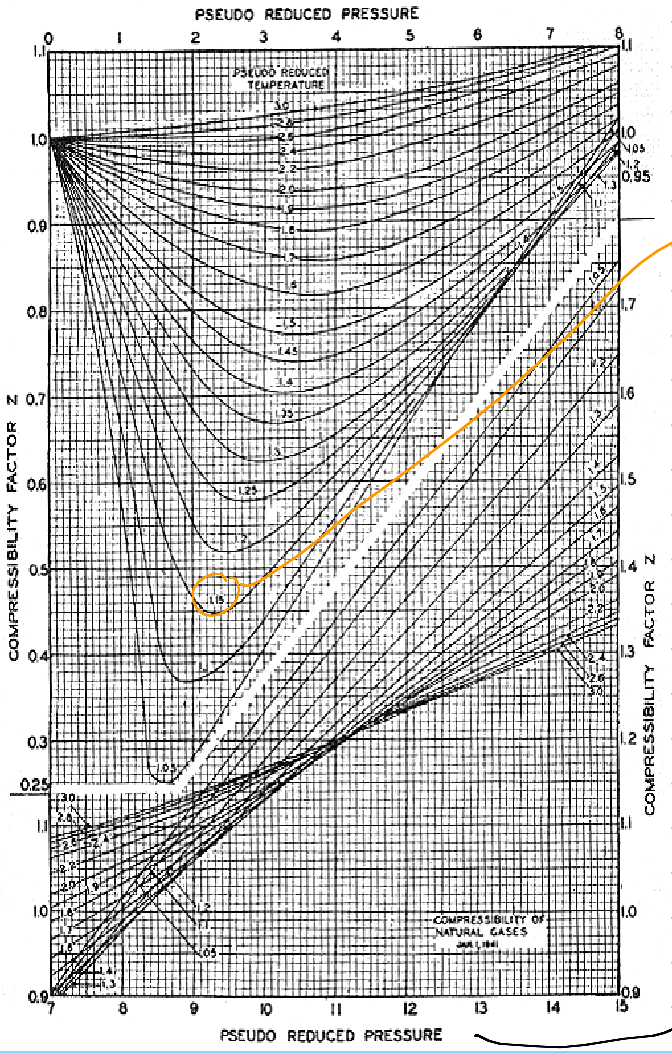
$$\frac{P_R}{z_R} = \frac{P_i}{z_i}\left(1 - \frac{G_p}{G}\right) \quad \Big\} \quad P \text{ vs } t$$

recovery factor

provide $G_p \rightsquigarrow P_R$

G_p

$$\frac{P_R}{z_R} = \frac{P_i}{z_i}\left(1 - \frac{G_p}{G}\right)$$



$T_r = \frac{T}{T_c}$ our process is at constant temperature T_R = const.

? $P_r = \frac{P}{P_c}$

1 equation

2 unknowns

P_R, Z_R

1 equ

$$P_{Rcal} = Z_R \frac{P_i}{Z_i}\left(1 - \frac{G_p}{G}\right)$$

2 unknowns.

G_p	P_R	Z	P_{Rcalc}	ε
G_{p_1}	$\boxed{P_{R_1}}$	Z_{R_1}	$P_{R_1 calc}$	$(P_{R_1} - P_{R_1 calc})^2$

//

- Evolution of P_R vs t
- IPR
- tubing equation
- pipeline equation

use the tubing equation with proper T_{av}, z_{av}.

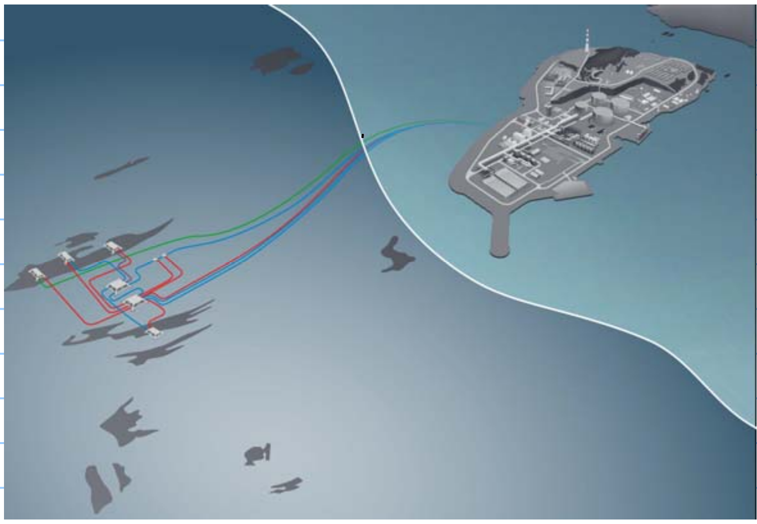
horizontal line $q = C_{PL}\left(P_1^2 - P_2^2\right)^{0.5}$

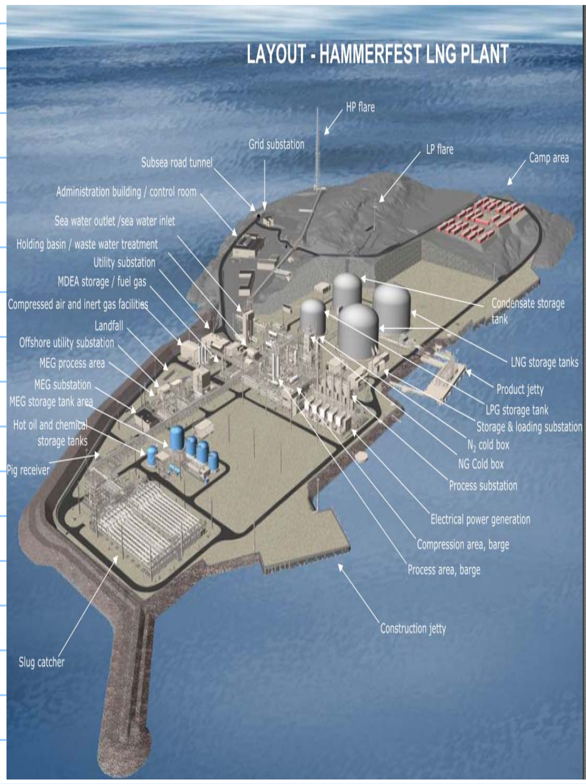
Snøhvit Field gas field

~150 km

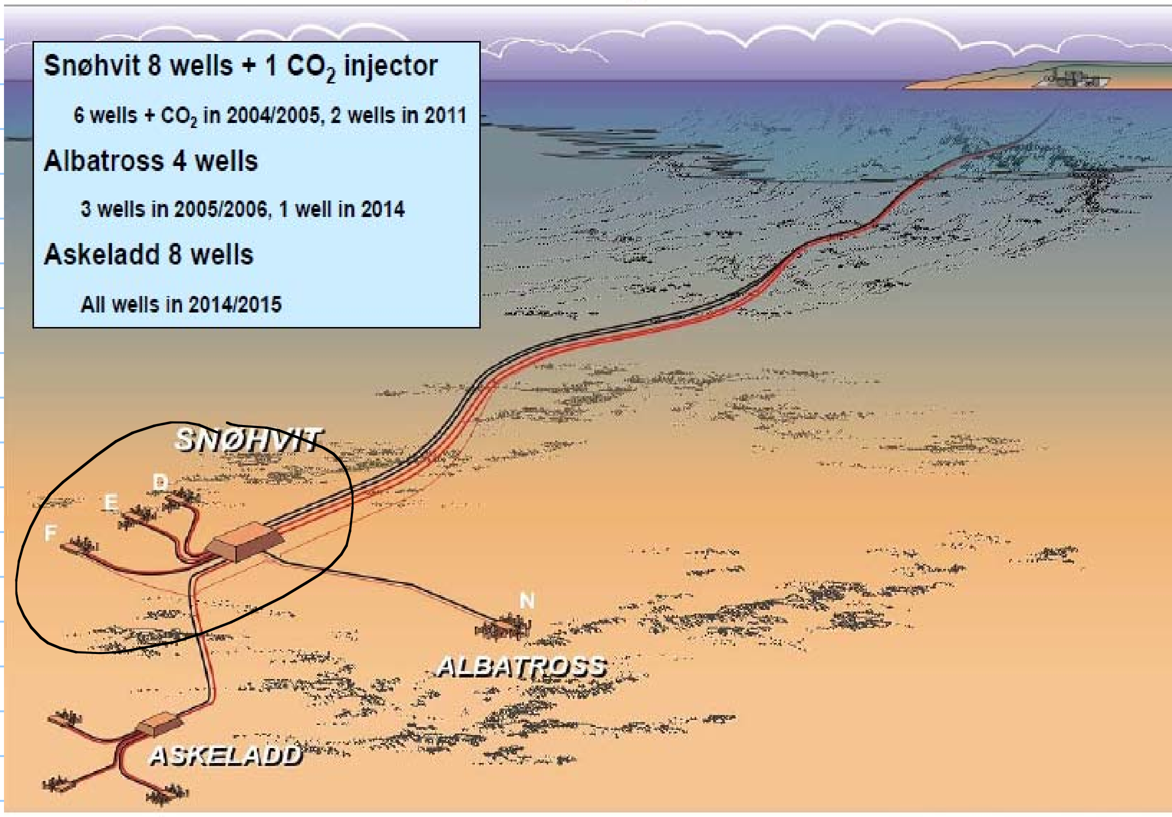
1984 discovered

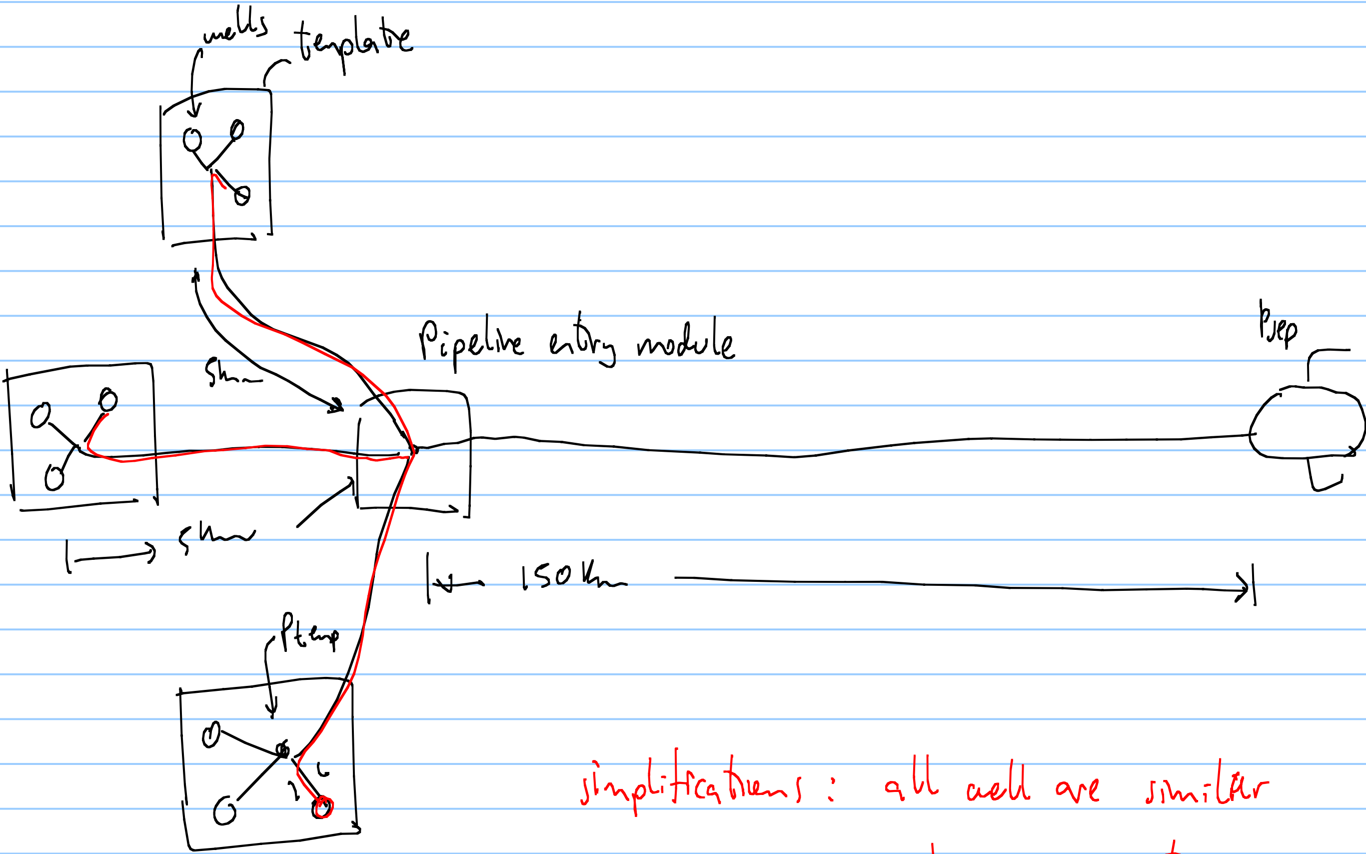
2007 began to produce





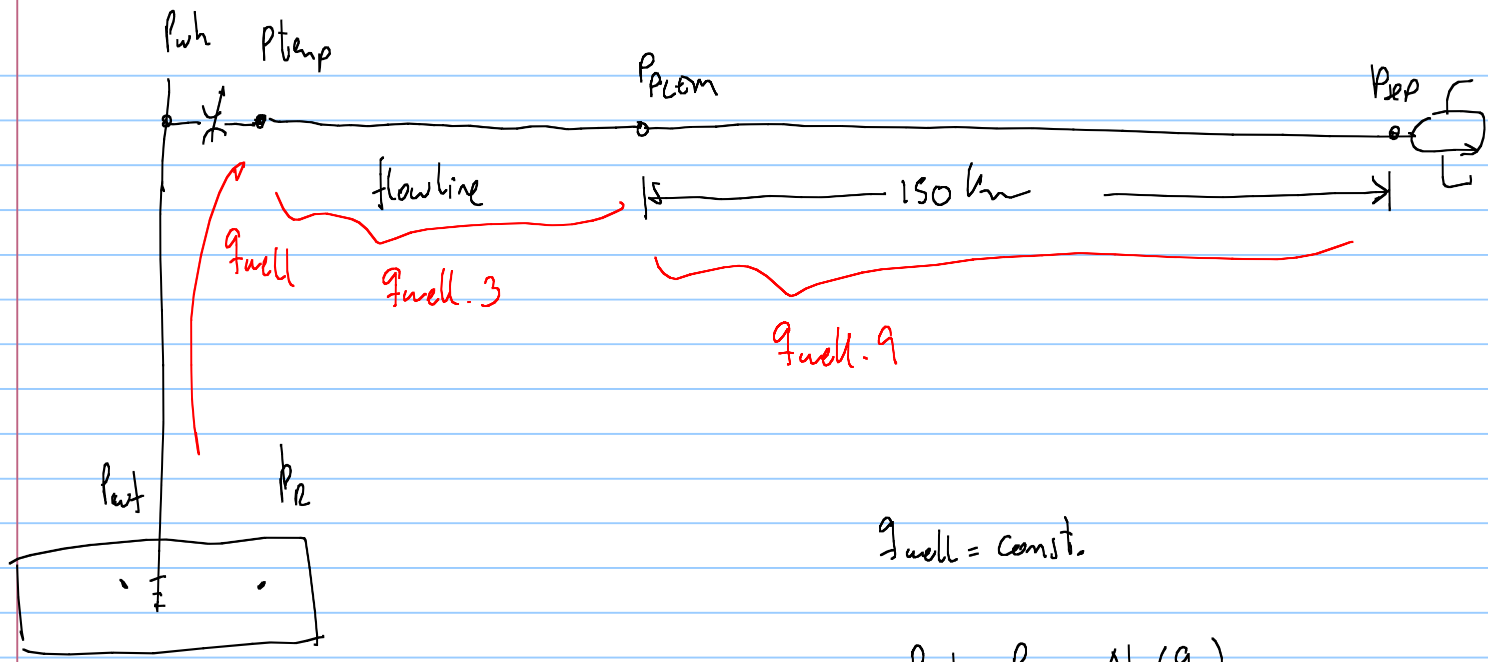
Snøhvit offshore – a subsea development





simplifications : all well are similar

: system is simetric



$q_{well} = \text{const.}$

$$P_{wf} = P_R - \Delta p(q, t)$$

$$\Delta p_{choke} = P_{wh} - P_{temp}$$