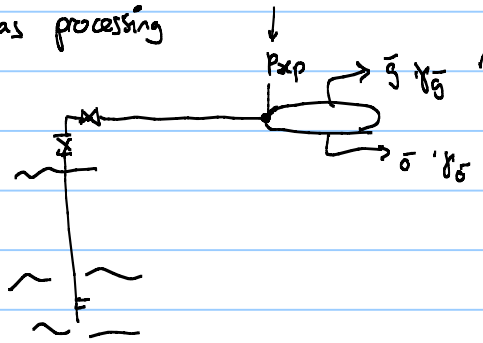
Note Title 07.11.2018

Day 10 Oil and Gas processing



GOR depends on surface process
↳ Black Oil tables

cricondenbar <105 bara
cricondentherm <40C

"Rich gas" pipeline, p = 80-200 barg
water dew -18@ 69 bara
H_2O <46/MMscf
CO_2 <2.5 mole %
H_2S <5 mole %

- dew point -10 C (50 barg)
- CO_2 <1.5 mole%
- H_2S < 5 ppm
- calorific value
- wobbe index

dehydration TEG
compression
gas plant:
- Conditioning (CO_2 H_2S)
- Dew point control
- NGL extraction

→ Sales
→ LNG → tanker
→ Natural gas Liquids

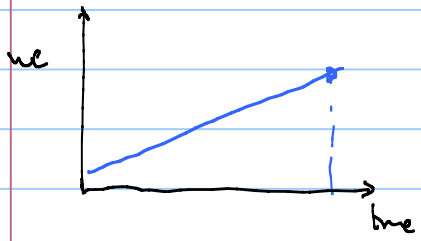
gas
- re injection (pressure support/EOR)
- gas lift
- Power generation (field)!

1800-750 psig
w/o 1-3%v
well stream
oil, gas, water separation and stabilization
oil
oil dehydration desalting and stabilizing
- pipeline
- tanker/truck

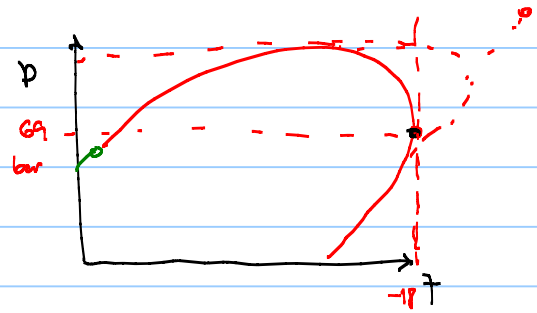
API: 8-65
w/o 0.5-1 %v, z:(N)
↳ tanker/truck <11 psia RVP Reid
↳ pipeline <111 psia RVP
↳ salt 10-30 PTB (pounds per thousand barrels)
↳ H_2S, 10-100 ppmw

water
oew 500 (1000 ppmw)
produced water treatment
- disposal (sea, river) <40 ppmw oiw
- re injection (pressure support)

offshore field

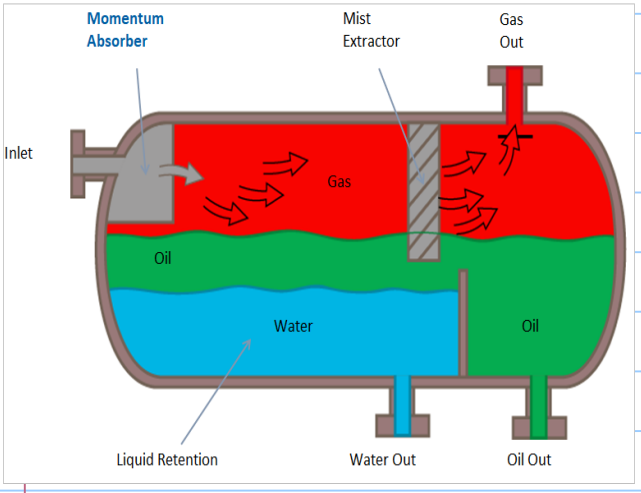


facilities bottlenecked

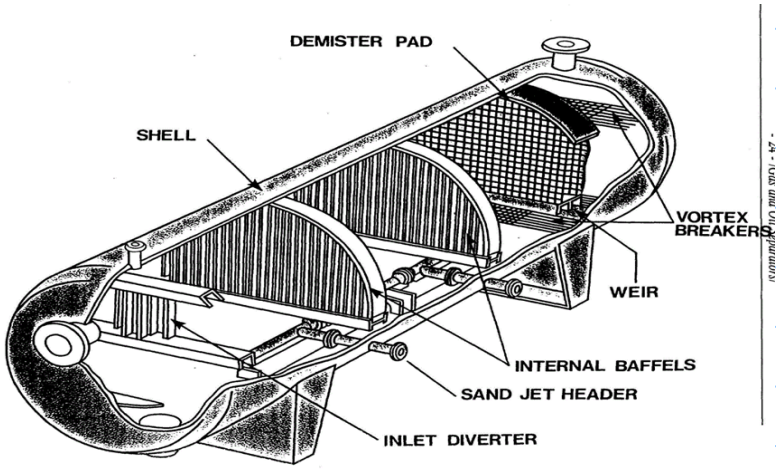


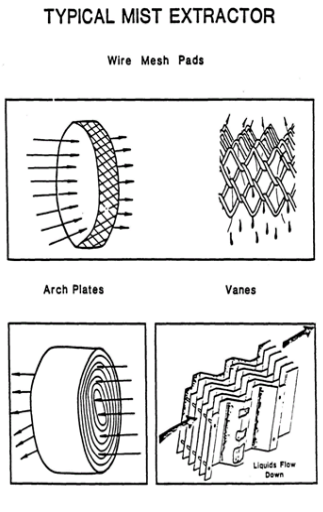
oil / gas / water separation use : multi stage separation train (1-4 stages)
multiple trains as needed (onshore)
1-2 trains (offshore)
interstage cooling / compression

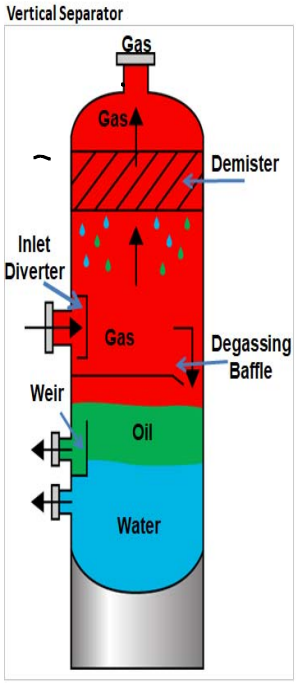
Horizontal Separator

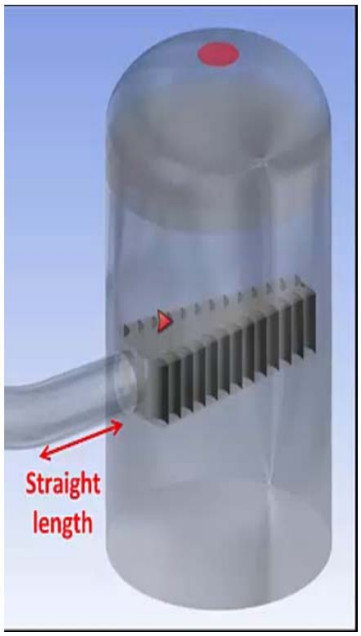


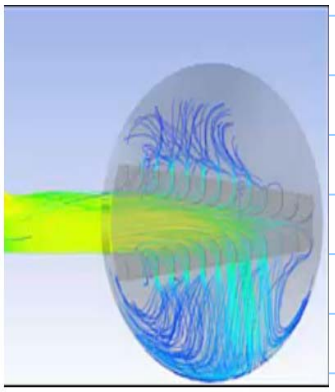
three phase horizontal separator



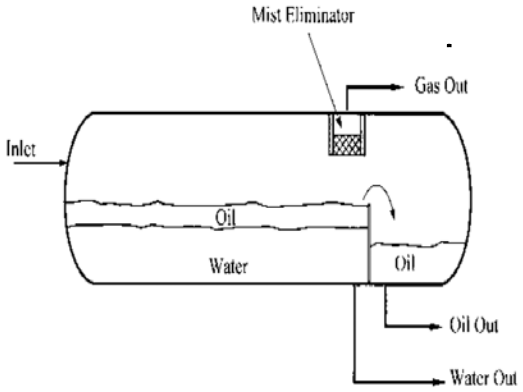


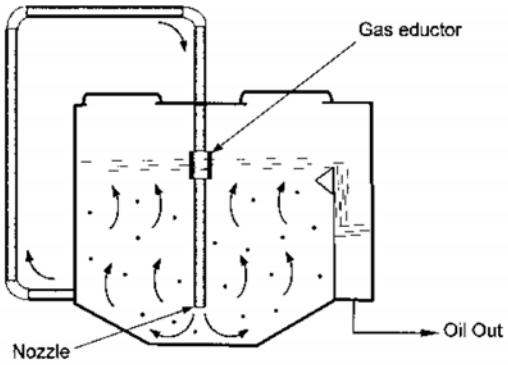

Vertical Separator
Gas
Gas
Demister
Inlet
Diverter
Gas
Degassing
Baffle
Weir
Oil
Water


Straight
length



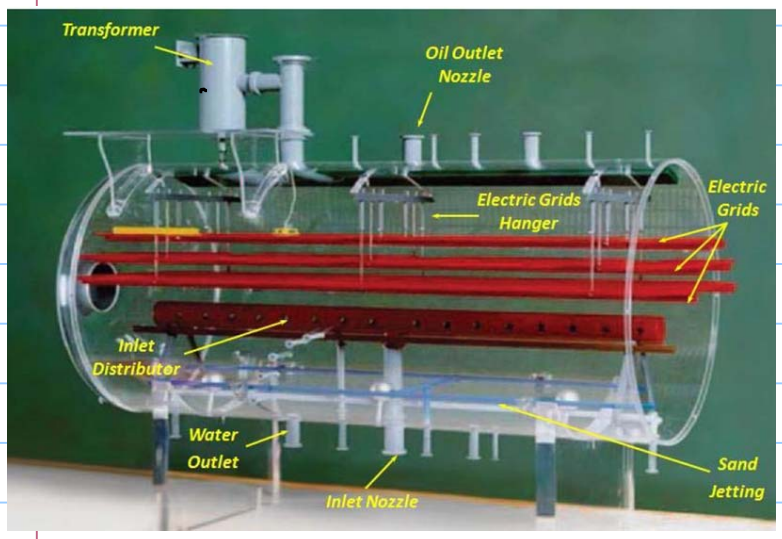
water treatment : • Skim tank + degassing (onshore)
• hydrocyclones + flotation unit





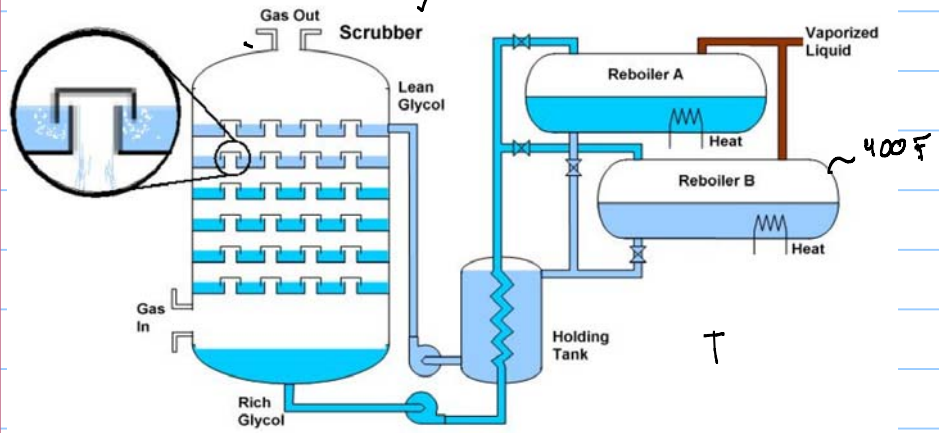
• oil dehydration / desalting : electric coalescer

desalter ≈ electric coalescer



• Gas dehydration : TEG contactor

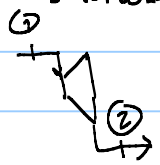
~ p ≈ 800-1200 psig



- Gas plant HDPC Hydrocarbon dew point control : - JT expansion
  (recover some NGL) └ Joule-thomson expansion (valve expansion) isatholpic

Demethanizer, NGL fractionation } distillation tower

- turbo-expander



- refrigeration

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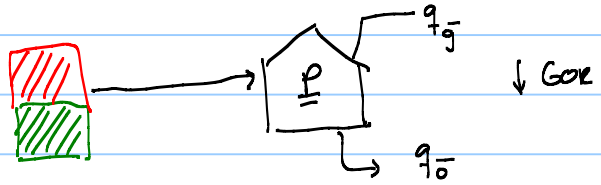
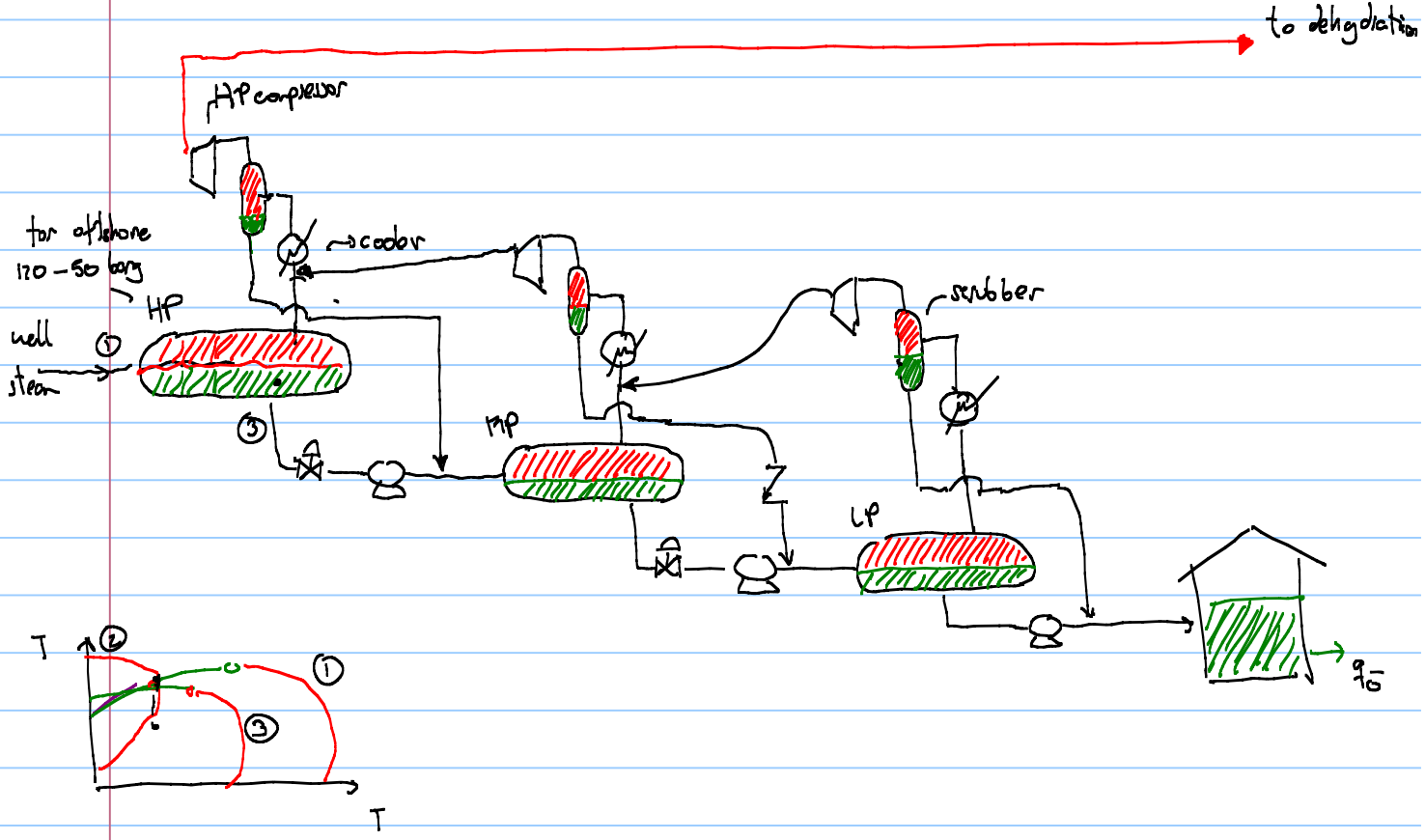
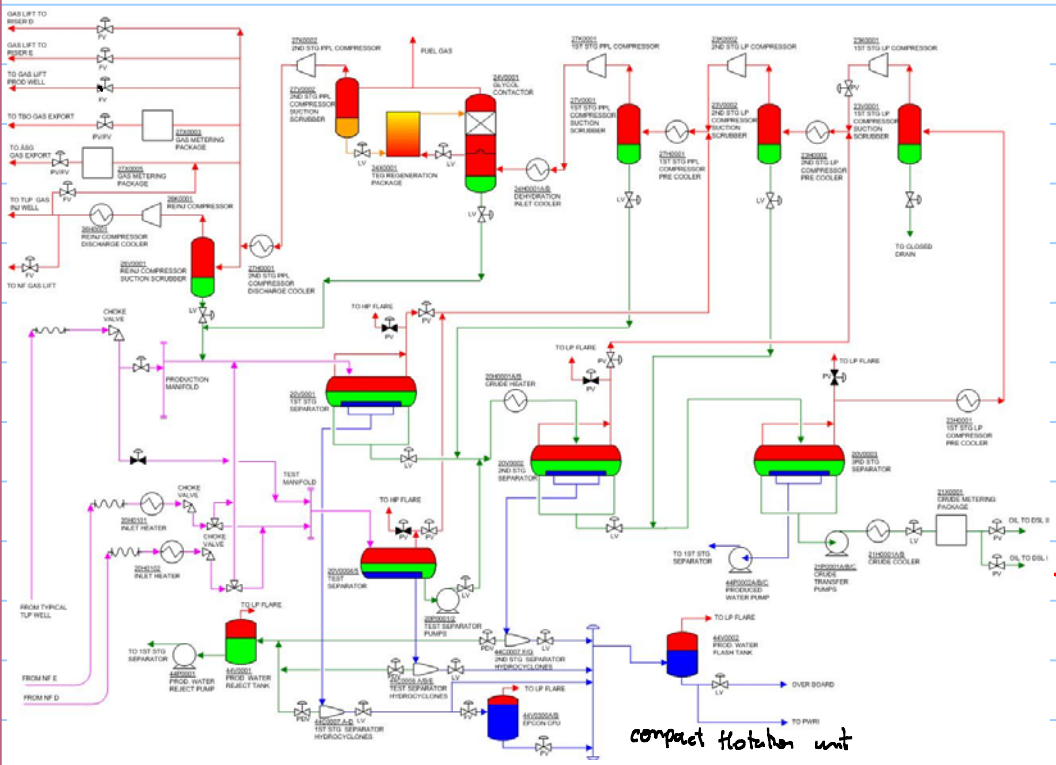
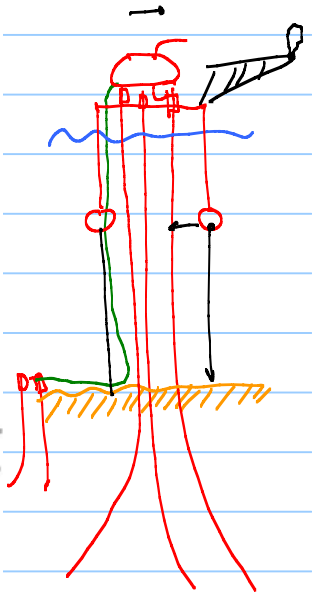
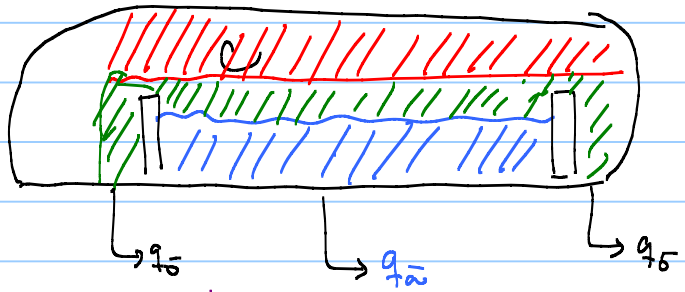
multistage separation
- separate oil, gas water
- increase amount of oil from well stream

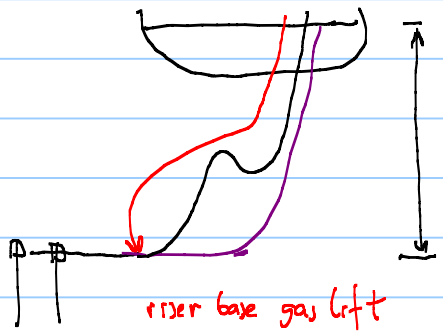


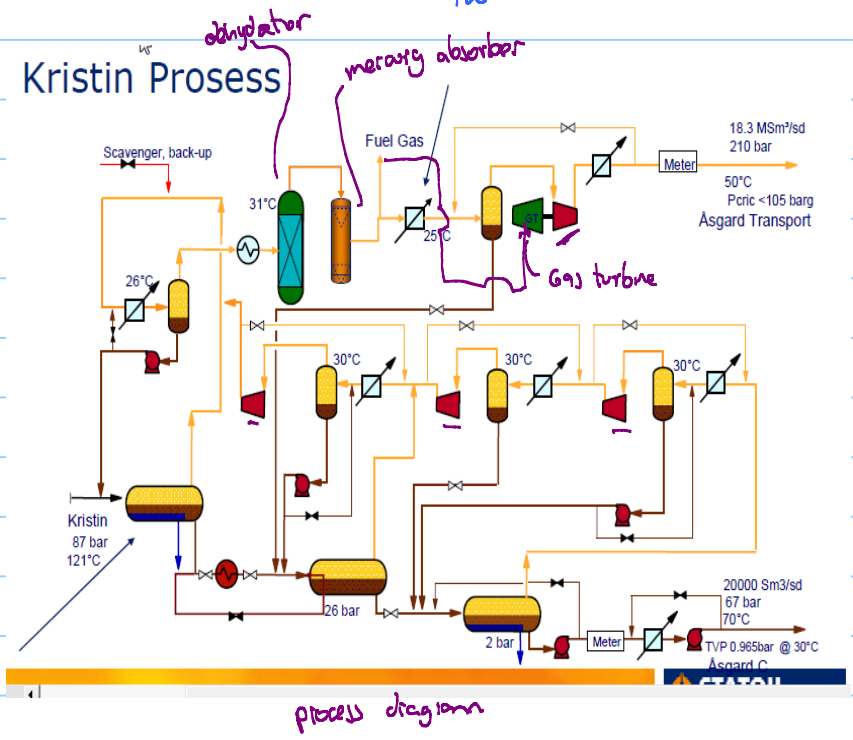








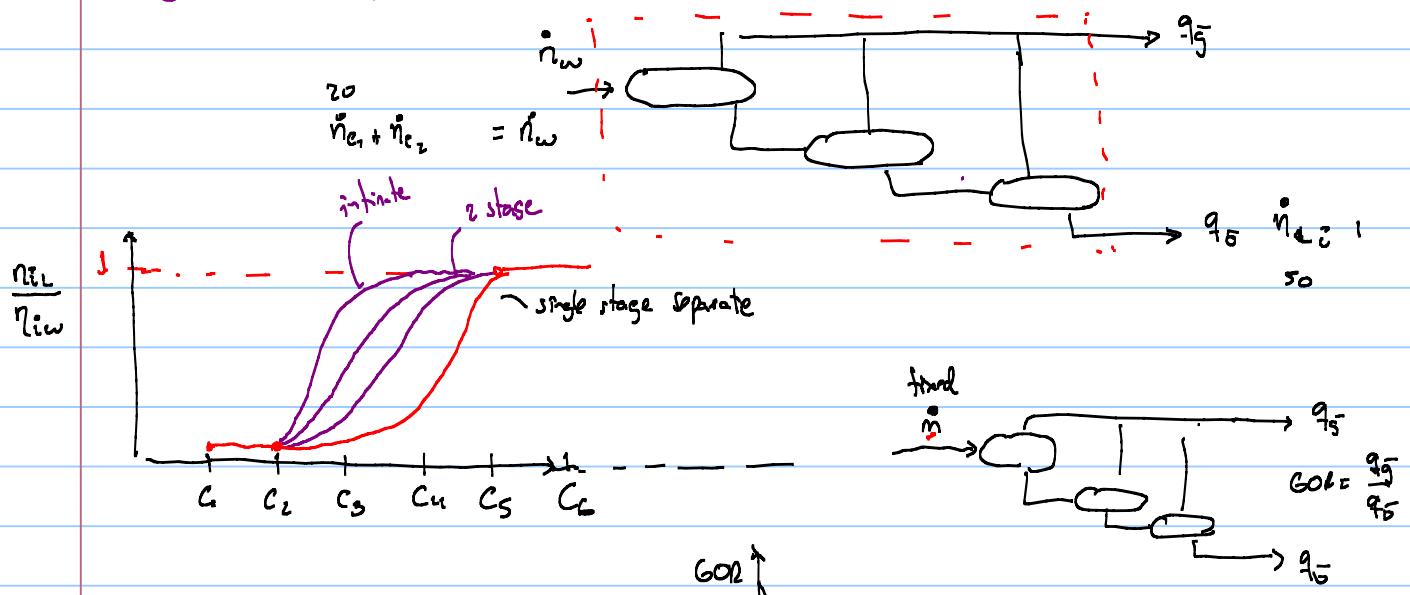




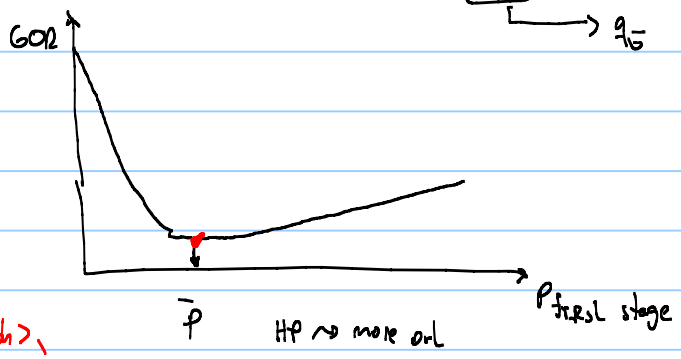
Process and instrumentation diagram

process diagram

why multistage separation ?

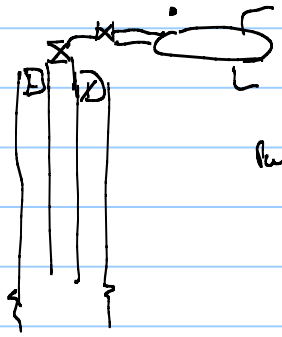


- effect of HP pressure
- effect of MP pressure
- sizing of separator

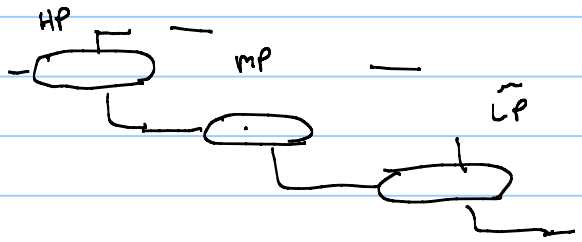


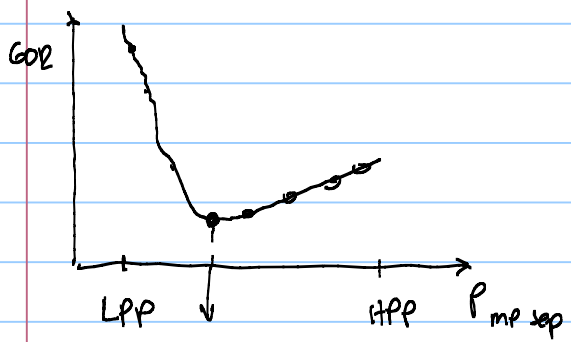
HP ↗ more oil

usually this is important for gas condensate ↑ GOR



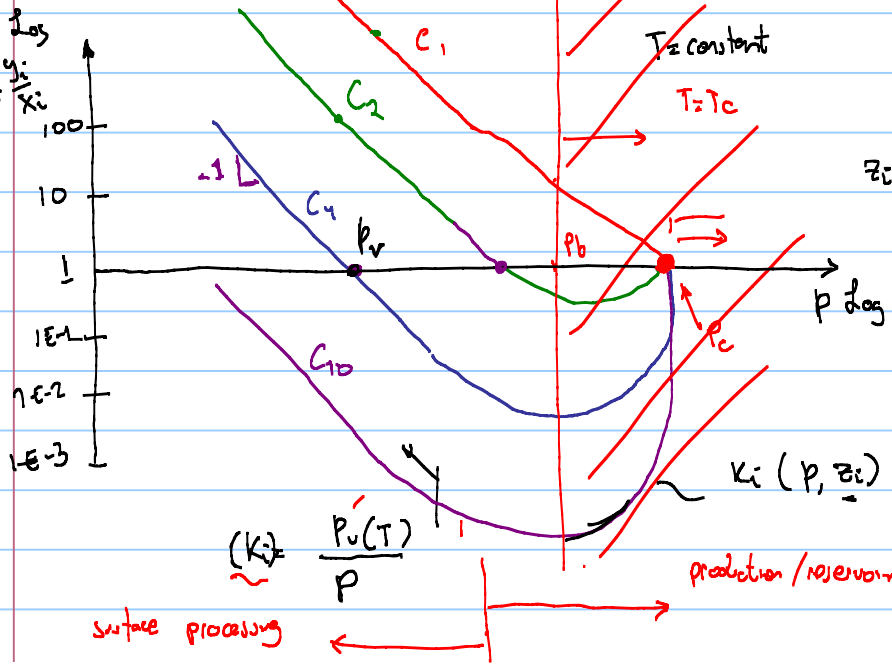
- MP separator pressure





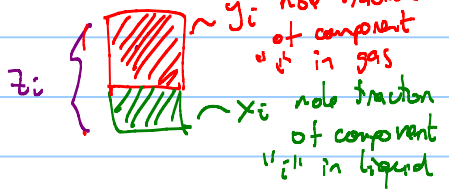
How to study / model separation process → Fluid model → K factors

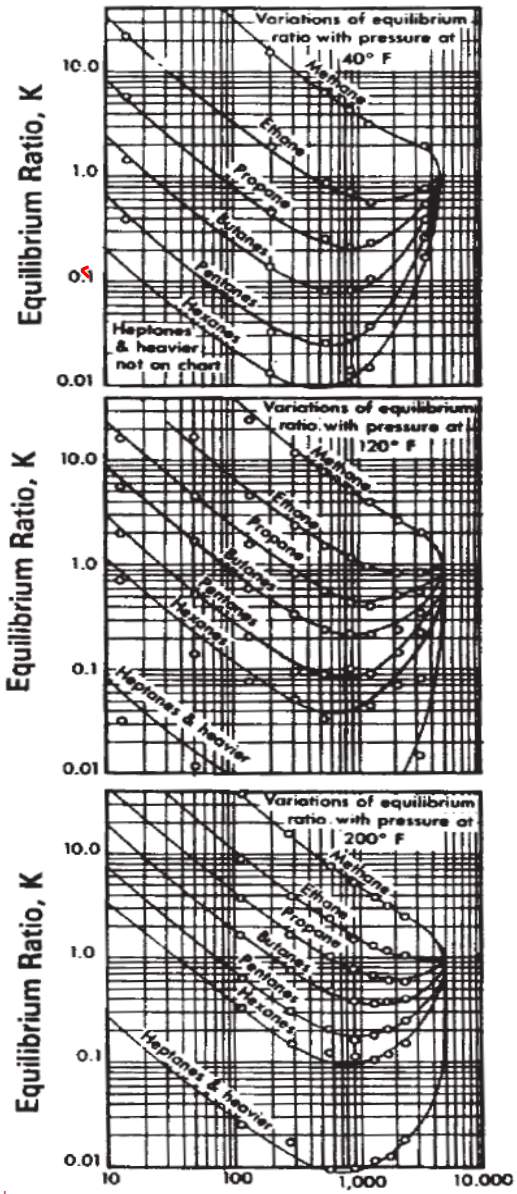
→ EOS equation of state



z_i is composition of mixture (mole fraction)

i is the component





Wilson equation

acentric factor

$$T_{ri} = \frac{T}{T_{ci}}$$

$$K_i = \left(\frac{p_{ci}}{p_K}\right)^{A_1^{-1}} \frac{\exp\left[5.37 A_1 (1+\omega_i)\left(1 - T_{ri}^{-1}\right)\right]}{p_{ri}}, \qquad p_{ri} = \frac{p}{p_{ci}}$$

what do we do with K_i? x_i? y_i?

$\sum y_i = 1$ (1) N components

$\sum x_i = 1$ 2

$K_1 = \frac{y_1}{x_1}$ 3

$K_2 = \frac{y_2}{x_2}$ 4

$K_3 = \frac{y_3}{x_3}$ 5

x_i ? y_i? are unknowns

z_i is given

K_i is calculated from correlation

$N-2$

$x_i \rightarrow N$ unknown

$y_i \rightarrow N$ unknowns

$2N+1$

if $N=3$

x_1 y_1

x_2 y_2

x_3 y_3

vapor mole fraction $\frac{n_v}{n_v + n_L}$

$$z_i = F_v y_i + (1 - F_v) x_i$$

method to solve the system of equations ~ to avoid iterating with composition x_i, y_i to iterate F_v

$$z_i = F_v y_i + (1-F_v) x_i$$

$$K_i = \frac{y_i}{x_i}$$

$$z_i = F_v x_i K_i + (1-F_v) x_i$$

$$z_i = x_i (F_v K_i - F_v + 1)$$

$$x_i = \frac{z_i}{(F_v K_i - F_v + 1)}$$

$$\sum x_i = 1$$

$$\sum y_i = 1$$

$$\sum (y_i - x_i) = 0$$

$$\sum x_i (K_i - 1) = 0$$

~ Rachford-Rice function

$$\sum_{i=1}^{N} \frac{z_i (K_i - 1)}{(F_v K_i - F_v + 1)} = 0$$

find

SEPARATION PROCESS					
Stage	p	T	z-C1	z-C3	z-N-C10
[-]	bara	C	[-]	[-]	[-]
1-HP	50	70	0.5	0.2	0.3
2-MP	35	50	0.07679	0.22803	0.69518
3-LP	1.01325	15.56	0.06580	0.22901	0.70519

FLASH CALCULATIONS					
p	[bara]	1.01325			
T	[C]	15.56			
		fv	0.222358		
Comp	zi	Ki (T)	RR_term	xi	yi
C1	0.06580	288.91824	2.91E-01	0.00101	0.29239
C3	0.22901	7.60289	6.13E-01	0.09278	0.70543
N-C10	0.70519	0.00241	-9.04E-01	0.90620	0.00218
		SUM=	-1.20E-06	1.00000	1.00000