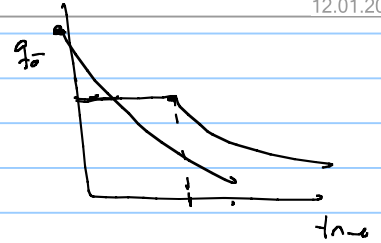


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Flow performance of production systems

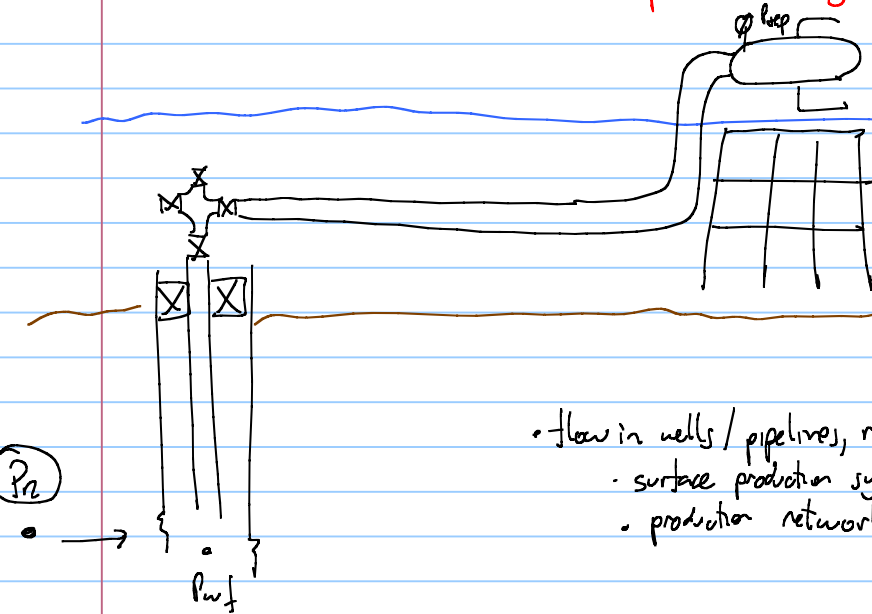
$$NPV \uparrow (q_o(t))$$



- Depends on:
 - deliverability of formation $\rightarrow$ storability of formation p vs time
 - pressure drop in porous media when fluids flow from formation to wellbore

discipline: Res. eng.

- model: a reservoir simulator
- material balance and
- Decline curve analysis



- flow in wells/pipelines, rivers $\rightarrow$ p and T drop along the system
- surface production system
- production network

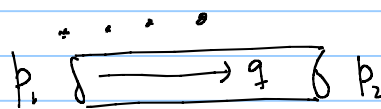
 p_2

p_2 is a function of time,

in early development stages only reservoir model is used for production forecast

Flow equilibrium:

horizontal pipe with single phase fluid



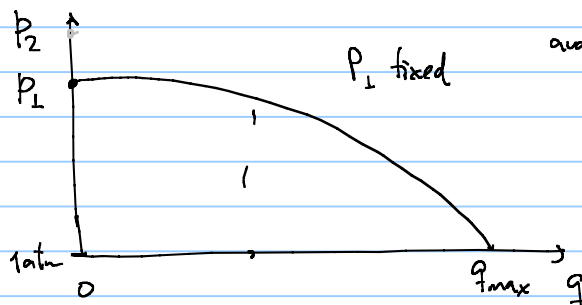
$$p_2 = p_1 + \Delta p$$

$$\Delta p \approx \Delta p_g + \Delta p_f$$

1: with p_1 fixed and q

$\hookrightarrow$ calculate p_2

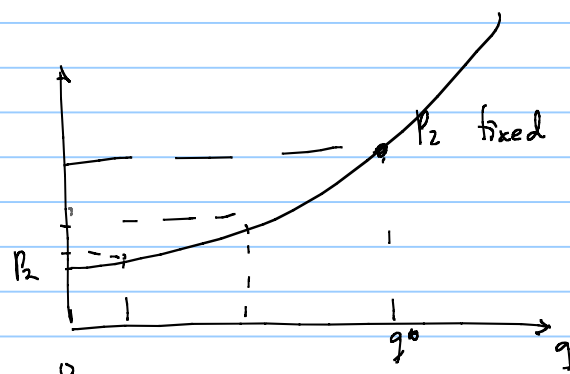
upstream to downstream calculation
co-current



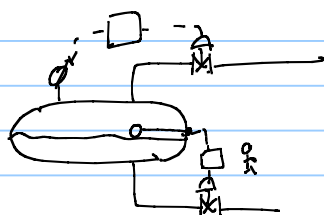
2: with p_2 fixed and q

calculate p_1

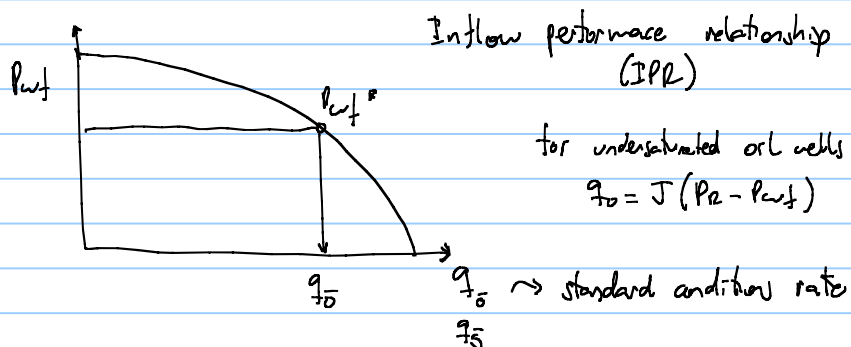
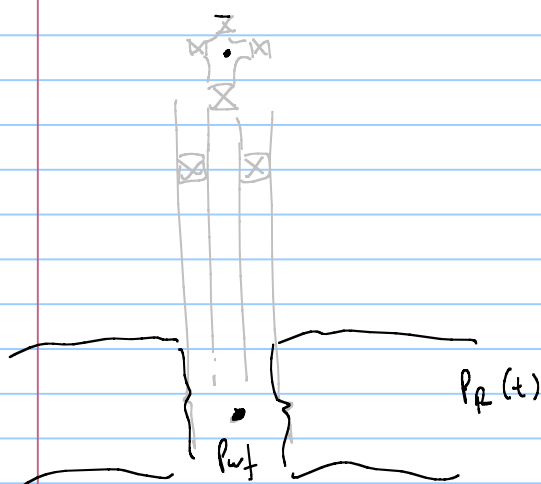
downstream to upstream calculation
counter-current



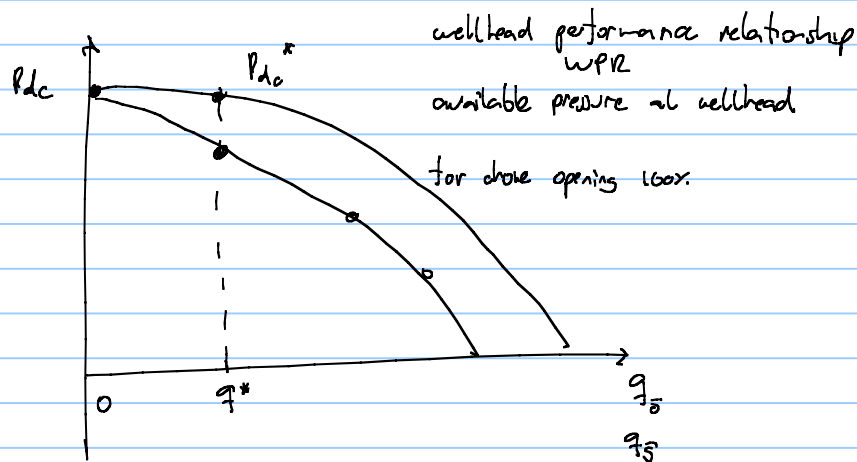
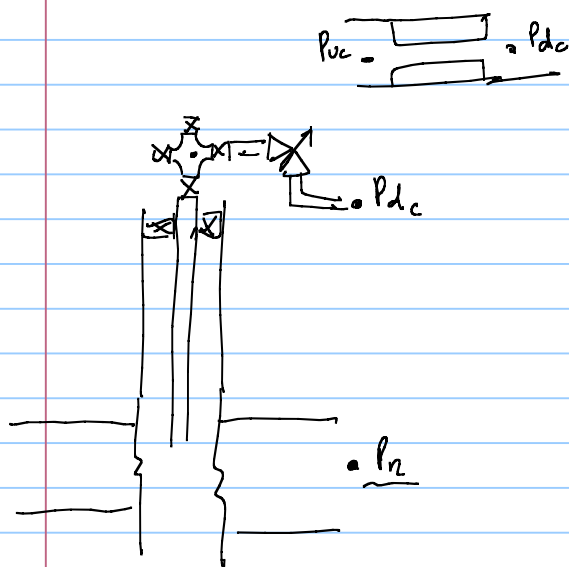
3: provide $P_1, P_2 \rightarrow$ calculate q



the same curves can be used to characterize parts of the production system



for dry gas
low pressure

$$q_o = C(P_R^2 - P_{wf}^2)^n$$


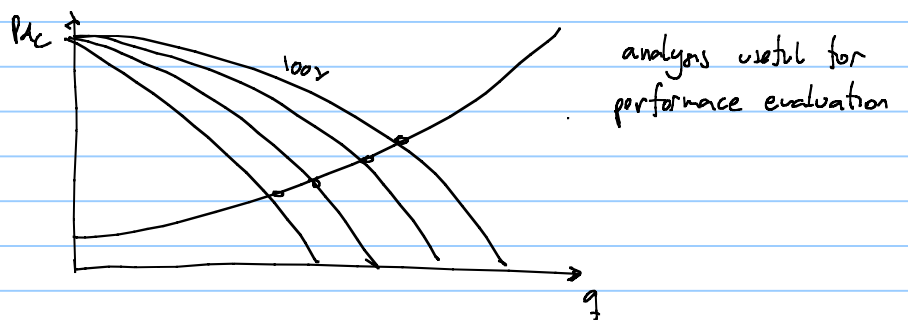
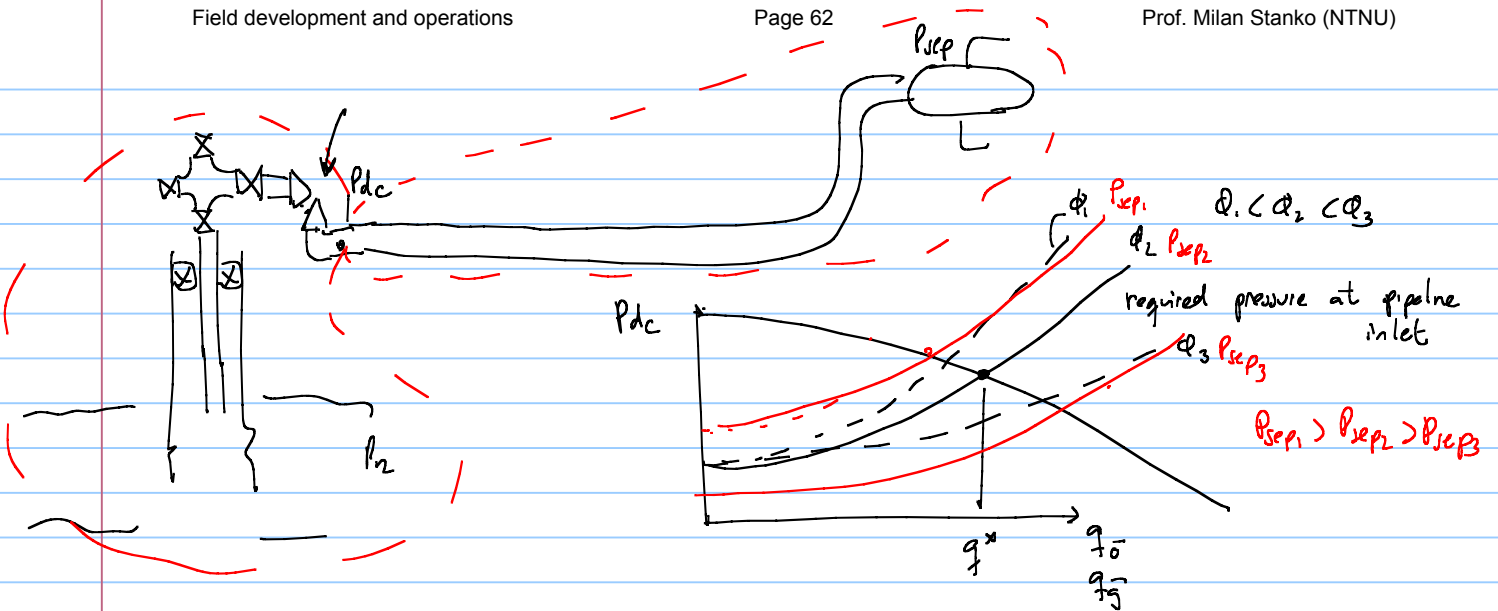
$$P_{dc} = P_R - \Delta p_{res} - \Delta p_{tubing} - \Delta p_{choke}$$

for 100% choke opening $\Delta p_{choke} = 0$

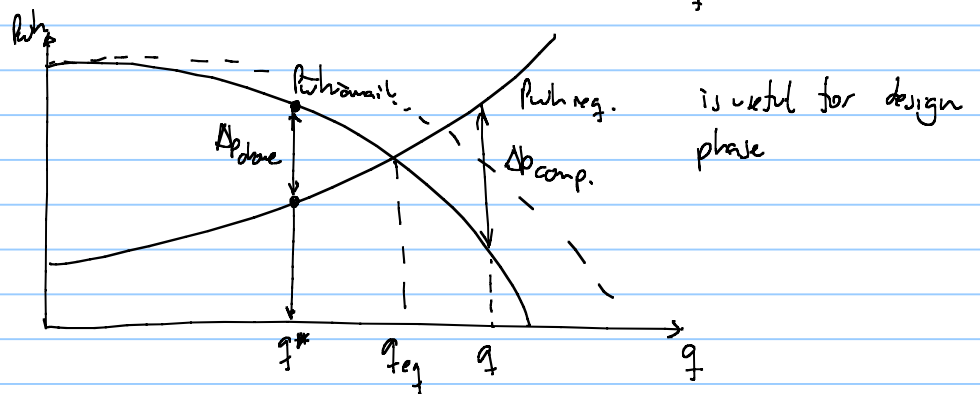
$$P_{dc} = P_R - \Delta p_{res} - \Delta p_{tubing}$$

for 80% choke opening $\Delta p_{choke} \neq 0$

$$P_{dc} = P_R - \Delta p_{res} - \Delta p_{tubing} - \Delta p_{choke}$$

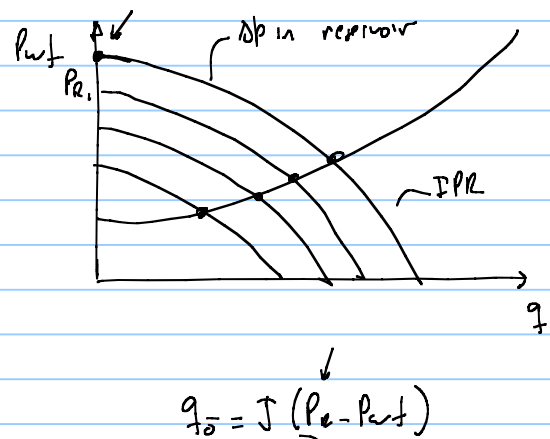
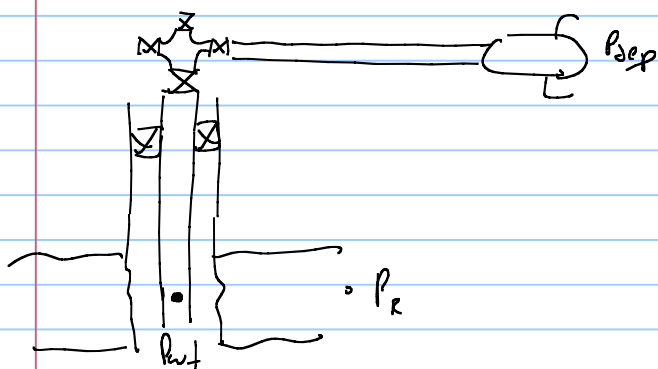


- remove the choke from system (assume open choke)



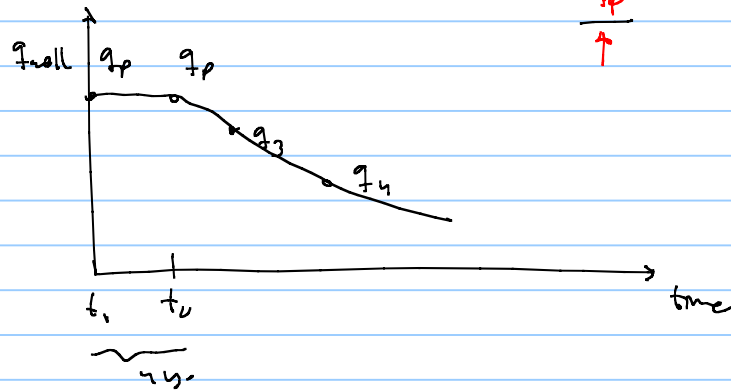
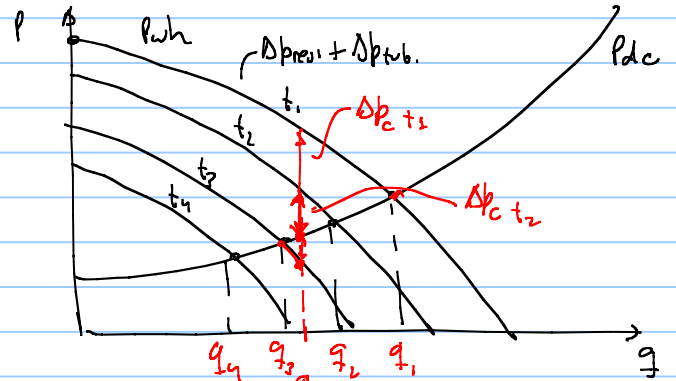
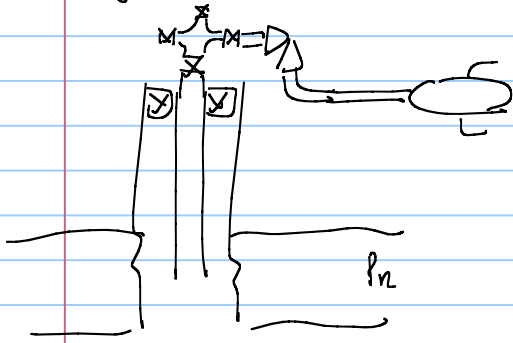
for design-type analysis, the equilibrium point must be at location of equipment.

Depletion effect (time effect)



$$q_o = J(P_R - P_{wf})$$

System with depletion and adjustable choke



when the flow is multiphase G + liquid O + gas + water the pressure curve looks slightly different

