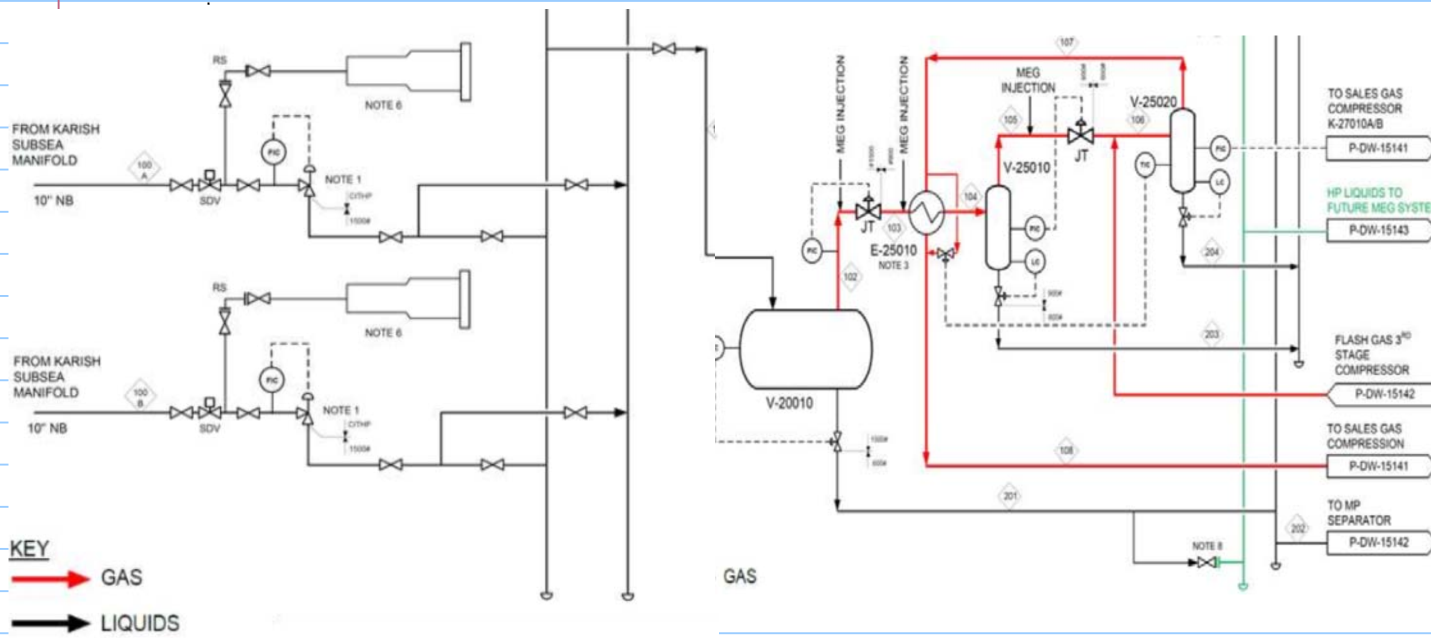
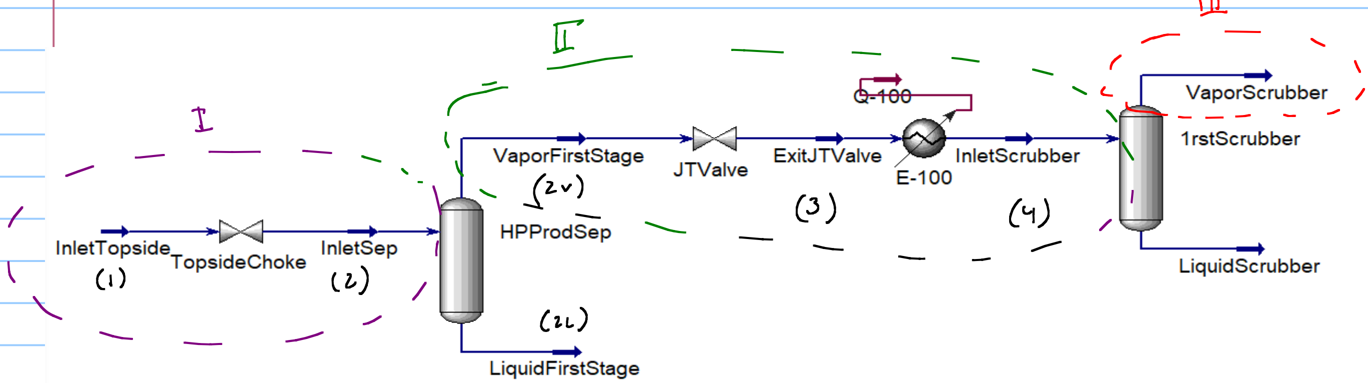
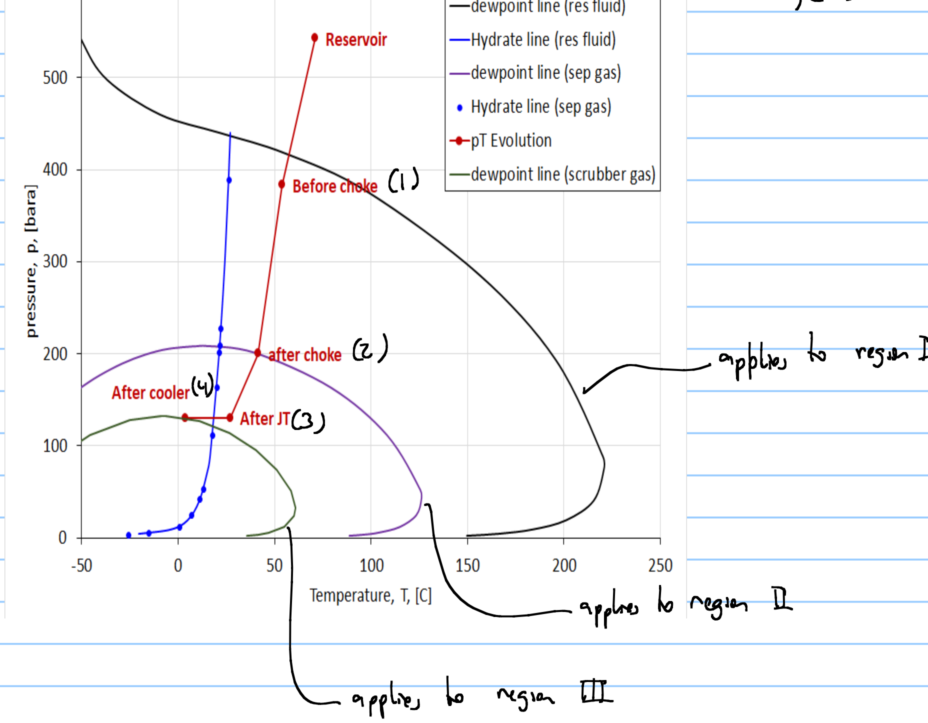
Modeling the topside facilities of the Karish and Tanin field in Hysys



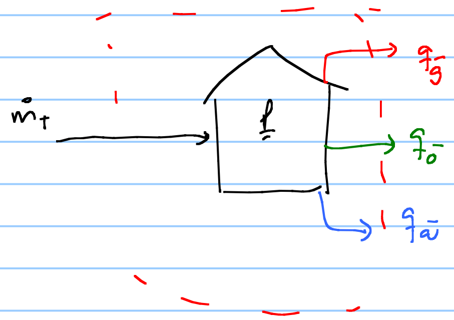
Hysys model:



(2),(2v) and (2L) have the same p,T conditions



Estimating inlet mass flow to the processing facilities:



$$\dot m_T = q_{\bar g}\,\rho_{\bar g} + q_{\bar o}\cdot\rho_{\bar o} + q_{\bar w}\cdot\rho_{\bar w}$$

m^3/d $\frac{kg}{m^3}$

assume $q_{\bar o}$ and $q_{\bar w} << q_{\bar g}$

gives:

$$\dot m_T \approx q_{\bar g}\,\rho_{\bar g}$$

$$\frac{p_{sc}}{\rho_{sc}} = \frac{R_u}{MW}\cdot T_{sc}$$

$$\rho_{\bar g} = \rho_{sc} = \frac{p_{sc}\,MW}{R_u\,T_{sc}}$$

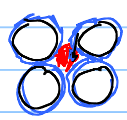
B11 =1.01325/(0.08314*(15.56+273.15)/(B4*28.97))

	A	B	C
1	Class exercise, TPG4230, Prof. Milan Stanko (NTNU)		
2			
3	Initial separator pressure	200	bara
4	Gas specific gravity	0.612	[-]
5	Reservoir Temperature, T_R	71	°C
6	Initial reservoir pressure, p_{Ri}	542.5	bara
7	$p_{downstreamJTvalve}$	130	bara
8	$T_{arrivalFPSO}$	54	°C
9			
10	q_{Karish}	8.33E+06	[Sm3/d]
11	sc gas density	7.48E-01	[kg/m3]
12	massflow	6.24E+06	[kg/d]

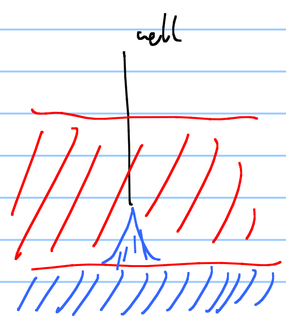
q_{Karish}	8.33E+06	[Sm3/d]
sc gas density	7.48E-01	[kg/m3]
massflow	6.24E+06	[kg/d]

- water content in natural gas

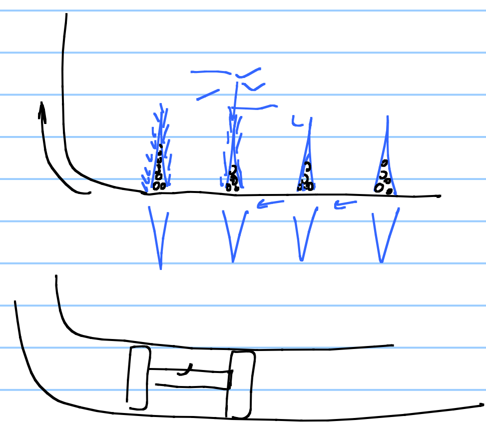
Sources of water in gas wells



Saturation from connate water



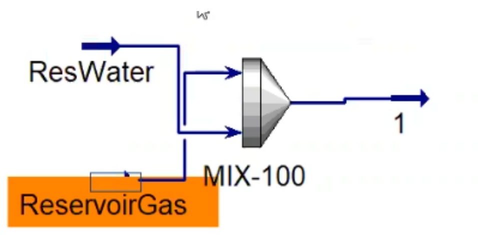
From aquifer (dangerous!)



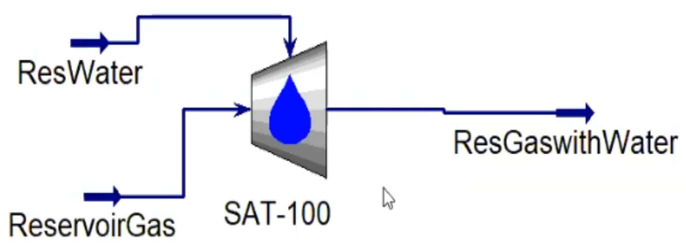
From frack jobs (shale gas)

In this field we assume water comes from saturation by connate water only

How to do it in Hysys?
OLD approach:
-Two streams, reservoir water and reservoir gas at same p and T
-Increase molar rate of res water until stream 1 just becomes two phase.
-Read the composition of stream 1

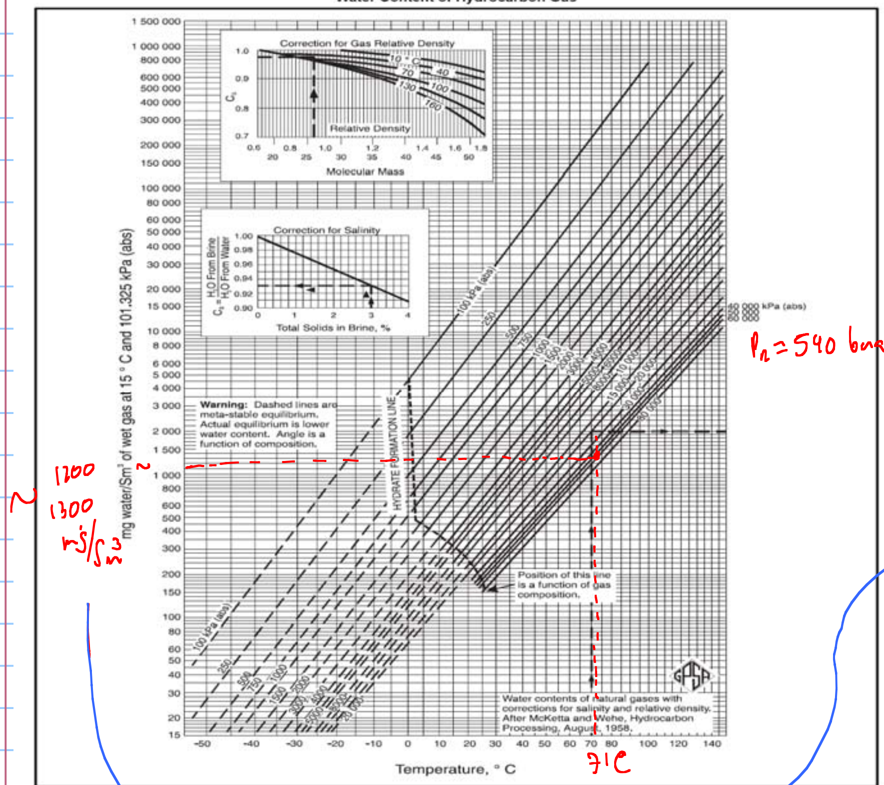


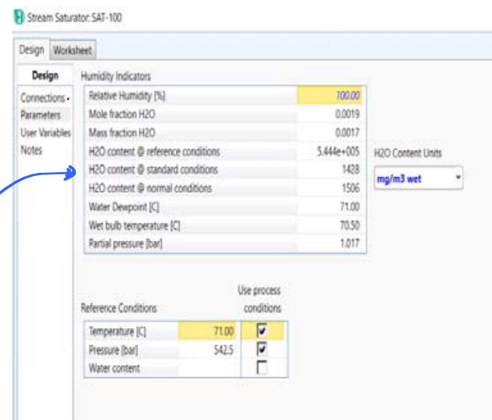
How to do it in Hysys?
NEW approach, use the saturation unit



Quality control of the result of the saturation unit:

FIG. 20-4
Water Content of Hydrocarbon Gas





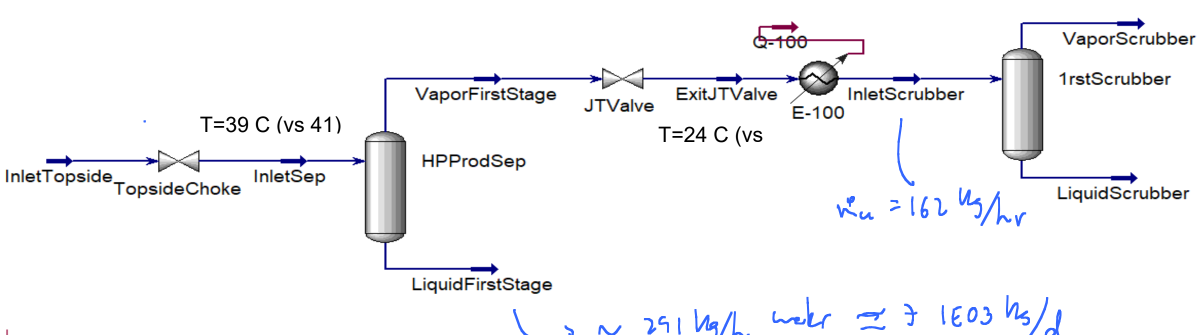
20-5

Similar to:

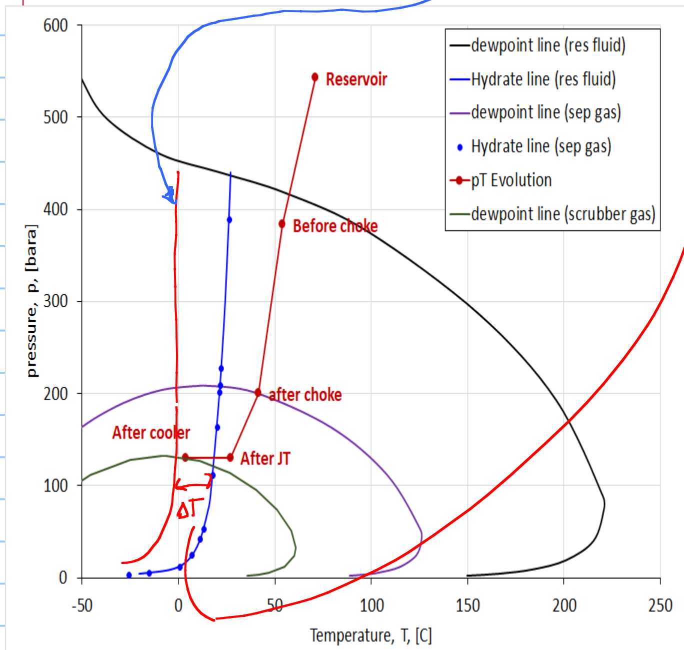
Component	Mole fraction (res gas)	Mole fraction (res gas sat with water)
N2	6.27E-03	6.26E-03
CO2	7.60E-04	7.59E-04
C1	9.42E-01	0.940683628
C2	1.56E-02	1.56E-02
C3	9.44E-03	9.42E-03
iC4	2.75E-03	2.74E-03
C4	2.97E-03	2.96E-03
iC5	1.80E-03	1.80E-03
C5	1.14E-03	1.14E-03
C6	1.90E-03	1.90E-03
C7	2.77E-03	2.76E-03
C8	1.78E-03	1.78E-03
C9	1.16E-03	1.16E-03
C10	1.00E-03	9.98E-04
C11	9.60E-04	9.58E-04
C12	8.90E-04	8.88E-04
C13	1.11E-03	1.11E-03
C14	6.20E-04	6.19E-04
C15+	4.65E-03	4.64E-03
H2O	0.00E+00	1.87E-03

New composition considering saturation with water

How does it affect our previous results?



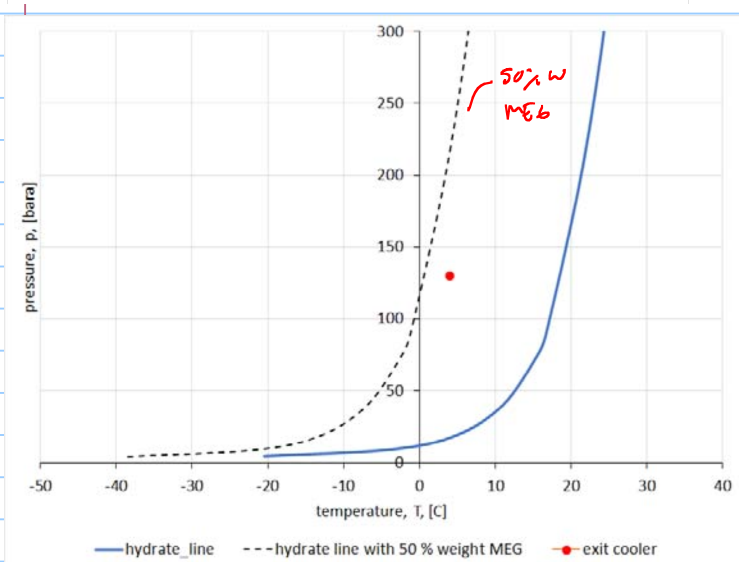
We have free water in the separator gas line, and after the cooler there is a risk of hydrate formation. Therefore it is necessary to inject an inhibitor (e.g. MEG), to move the hydrate line to the left. There should be enough MEG to suppress hydrates in the place where there is most water (just after the cooler)



$$wt\%\ MEG = \frac{\dot{m}_{MEG}}{\dot{m}_{MEG} + \dot{m}_{H_2O}}$$

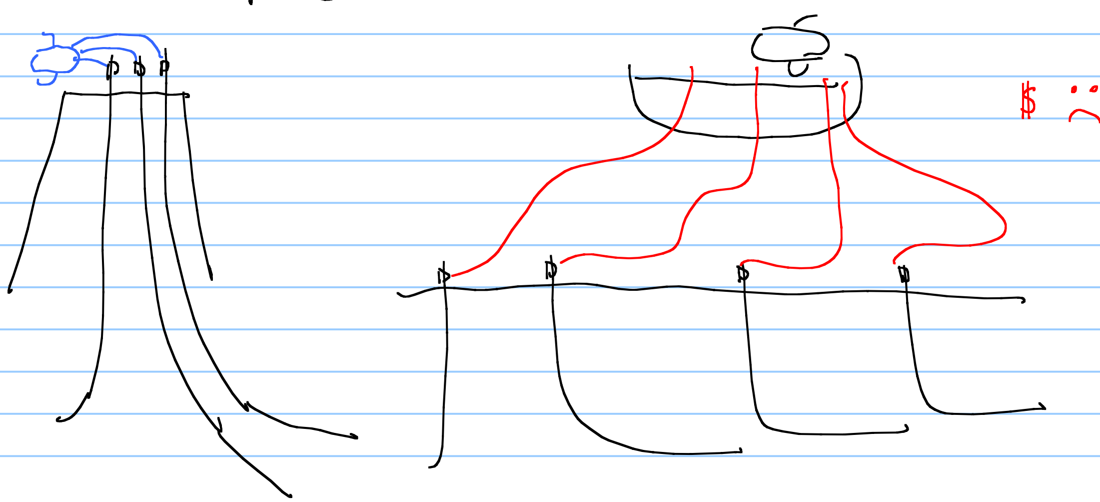
Can be calculated from Hammerschmidt equation

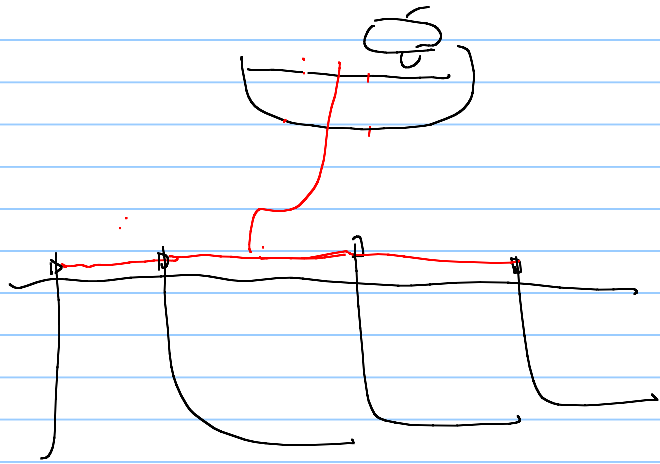
We can use the excel sheet of question 4, quiz 18:
http://www.ipt.ntnu.no/~stanko/files/Courses/TPG4230/2021/Quizzes/Quiz18.html
We substitute our hydrate line and calculate the amount of weight % of MEG required such that the outlet of the cooler is outside the hydrate formation zone

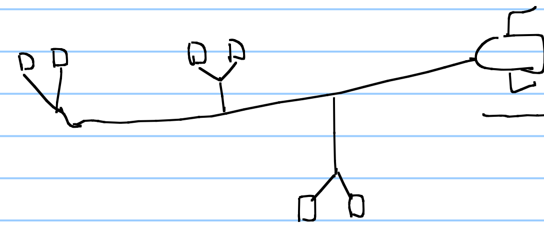


So approximately 162 kg/hr of MEG is needed

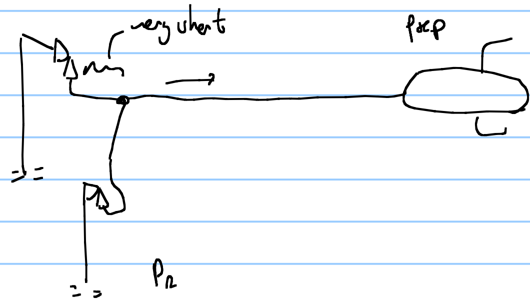
- Networks: collection of pipes, flowline, pipeline, valves, pumps, take the fluids from wells to the processing facilities.







Example: 2 Dry gas wells

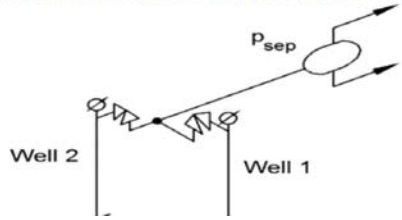


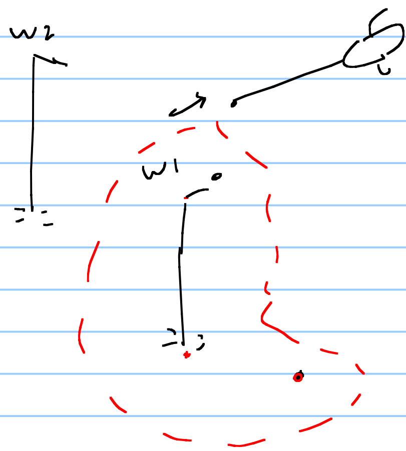
open choke $\Delta p_{c_1} = 0$ $\Delta p_{c_2} = 0$

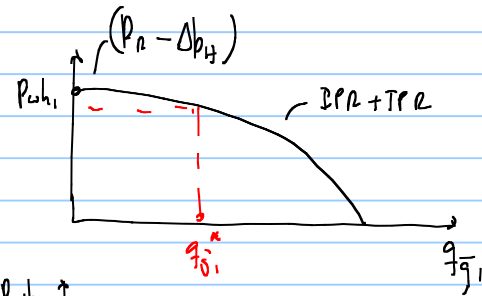
	Equations	Nr equations		Nr unknowns	
IPR	$q_{g_1} = C_{R_1}\left(p_{R_1}^2 - p_{wf_1}^2\right)^{n_1}$ $q_{g_2} = C_{R_2}\left(p_{R_2}^2 - p_{wf_2}^2\right)^{n_2}$	2		4	
TPR	$q_{g_1} = C_{T_1}\left(\frac{p_{wf_1}^2}{e^{s_1}} - p_{wh_1}^2\right)^{0.5}$ $q_{g_2} = C_{T_2}\left(\frac{p_{wf_2}^2}{e^{s_2}} - p_{wh_2}^2\right)^{0.5}$	2	4	2	6
PPR	$q_{g_1} + q_{g_2} = C_{PL}\left(p_j^2 - p_{sep}^2\right)^{0.5}$	1	5	1	7
	$\Delta p_{c_1} = 0$ $p_{wh_1} = p_j$	1	6	0	7
	$\Delta p_{c_2} = 0$ $p_{wh_2} = p_j$	1	7	0	7

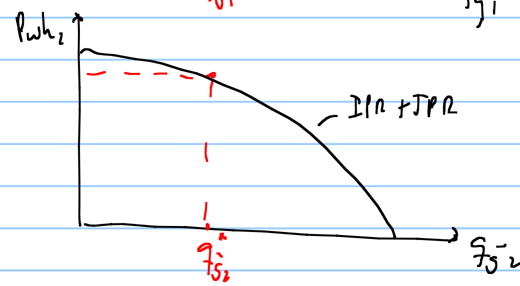
PROBLEM 4 (18 POINTS). Network solving. (2017) exam

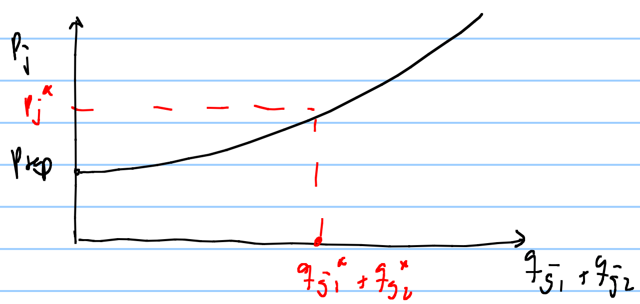
Consider the gas field with two wells, a manifold a pipeline and a separator shown in the figure below. The wellhead of the wells are very close to the junction so it can be safely assumed that the wellhead pressure and junction pressure are equal when the choke is open.











approach nr. 1

1: assume q_{g1}^*, q_{g2}^*

2: Read P_{wh1}^* (WPR1), P_{wh2}^* (WPR2), P_j^* (PPR)

3: Verify $P_{wh1}^* = P_{wh2}^* = P_j^*$ — not → back to 1

↓ yes

q_{g1}^*, q_{g2}^* are solution

approach nr. 2

1. assume $P_j^* = P_{wh1}^* = P_{wh2}^*$

2. Read q_{g1}^* (WPR1), q_{g2}^* (WPR2), $q_{pipeline}^*$ (PPR)

3. Verify

$q_{g1}^* + q_{g2}^* = q_{pipeline}^*$ — not → back to 1

↓ yes

solution

1st iteration

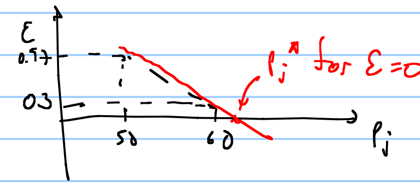
$p_j = 50$ bara

$q_{g_1}^* = 1.2\text{E}06$ Sm³/d
$q_{g_2}^* = 1.57\text{E}06$ Sm³/d + → 2.77 E6 Sm³/d → $\varepsilon = 0.97$ 1E06 Sm³/d
$q_{pipeline}^* = 1.8\text{E}06$ Sm³/d → 1.8 E06 Sm³/d

2nd

$p_j = 60$ bara

$q_{pipeline}^* = 2.3\text{E}06$ Sm³/d → 2.3 E06 Sm³/d → $\varepsilon = 0.3$ 1E06 Sm³/d
$q_{g_2}^* = 1.45\text{E}06$ Sm³/d + → 2.60 E06 Sm³/d
$q_{g_1}^* = 1.15\text{E}06$ Sm³/d



$$\frac{\varepsilon_1 - \varepsilon_2}{p_{j_1} - p_{j_2}} = \frac{\varepsilon_1 - 0}{p_{j_1} - p_j^*}$$

$p_j^* = \sim$