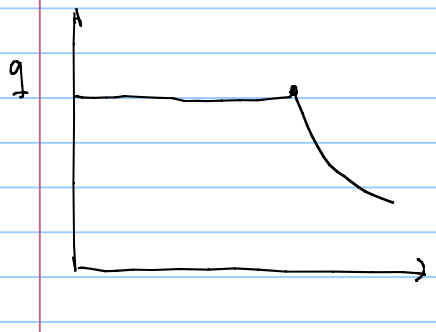
Note Title 12.01.2016

- Friday: tentative day for consultation hours with the assistants.
  - Discussions or forum facility on cts learning

Outline for today:
- Production schedule
- Architecture of production systems

mode A

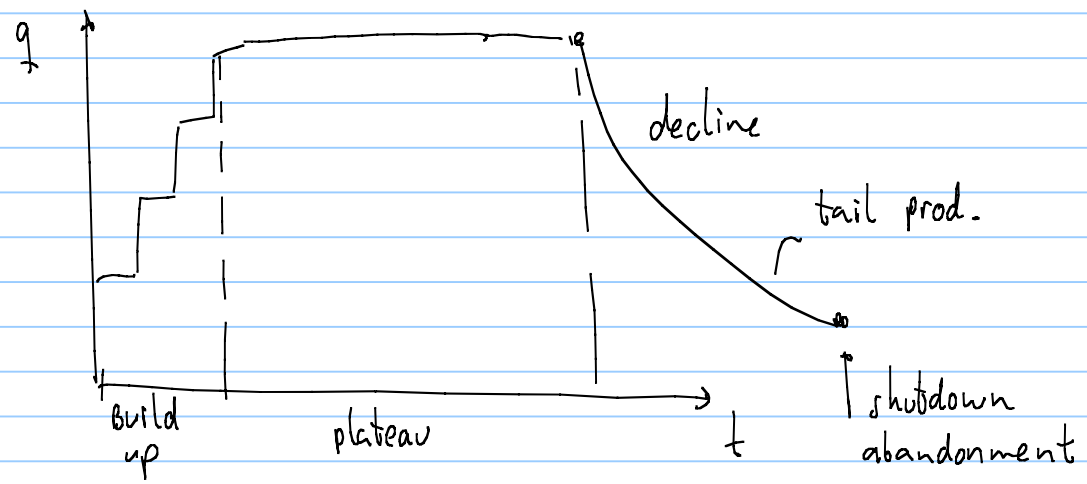
Constant rate

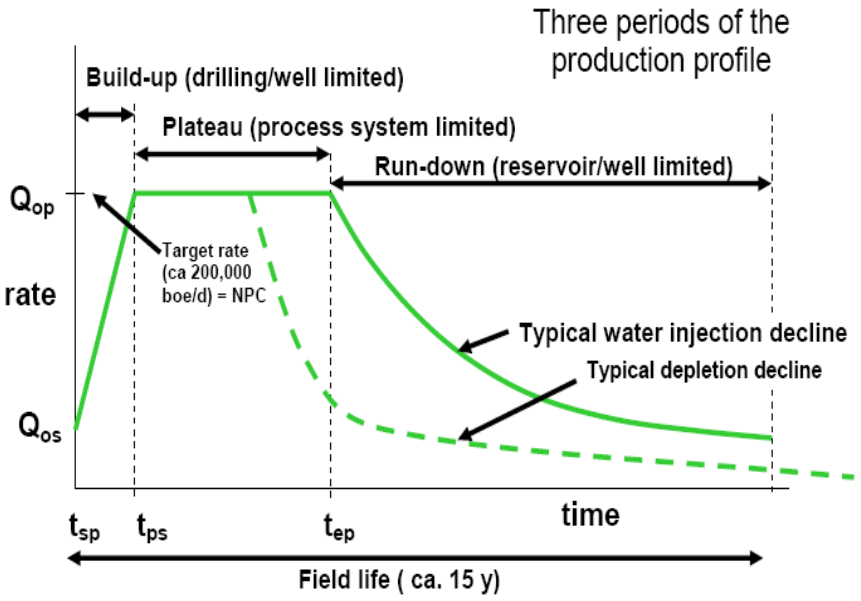


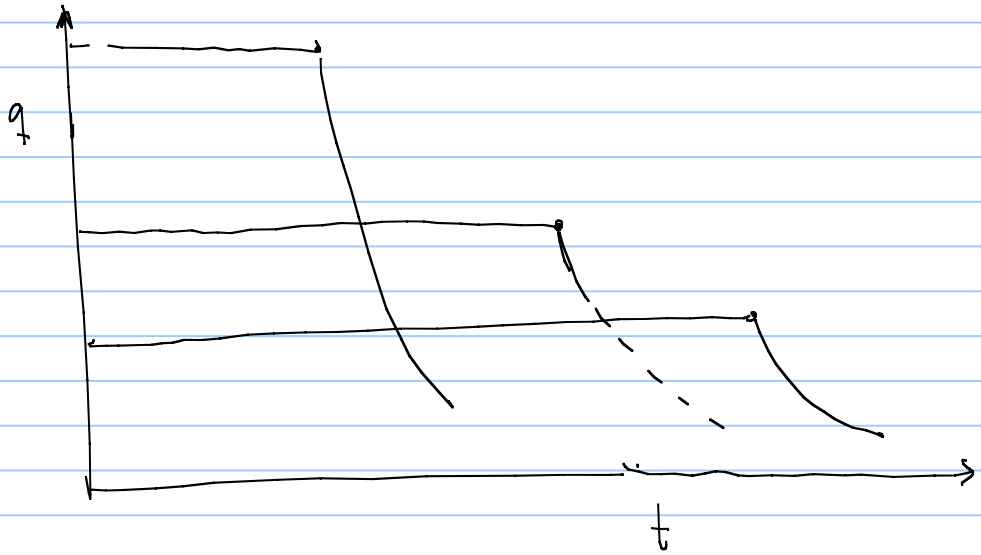
mode B

Gas fields
- sales contract (long term)
- Costumer
- infrastructure
  - pipeline
  - LNG ~ special plant to liquify sending
    to receiving terminal

- Snøhvite
- Edvard Grieg
- Marvin field satellite to Åsgard





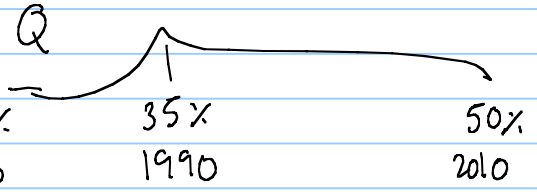


rule of thumb to determine plateau rate
↳ first order estimation

for oil fields annual offtake = TRR · 0.1 → 8-10 years

TRR = total recoverable reserves (produced economically with existing technology)

$$TRR = \frac{IOIP(N)}{IGIP(G)} \cdot RF$$



for gas fields annual offtake = 0.035 . TRR

↳ G . RF

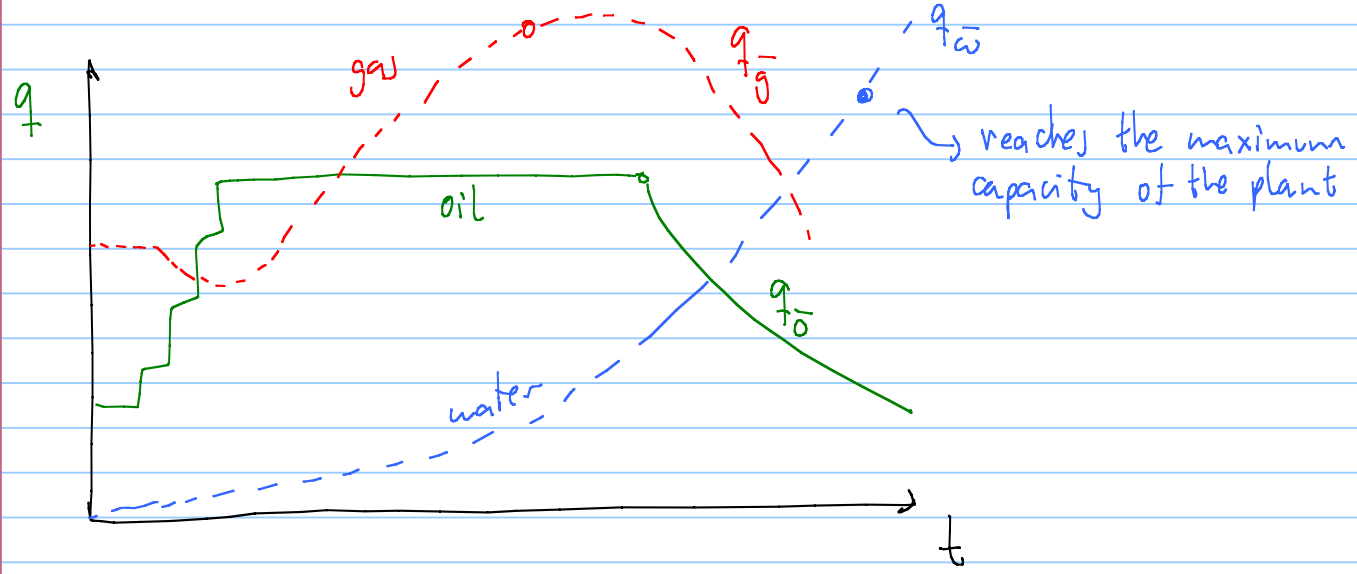
↳ Sm^3

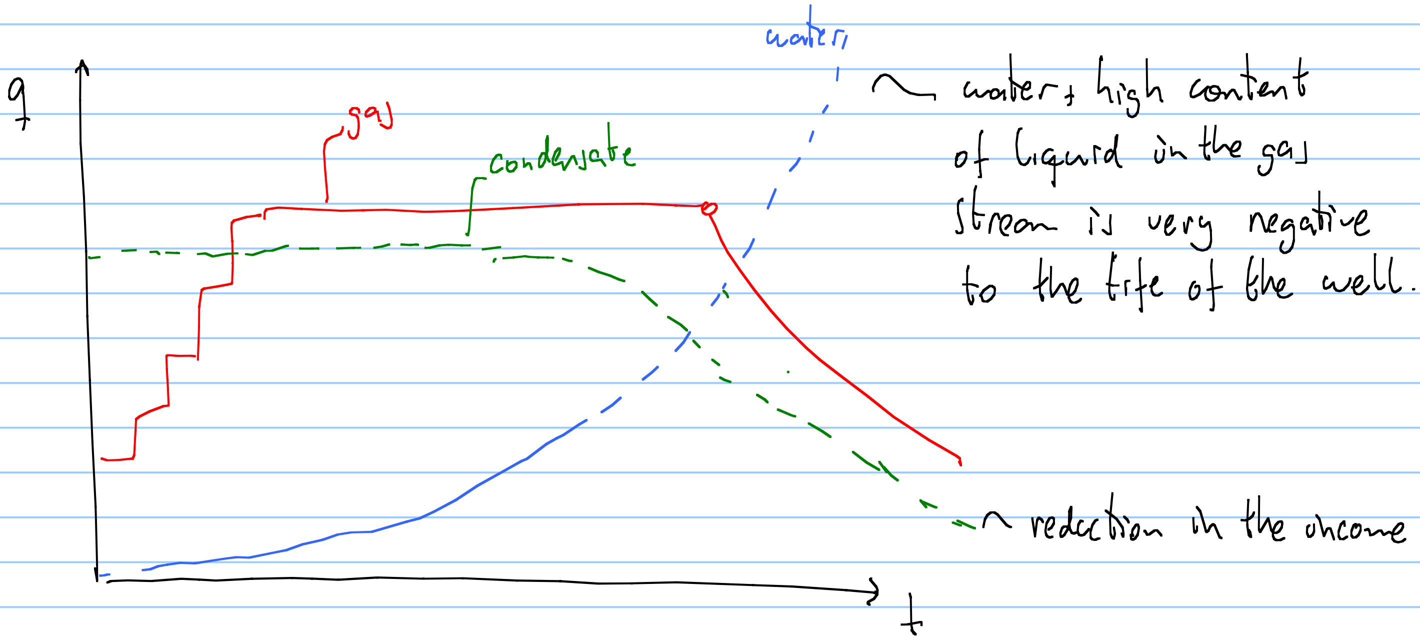
$$\text{field rate} = \frac{\text{Annual offtake} \left(\quad \right)}{\text{N° operational days in the year } [d]} = \left[Sm^3/d \right]$$

Associated fluids coming with the main production fluid should be also taken into account

oil field ⇝ gas production, water production

gas field ⇝ condensate, water production

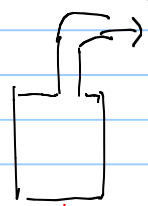




Single well + reservoir behaves like a tank.

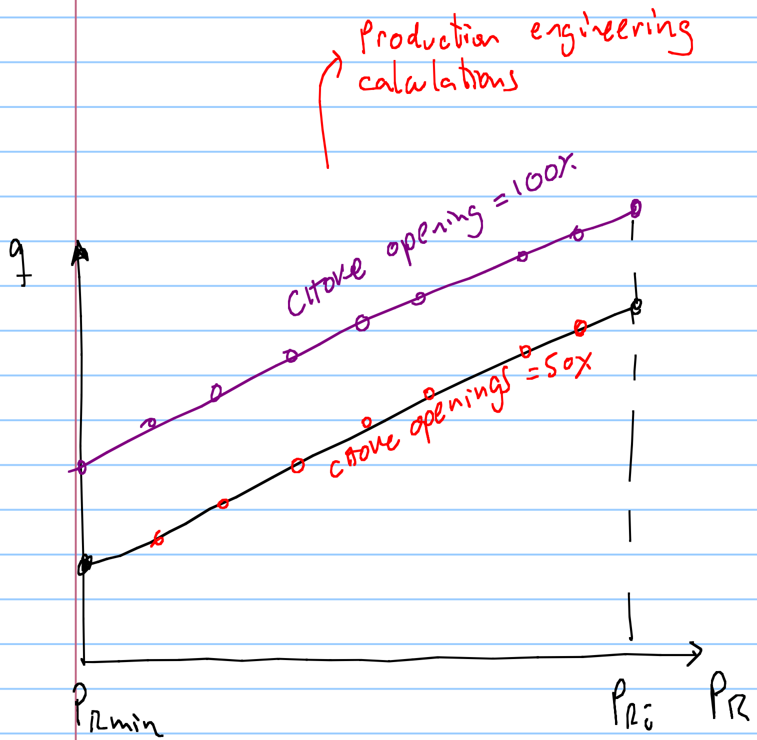
$$q = f(P_R, P_s) \Rightarrow q = f(P_R) \quad \text{if choke is fixed}$$

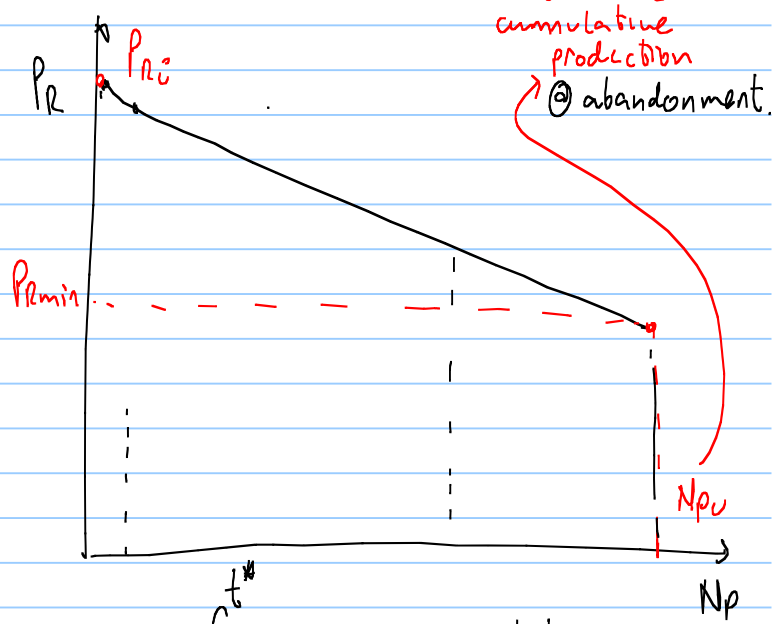
(P_s → sep pressure is constant.)



what is left ↓, what I have ↓, taken ↓

$$A = N - N_p$$
$$G - G_p$$

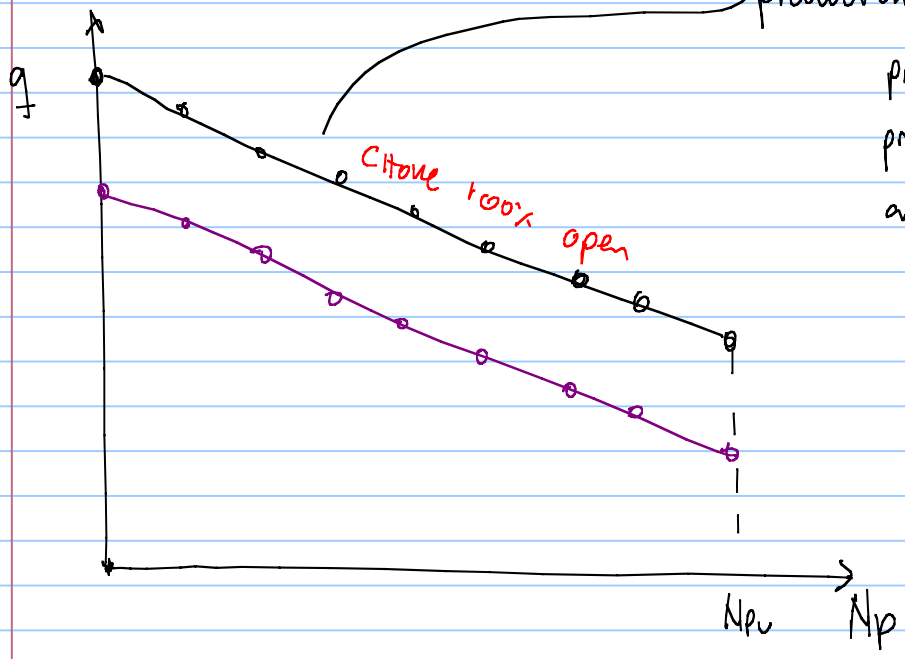




they are not necessarily linear
be careful !

$$N_p(t^*) = \int_0^{t^*} q_o(t)\,dt$$

cummulative production, how much I have taken out of the reservoir.



flow potential: q_{fp}

production potential: is the maximum production rate that my production system* can deliver at a given { Reservoir pressure, N_p, Depletion state of the reservoir

→ fully open choke artificial lift.

* well + pipeline + sep + network

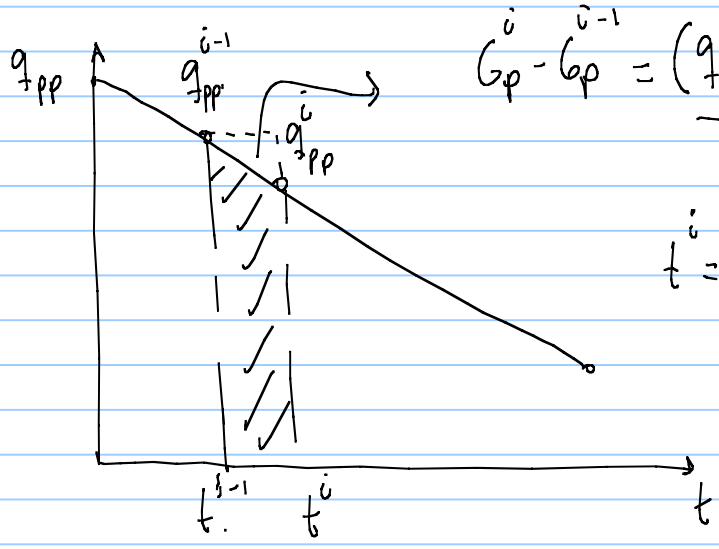
case 1: Produce all the time at production potential (open choke)

how do I estimate production schedule q_f vs. t

having q_{fp} vs G_p as a collection of points?

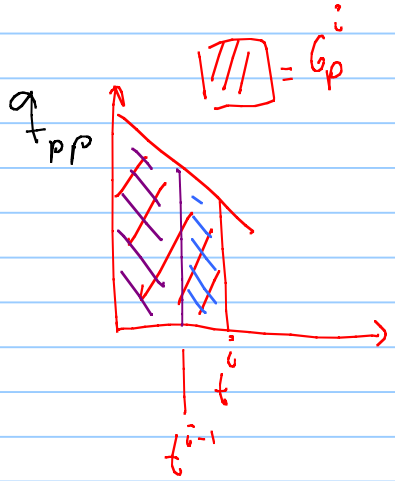
NPV, cashflow, cost, revenue is calculated time-based and not G_p based

$$G_p = \int_0^{t^*} q_f \, dt \qquad q_f = q_{fp} \rightsquigarrow \text{discretize the integral}$$



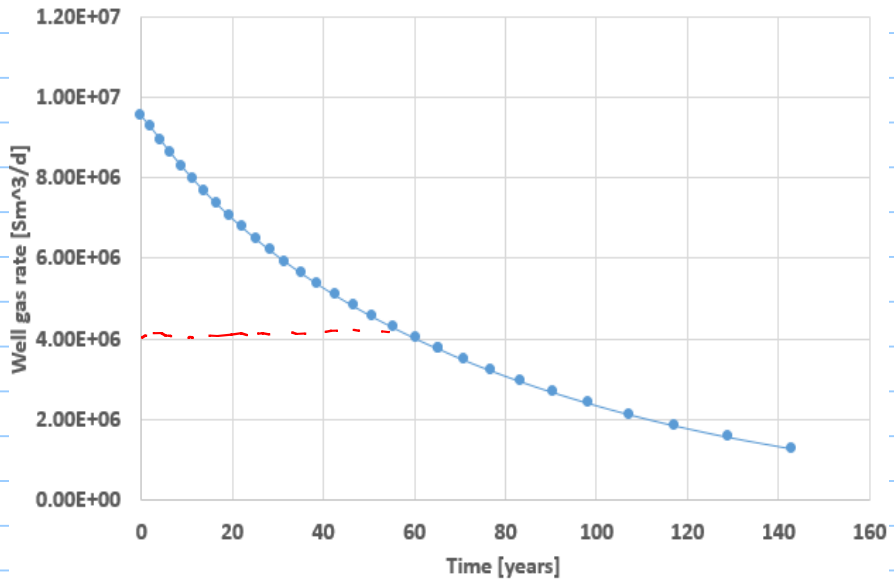
$$G_p^i - G_p^{i-1} = \frac{\left(q_{fp}^i + q_{fp}^{i-1}\right) \cdot \left(t^i - t^{i-1}\right)}{2} \quad Sm^3$$

$$t^i = \frac{2\left(G_p^i - G_p^{i-1}\right)}{\left(q_{fp}^i + q_{fp}^{i-1}\right)} + t^{i-1} \quad \rightarrow Sm^3/d$$

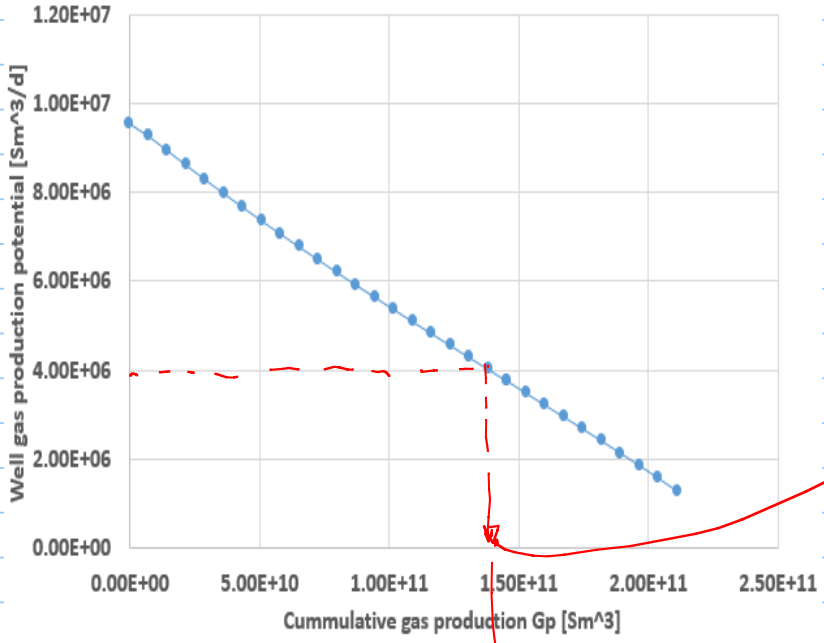


all the time producing at prod. potential.

production rate for open chone



production potential curve



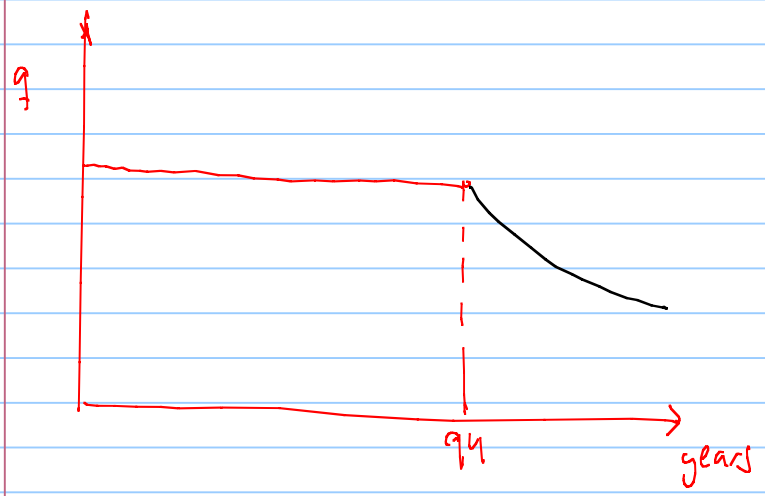
Case 2

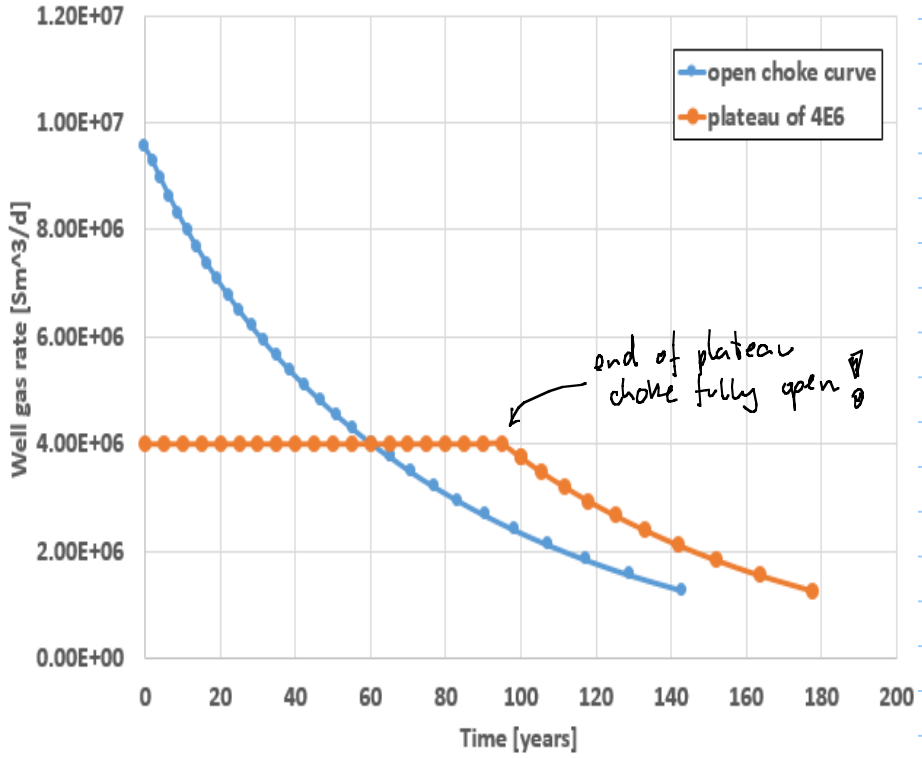
we wish to produce 4E6 Sm^3/d from the well in mode A. Calculate the duration of the plateau?

$$t_{plateau} = \frac{G_p^*}{q_{plateau} \cdot 365}$$

↳ up to this G_p^*, P_R^* the well is able to provide the rate that we want. after that the production potential is less than the desired plateau rate.

for plateau of 4E6 Sm^3/d





Estimating production profile for the full field

$G = IGIP = 2.7E11\ Sm^3$ $\qquad RF = 0.90$

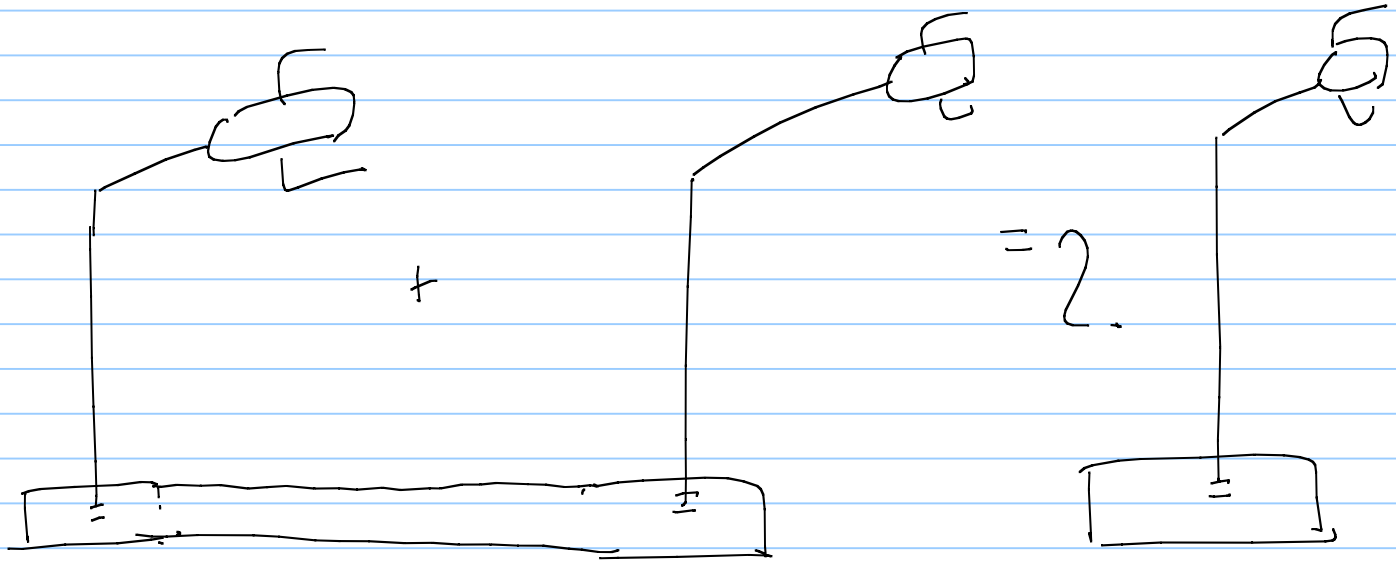
$$q_{plateau} = \frac{IRR \cdot 0.035}{355\ day/year} = \frac{0.90 \cdot 2.7E11 \cdot 0.035}{355} = 24\ E6\ Sm^3/d$$

Single well rate (recommendation of the reservoir engineer, avoid sand production, erosion, etc.)

3E6 Sm^3/d

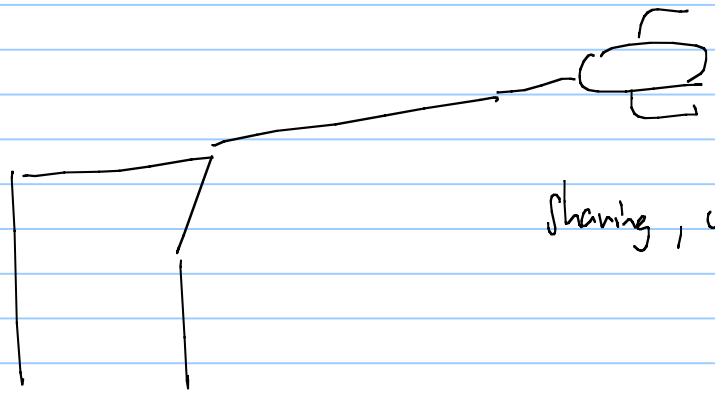
As a first approximation Nwells = 8

We will assume at this point that all wells are identical and that the production potential of a group of wells is just the production potential single well multiplied by the number of wells

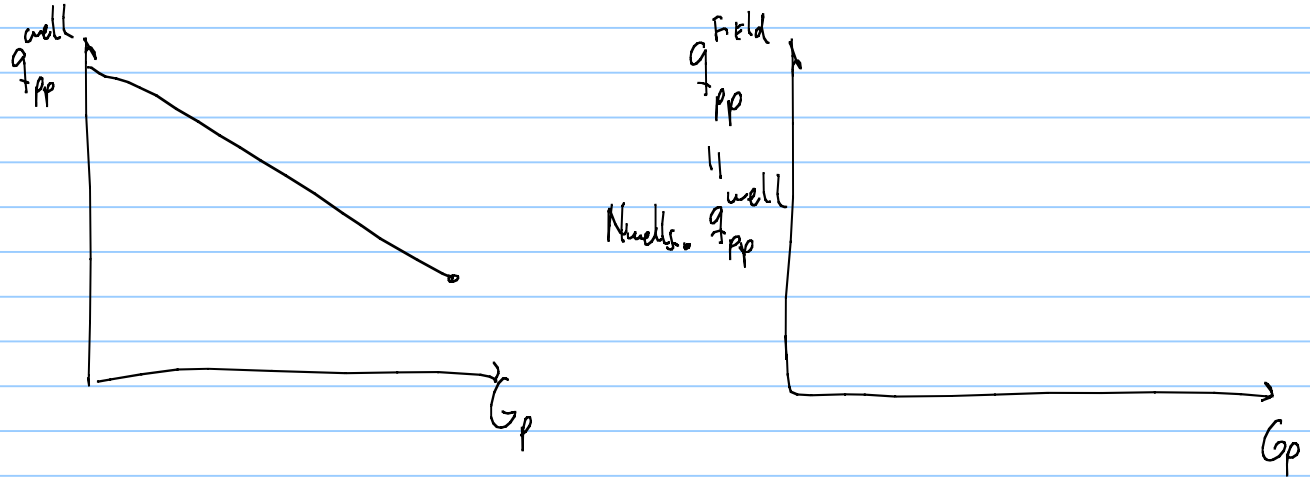


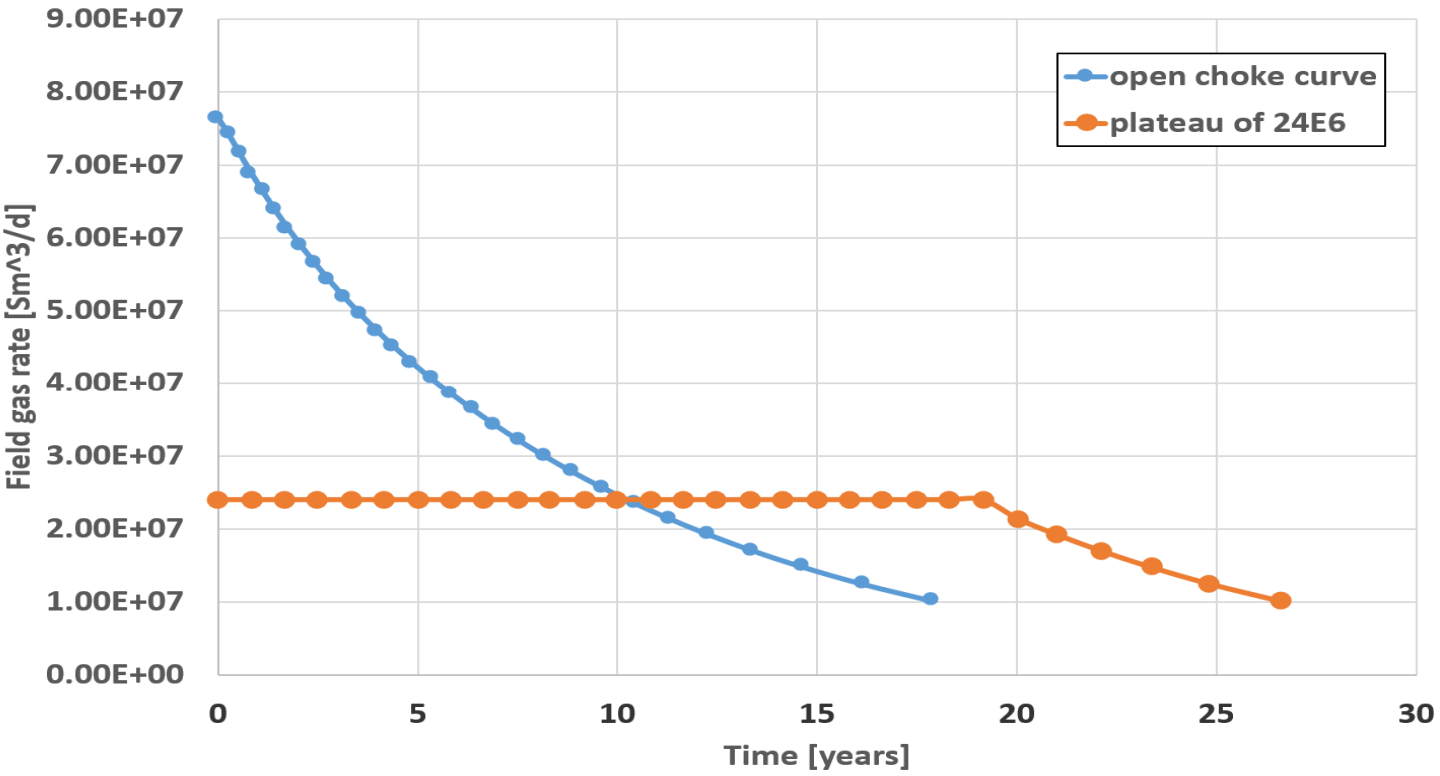
no interference between the wells in the surface production syste

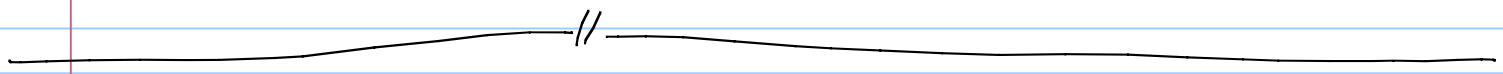
In reality, if the wells production is connected by flowlines and pipelines, there could be hydra interference between them so the production potential of a group of wells is not additive.



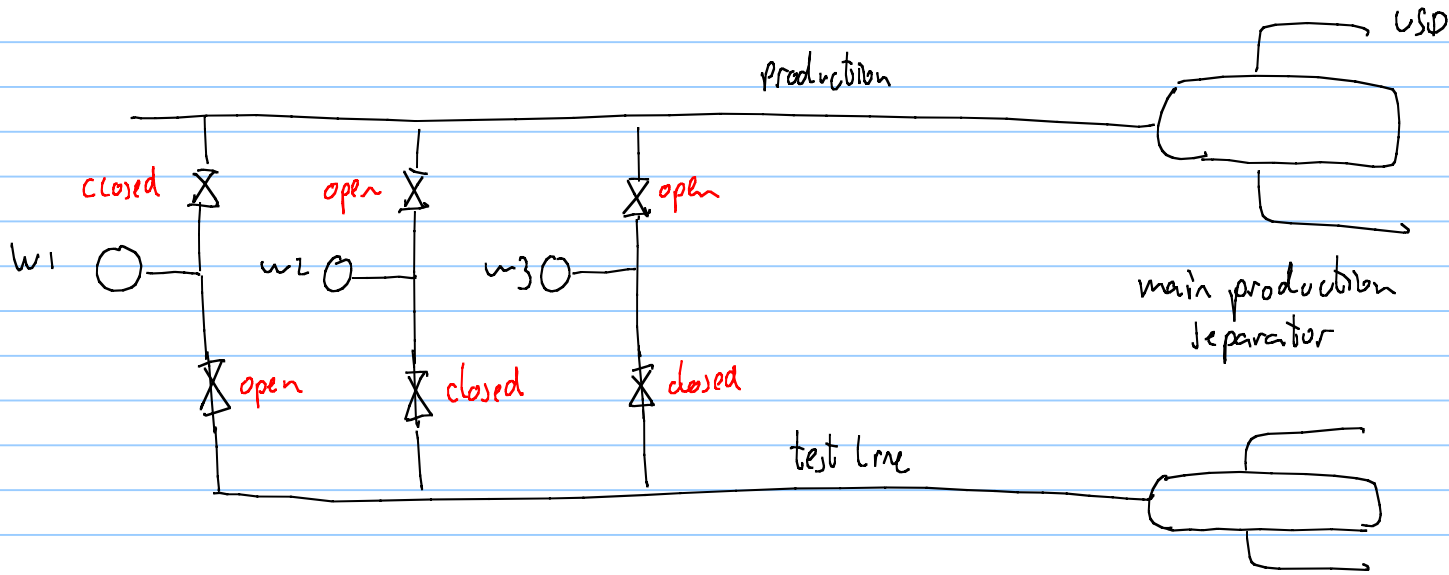
Sharing, usually







Arquitecture of the production system



control valves

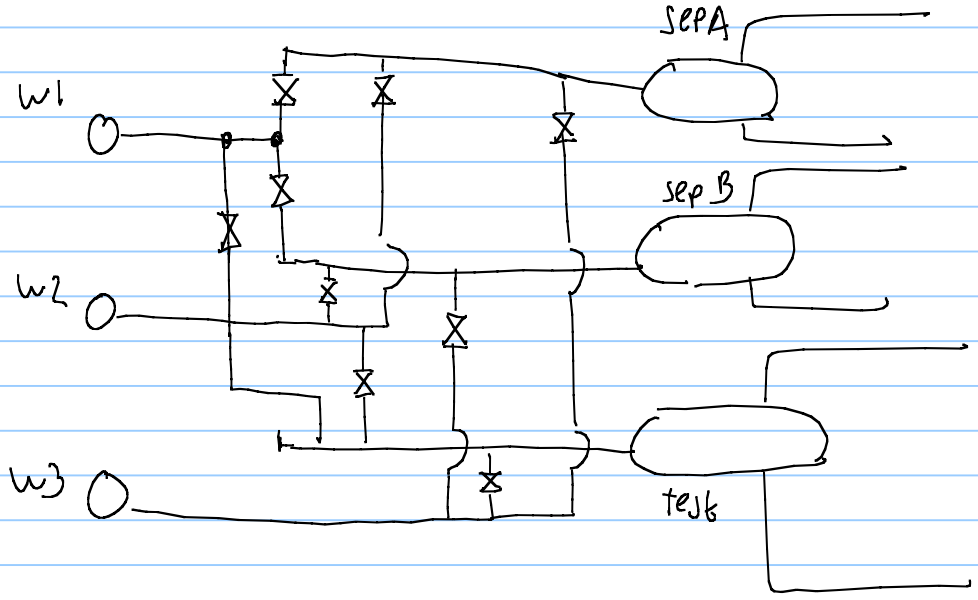
chokes

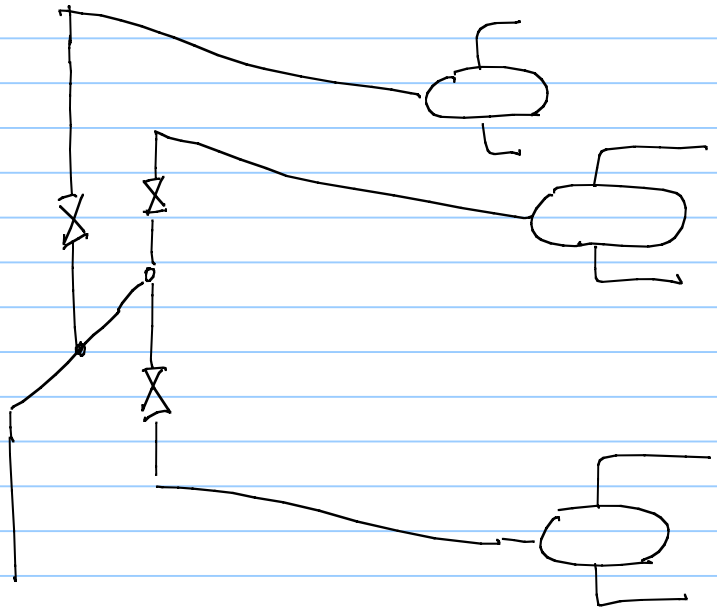
on-off valves

test separator

- measure rate
- fluid sampling
- potential of the well
- fluid properties
- detect bad wells, TGOR (gas-oil ratio), TWC (watercut)
- match reservoir model
- verify reservoir recovery
- split the cake allocation

class exercise





An Isometric view

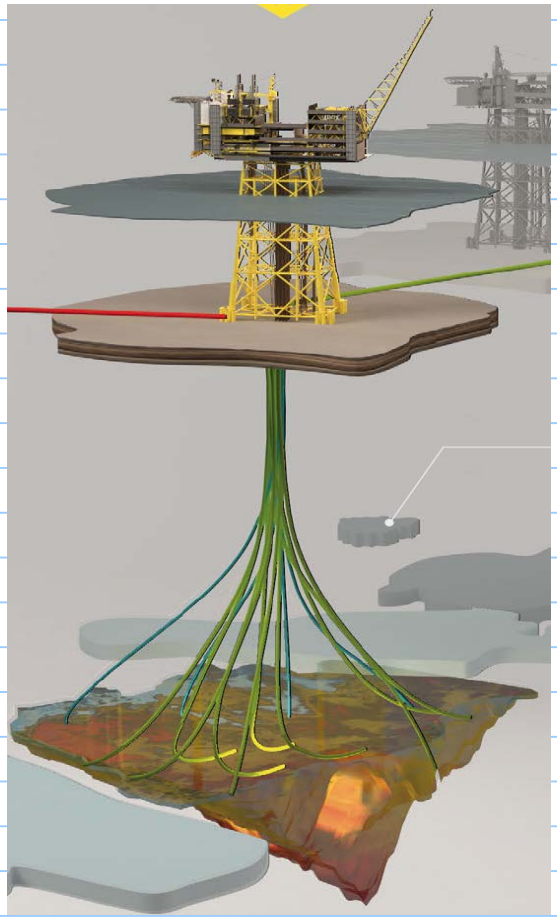
Test and production manifolds on an Onshore field

no need for separator, just production manifold and test manifold

single phase oil + water

measure ~ coriolis meter

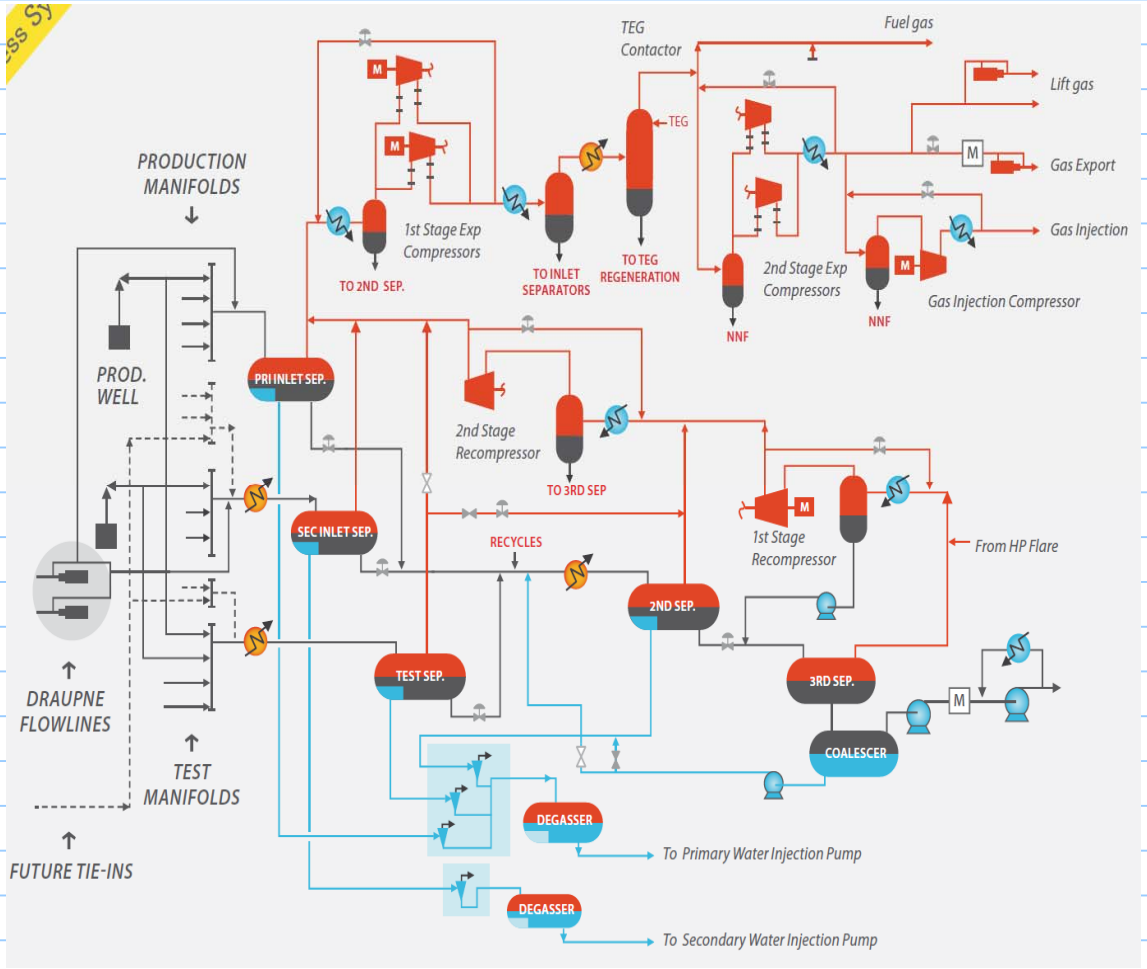
Test and production manifolds on an offshore field



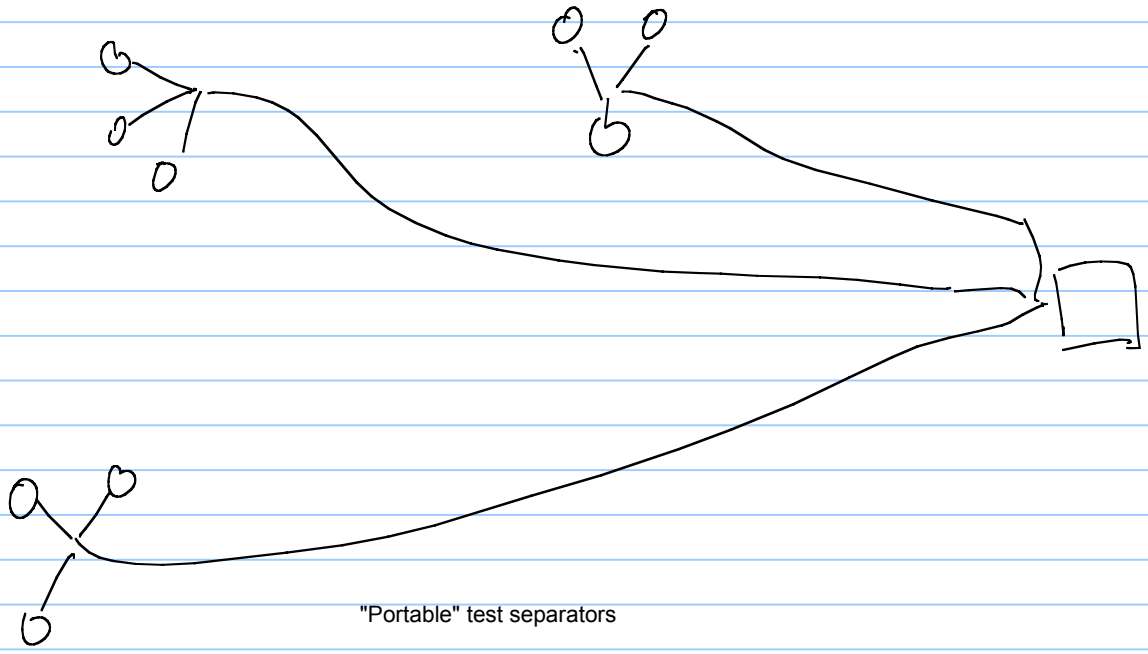
Surface Xmas Tree

Subsea Xmas Tree

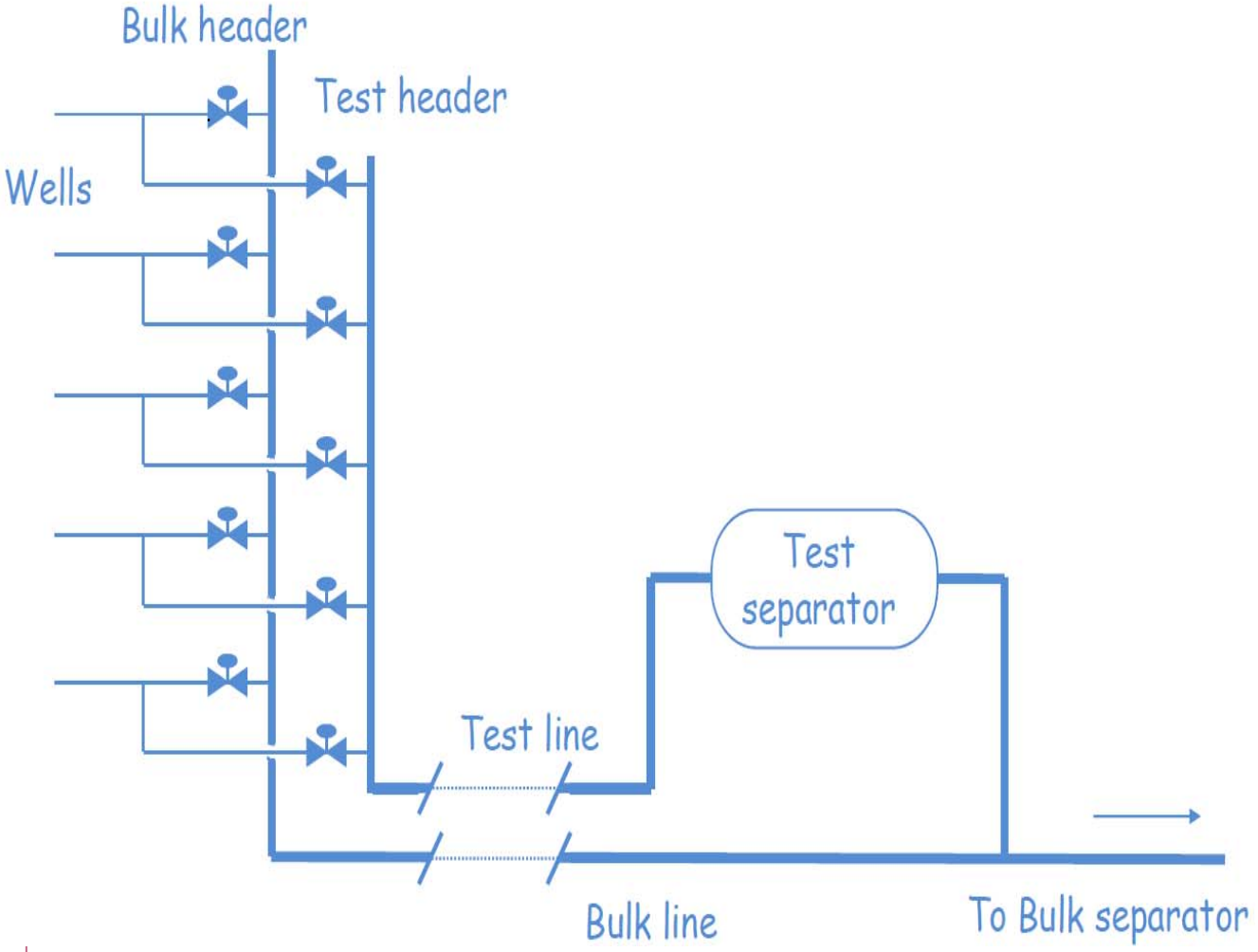
A dry christmas tree vs. a wet christmas tree



Onshore fields and test separators



"Portable" test separators


Bulk header
Test header
Wells
Test separator
Test line
Bulk line
To Bulk separator