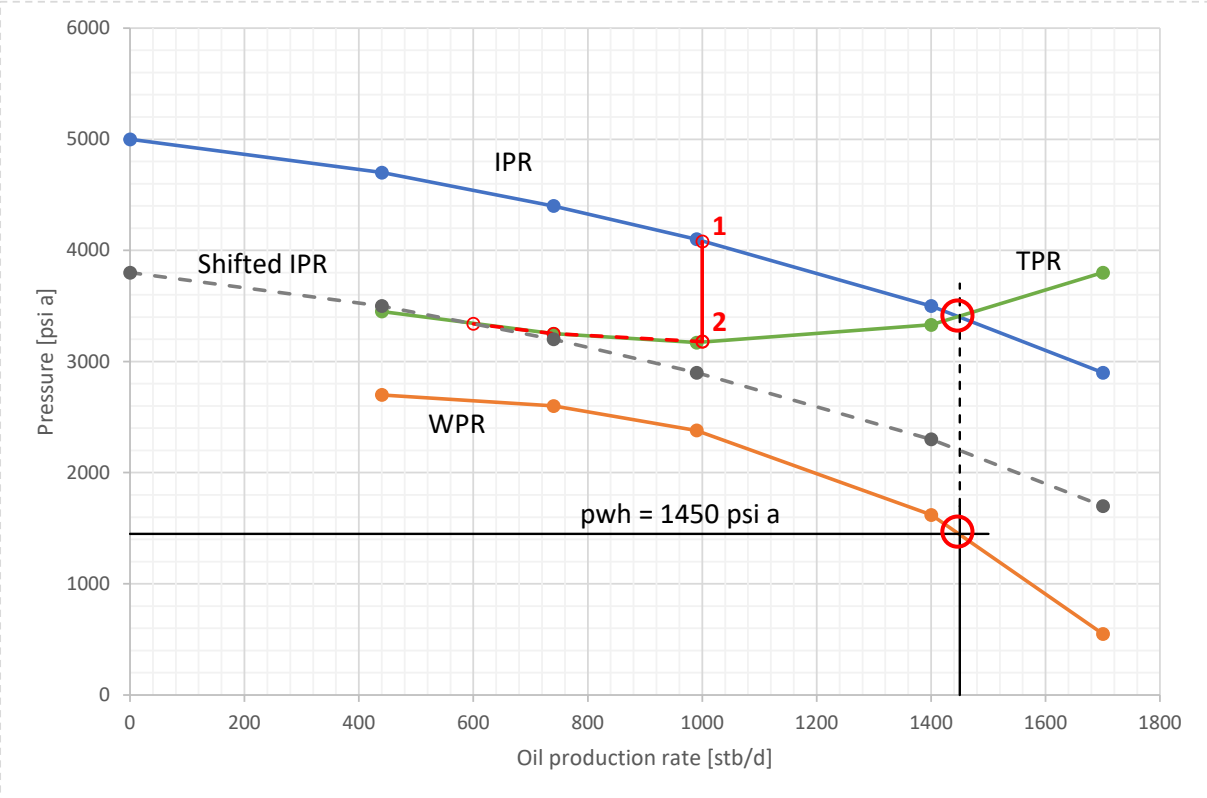
ENP100 - Prosess og produksjon

Øving 5 - Løsningsforslag

Basically all the points in this exercise can be answered by reading off the various graphs involved.

A) IPR, WPR and TPR from the current data:

qo	pwf	pwh	Δp	TPR (pwh = 1450)
0	5000	-	-	-
440	4700	2700	2000	3450
740	4400	2600	1800	3250
990	4100	2380	1720	3170
1400	3500	1620	1880	3330
1700	2900	550	2350	3800



Maximum production rate, given pwh = pwh, min = 1450 psi a (since the TPR is valid for pwh, min this corresponds to the intersection between the TPR and the original IPR - i.e. before pressure decline). Initial qo = 1450 stb/d (coincidentally the same numerical value as the pressure)

B)

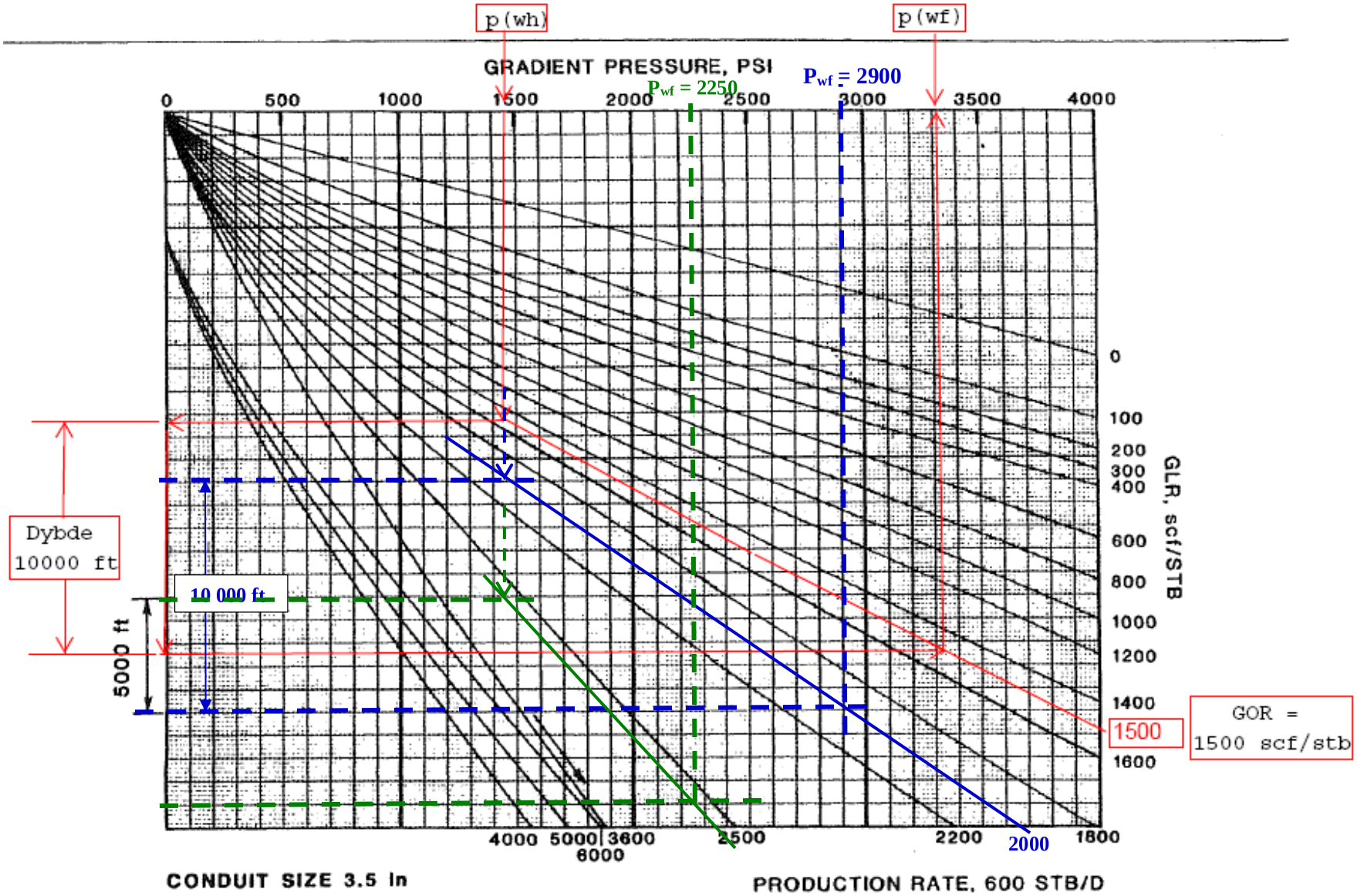
- Process path is downwards, i.e. constant production rate, from "1" to "2" (red line)
- The wellhead pressure controls the flow rate, again controlled by the choke setting.
- Point "2" marks the limit for a natural flowing well. (First, the minimum wellhead pressure is reached; second, further decline in reservoir pressure will leave too little pressure at the bottom hole to produce at all, since the TPR curve dips the "wrong way")

Assuming all points on the IPR is shifted downwards by the same amount as the reservoir pressure, we can estimate the pressure decline to $\Delta p = 4080 - 3180 = 900$ psi. With 200 psi / year this will take appr. 4.5 years.

C)

- Theoretically there is an intersection point between the IPR and the TPR also at qo = 600 stb/d. The corresponding bottom hole pressure is pwf = 3340 psi a.
- **NOTE:** The use of gradient curves are probably out of the curriculum by now (2022), but a recipe on how to used them can be found in Golan & Whitson chapter 1.4. Lines in red (see last page) indicate a bottom hole pressure of pwf = 3320 psia (which is very close to the value found above, and hence can be applied to the current well*)
- "Natural" GOR is 1500 scf/stb; if 1/3 of this (= 500 scf/stb) is recycled as extra gas lift the effective GOR will be 2000. Lines in blue shows the construction above repeated with the new GOR => pwf = 2900.
- Gas injection rate (i.e. through compressor) qg = 600 std/d * 500 scf/stb = 300.000 scf/d
- Anything that has to do with cost/gain: Installation and operation of compressor vs. price for extra oil, gas price vs. oil price (i.e. just sell the gas?), availability of gas.

*: Probably design that way by the author of the original exercise.


p(wh)
p(wf)
GRADIENT PRESSURE, PSI
Pwf = 2250
Pwf = 2900
0
500
1000
1500
2000
2500
3000
3500
4000
Dybde
10000 ft
10 000 ft
5000 ft
0
100
200
300
400
600
800
1000
1200
1400
1500
1600
GLR, scf/STB
GOR =
1500 scf/stb
4000
5000
3600
6000
2500
2200
2000
1800
CONDUIT SIZE 3.5 in
PRODUCTION RATE, 600 STB/D