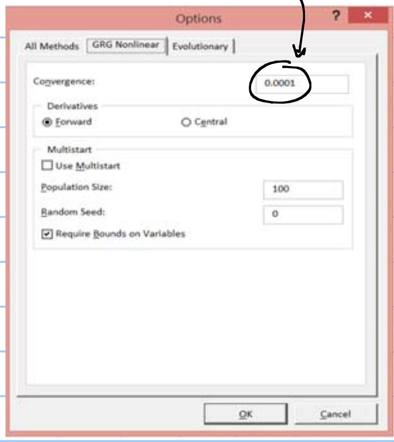
20180306

Gas specific gravity	0.55	Gas specific gravity										
Gas density at Sc	0.67	kg/m^3										
Number of templates	3											
Number of wells	9											
Desired plateau	20	years										
qfield	20.0E+6	[Sm^3/d]										
												for each well
		qfield	Gp	Z	PR	qwell	Pwf	Pwh avail	Ptemp req	Pplem req	Psep	qtemp	DeltaPchoke
		[Sm^3/d]	[Sm^3]	[-]	[bara]	[Sm^3/d]	[bara]	[bara]	[bara]	[bara]	[bara]	[Sm^3/d]	[bara]
		51.7E+6			276	5.7E+6	265.4	199.9	199.9	190.4	30.0	17.2E+6	0

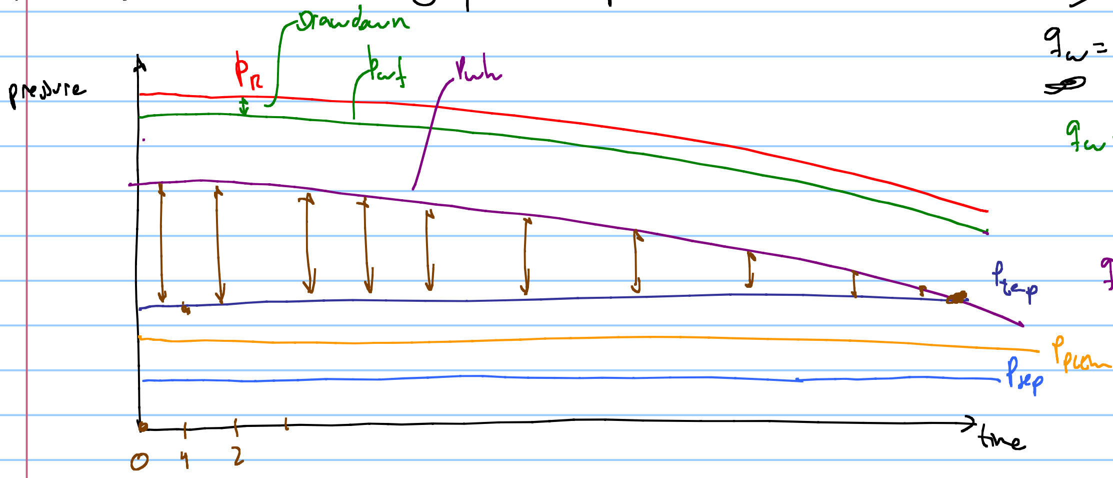
how to find equilibrium rate when choke is fully open → change this to drive to "zero"

AKA production potential of field

0 ± (ε) tolerance



Depletion effect when estimating production profile



$$q_w = C_R \left(P_R^2 - P_{wf}^2\right)^n$$

$$q_w = C_T \left(\frac{P_{wf}^2}{e^S} - P_{wh}^2\right)^{0.5}$$

$$q_{field} = C_R \left(P_{PLEM}^2 - P_{sep}^2\right)^{0.5}$$

$$q_{temp} = C_{PL} \left(P_{temp}^2 - P_{PLEM}^2\right)^{0.5}$$

we need an equation to compute P_R vs time

Dry gas material balance equation: $P_R = \frac{P_i \cdot Z_R}{Z_i}\left(1 - \frac{G_p}{G}\right)$

recovery factor; G_p: cumulative production; (1); G: initial gas in place

Z_R: VBA function zfac_Standing (p, T, γ_g, unit)

$$G_p = \int_0^t q_{field}\, dt = q_{plateau}\,[t - 0]\,\frac{N_{days}}{year}$$

$q_{plateau}$: Sm³/d; $[t-0]$: years; $\frac{N_{days}}{year}$: uptime

$PV = ZRT$

```
Function ZfacStanding(p1, T1, Yg, unit)

Rem ******************************
Rem ZStanding : Calculation of Z-facto
Rem P : Pressure (psia/bara)
Rem T : Temperature (oF/oC)
Rem Yg : Gas Specific Gravity (air=1)
Rem Unit:
Rem     1 : Field
Rem     2 : Metric
Rem ******************************
```

to solve eq. 1 (implicit)

- assume p_R
- Calculate Z_R
- use eq. to compute "real" p_R
- Compare $P_{R\,assume} \simeq P_{R\,real}$

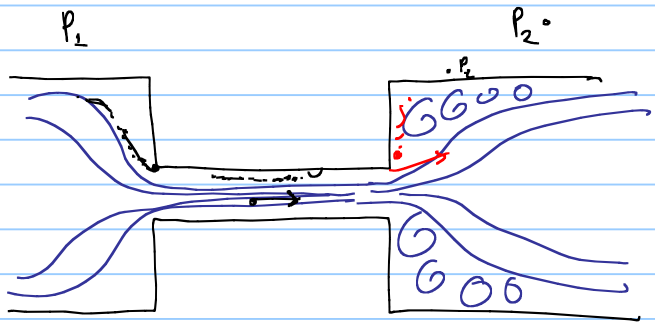
same? NOT → back to assume p_R; Yes → achieved solution

in the exercise use Z_R previous time instead of current to avoid performing this process

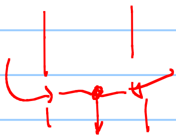
for year "0" we found we need a choke such as: $\Delta p = 163$ bar, $q = 7.2E06$ Sm³/d, $\gamma_g = 0.55$, $P_{inlet} = 245.5$ bara

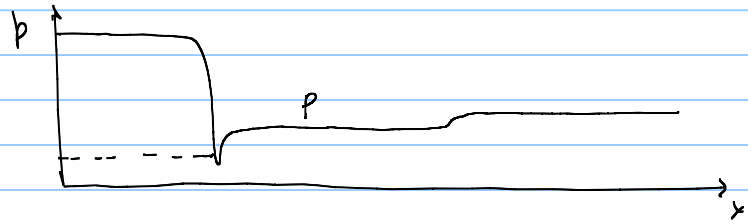
- erosion high Δp → higher velocities → higher wear

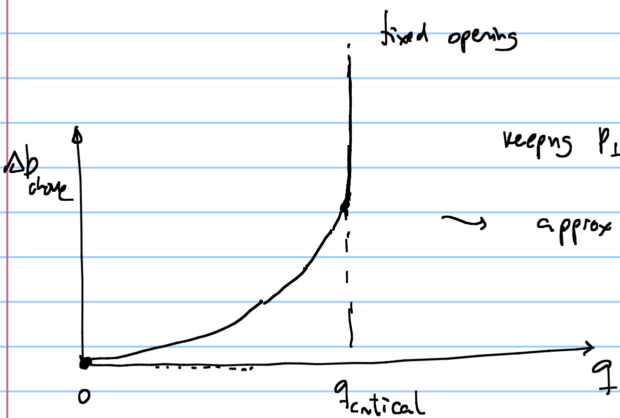
if Δp is too high, two chokes in series must be employed.



$\Delta p = P_1 - P_2$



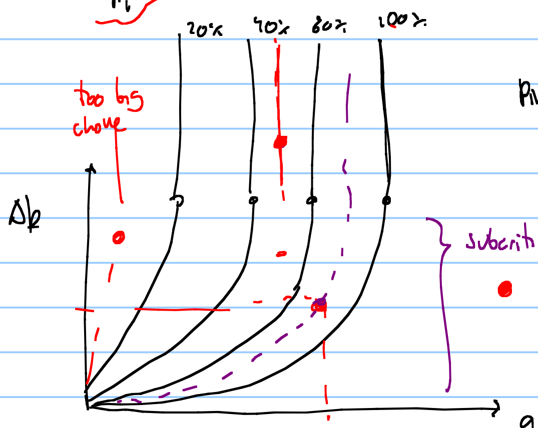




keeping P_1 fixed

→ approx when $\frac{P_2}{P_1} \simeq 0.5 - 0.6$

at this point the flow becomes critical at choke throat

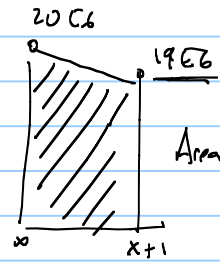


$P_{inlet} = 245$ bara

} subcritical

- choke is too small

• Note : when computing production profile in decline mode :

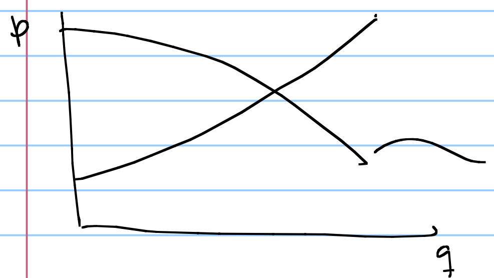


$$Area = \frac{(q_x + q_{x+1})(x+1-x)}{2}$$

time	q_{field}	G_p	P_R	P_{wf}	P_{wh}	P_{temp}	P_{plem}	P_{sep}	Δp_{choke}
x	20 E6		P_R						0
x+1	19 E6	◯	P_{R*}						6

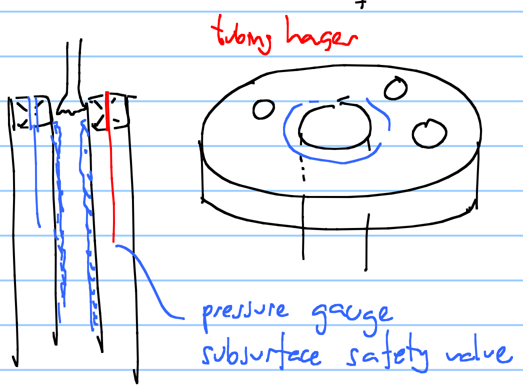
reducing the time-step improves the rectangular approximation.

how can we prolong the plateau



available pressure curve (reservoir + well + tubing)

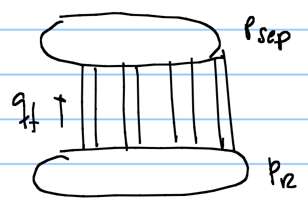
$$q_g = C_R \left(P_R^2 - P_{wf}^2\right)^n$$



- increase well deliverability (re-perforate, fracking, stimulation, acidizing)
- increase ⌀ $ and ⌀ might be limited by tubing hanger size
- remove deposits.

required pressure curve (pipeline, flowline)

- increase ⌀ $:(
- reduce separator pressure (if possible)
- deploy parallel lines

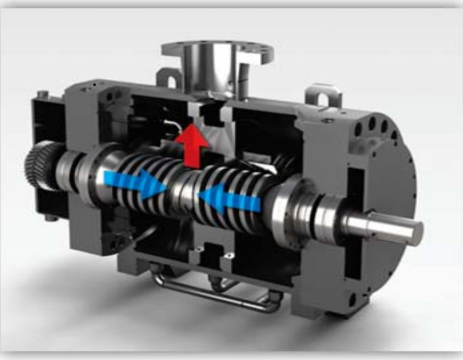


- add more wells $
- add boosting (subsea boosting) $

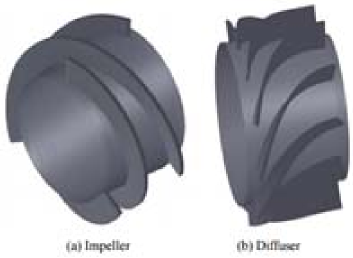
Surface boosting:

→ multiphase boosting
- twin screw pumps. } wide operation range
- helico-axial pump } low gas content high gas content
- wet gas compressor ↳

→ single phase boosting — typically requires separation before
- Åsgard subsea compression



based on positive displacement



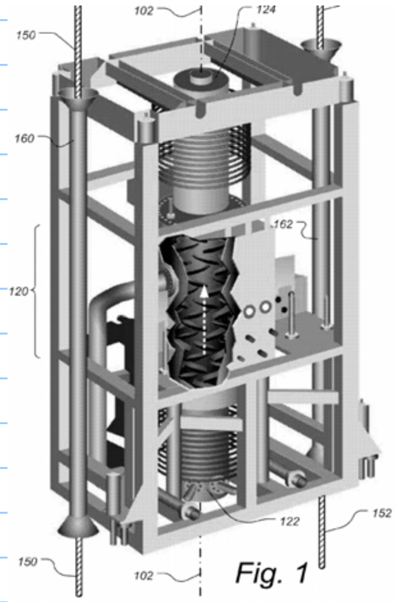
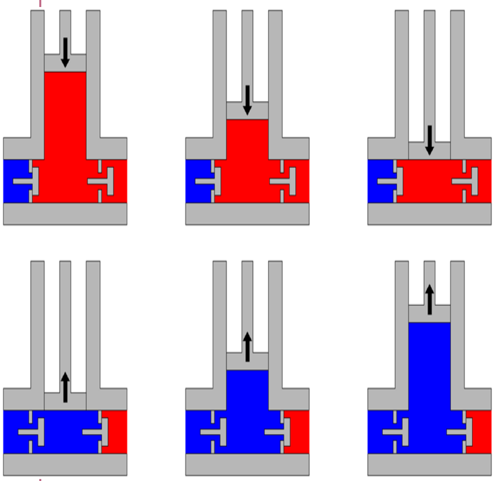


Fig. 1



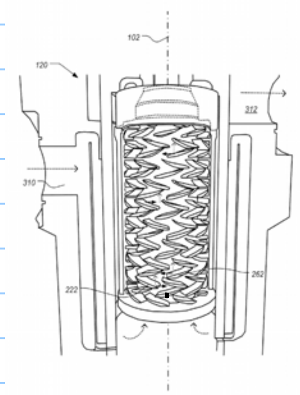


Fig. 3A

Single phase subsea compression/boosting