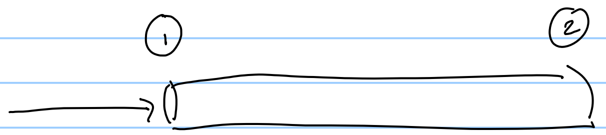
Note Title 12.01.2017

MENU FOR TODAY

- Work in groups on problem 1 exercise set Nr 3. → production scheduling using flow equilibrium

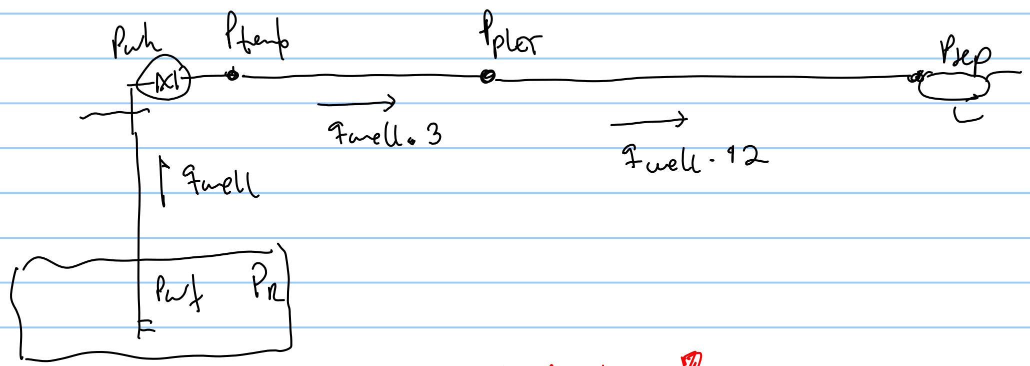
http://folk.ntnu.no/stanko/Courses/TPG4230/2017/Exercises/Exercise_0:

- Network solving → flow equilibrium in networks → theory
- Work in groups on problem 2 exercise set Nr 3. → using flow equilibrium



points ① and ② are defined by the flow direction. ① inlet, upstream
② outlet, downstream.

in our problem



Equilibrium point is the wellhead choke

co-current calculations:

co-current from reservoir to wh → IPR p_{wf}, using P_1 (P_R) calculate P_2 (P_{wf}) using q_{well}

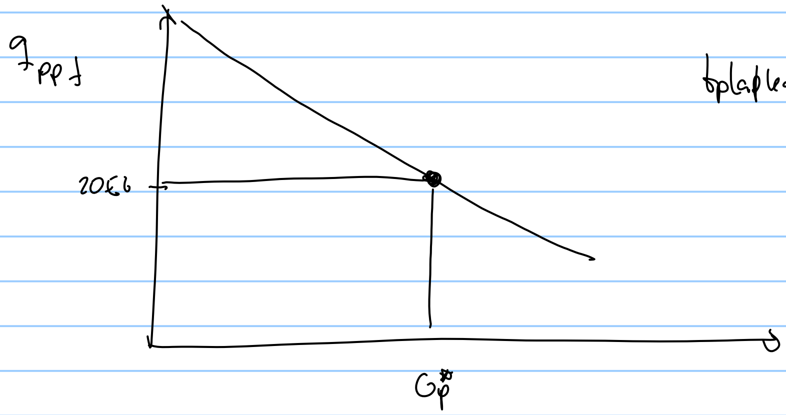
co-current from bottom-hole to wellhead → tubing P_2, using P_1 (P_{wf}) calculate P_2 (P_{wh}) using q_{well}

counter current calculations

- counter current from sep to pplet, use tubing eq, tubing P_1, using P_2 (P_{sep}) calculate P_1 (P_{PLET}) using q_{field}, (Remember to use C_{PL}, and S_PL !)
- counter current from pplet to template. use line P_1, using P_2 (P_{PLET}) calculate P_1 (P_{templ}) using q_{temp}

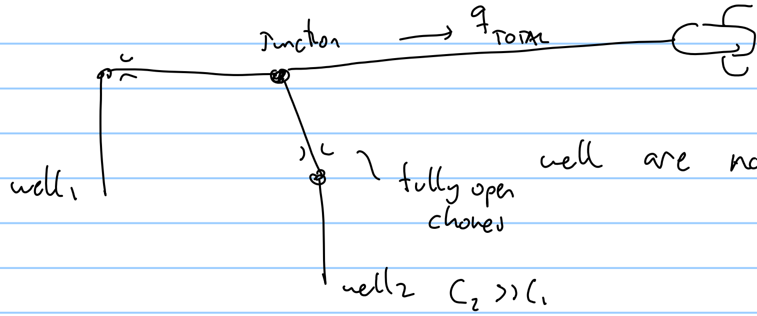
$$\Delta p_{choke} = P_{wh} - P_{Temp}$$

TASK 2: comments

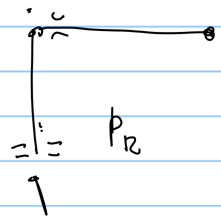


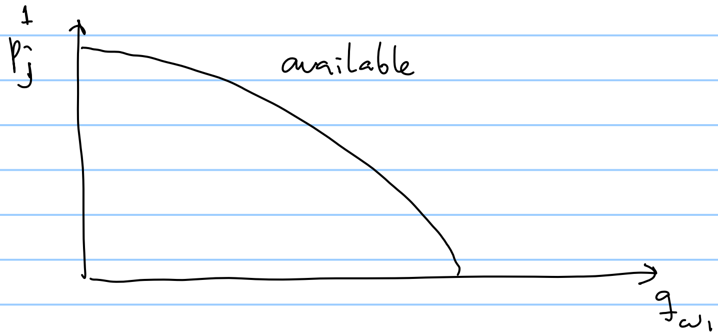
$$t_{plateau} = \frac{G_p^*}{2E6 \cdot 360}$$

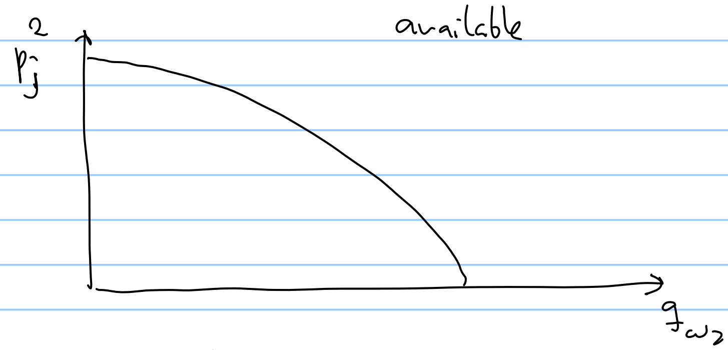
flow equilibrium in production networks

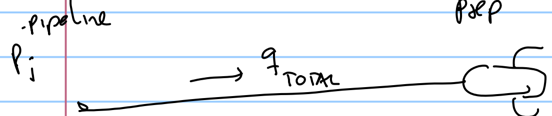


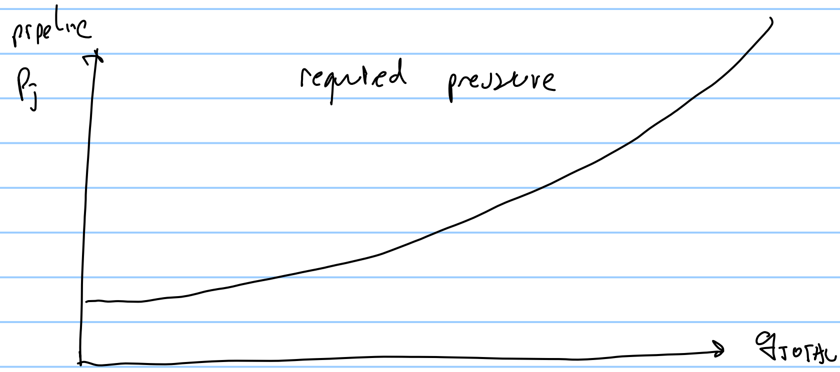
well are not identical, producing differently





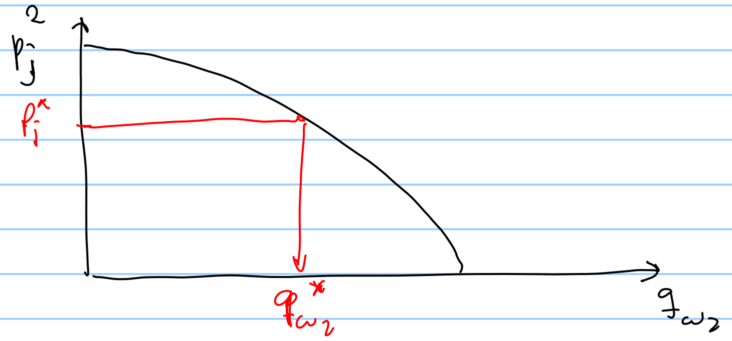






- Assume a unique junction pressure p_j^*
- from available pressure curve of well 1 calculate q_{w_1}

- from available pressure curve of well 2 calculate q_{w_2}



- from the required pressure curve of pipeline, calculate q_{TOTAL}

- Verify mass conservation in the junction

  if $q_{TOTAL}^* = q_{w_1}^* + q_{w_2}^*$ (NO → return to "Assume a unique junction pressure p_j^*")

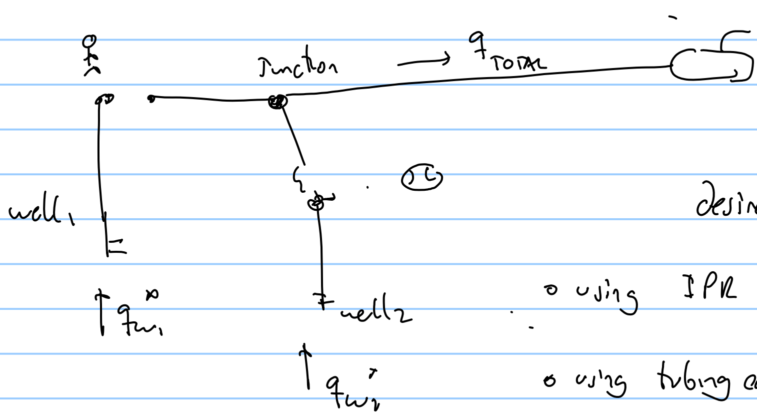
  YES ↓

  p_j^*, $q_{w_1}^*$, $q_{w_2}^*$, q_{TOTAL}^* are the equilibrium conditions

the equilibrium point is often calculated numerically, graphically is more difficult with increasing number of junctions.

equations	unknowns	Nr equ	Nr unknowns
IPR eq w1, IP eq w2	q_{w1}, q_{w2}, P_{wf1}, P_{wf2}	2	4
tubing eq 1, tubing eq 2	P_{wh1}, P_{wh2}	4	6
flowline 1, flowline 2	P_j	6	7
Pipeline eq	q_{TOTAL}	7	8
mass conservation in the junction $q_{TOTAL} = q_1 + q_2$		8	8 ✓

Fixed rate calculation method for networks.



desired rates q_{w1}^*, q_{w2}^*

- using IPR and q_w^* calculate P_{wf1}, P_{wf2}
- using tubing equation, P_{wf}, q_w calculate P_{wh1}, P_{wh2}
- using pipeline equation, P_{sep}, $q_{TOTAL}^* = q_{w1}^* + q_{w2}^*$ calculate P_j
- using flowline equations for each well, P_j, q_{w1}^*, q_{w2}^* calculate P_{dc1}, P_{dc2} dc → downstream of choke

verify if $P_{wh,1} > P_{dc1}$

$P_{wh,2} > P_{dc2}$

if there are adjustable elements A network can be considered as a function that provides well rates with certain setting of the adjustable element

output (well rates)

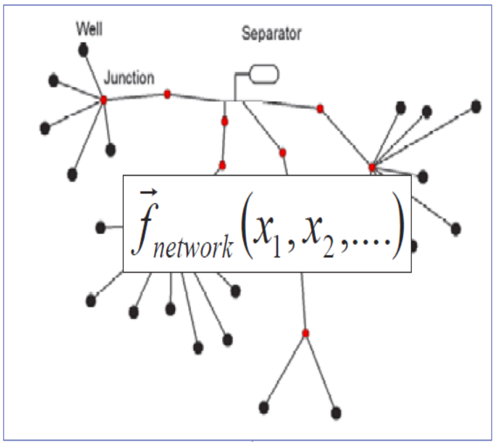
input (setting of the adjustable element):

choke opening 1

choke opening 2

Boundary conditions for injectors or producers:
-Well Inflow performance relationship (IPR)

INPUT



OUTPUT

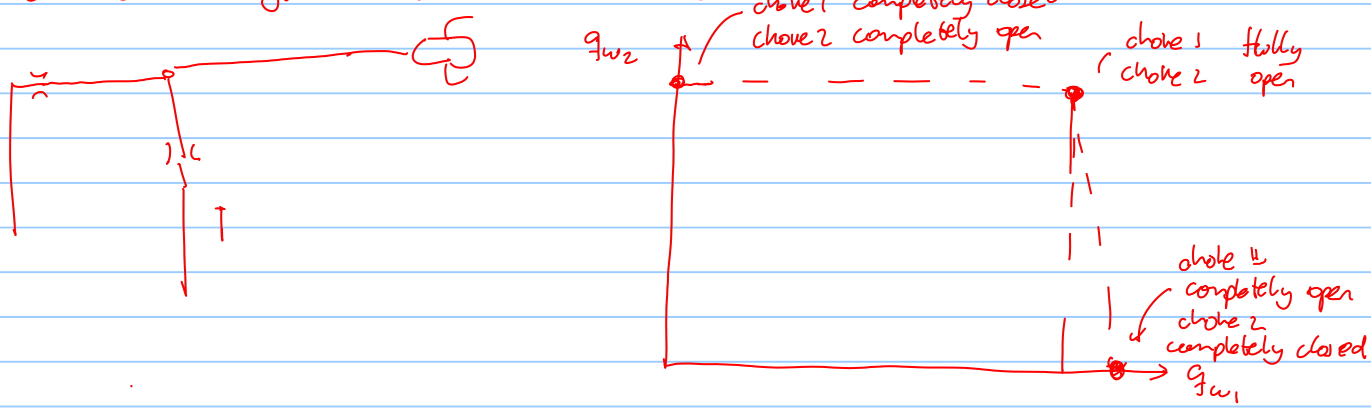
- **Well flow rates**
- Pressure and temperature along the system

INPUT

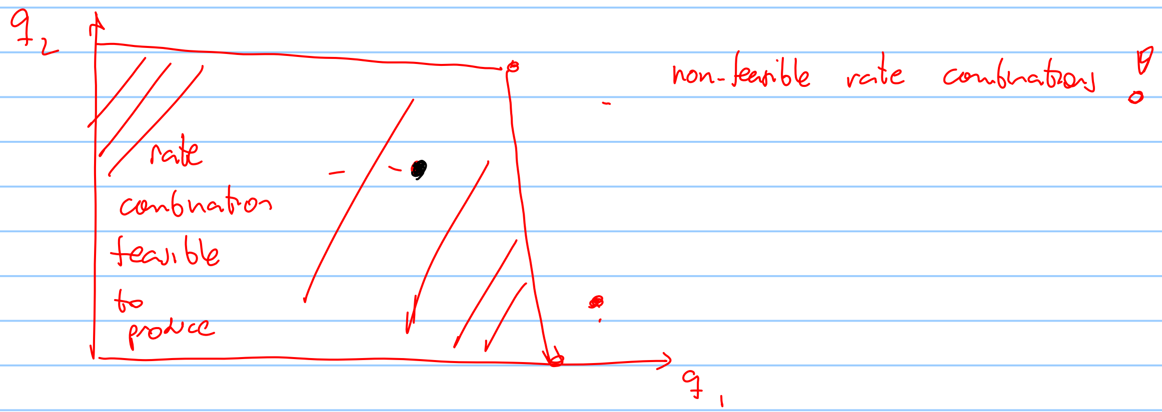
- System Properties (pipe dimensions, layout, fluid composition, EOS, separator pressure, ambient temperature)
- **Adjustable variables**: choke opening, well routing, Inflow control valves, gas lift injection rate, diluent injection rate, pump frequency, compressor.

These usually vary during the life of the field.

for the two well system with wellhead chokes



if I run my network with infinite combination of choke openings



in comercial software the process of finding the settings of adjustable elements that give a certain rate combination (q_{w1}^*, q_{w2}^*) is wrongly called optimization!

opening of choke OC