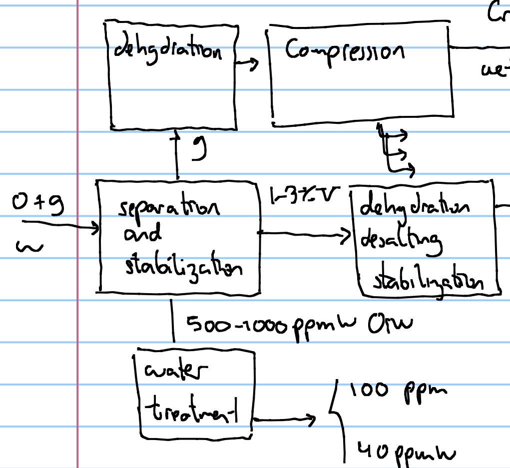
Class 2

Course introduction. Overview of field processing. Product specs.	Milan
Oil-Gas sep (VLE), Rachford Rice, EOS calculations.	Milan
Oil-Gas Separation . Introduction to process simulation (Hysys). —	Mariana
Oil-Gas Separation. Bubble and droplet dynamics. Separation capacity.	Mariana
Oil-water separation	Mariana
Water content in Natural gas. Gas dehydration (TEG)	Milan
Gas dehydration (TEG)	Milan
Pressure calculations in pipe (single and two-phase)	Harald
Pressure calculations in pipe (single and two-phase)	Harald
Heat transfer, pipe calculations, heat exchangers	Harald
Heat transfer, pipe calculations, heat exchangers	Harald
Pumping	Mariana
Compression	Harald
Compression	Harald

p: 100-200 barg
water dewpoint -18°C @ 69 barg
W in G < 4 lb / MMscf
CO_2 < 2.5 mole %
H_2S < 5 ppm
Cricondenbar < 105 barg
Cricondentherm < 40°C

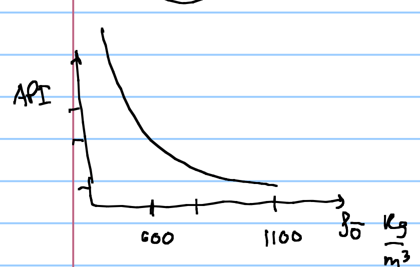


pipeline
Dew point -10°C @ 50 barg
CO_2 < 2.5%
H_2S < 5 ppm
- Calorific value
- Wobbe index
} burning gas energy

oil:
API: 8-65
W in O < 0.5 - 1% (N, 2%)
Tanker/truck < 11 psia RVP (Reid vapor pressure)
Pipeline 11.1 psia RVP / 150 TVP (True vapor pressure)
- Salt : 10-30 PTB (Norway) → pounds / thousand barrels
- H_2S : 10-100 ppmW

γ_o measured at p = 1.01325 bara
T = 15.56 °C

$$API = \frac{141.5}{\gamma_o} - 131.5$$



- axis in black
- outer tick marks
- font (14-18), bold
- axis titles, name of variable, symbol, unit
- number of significant digits !

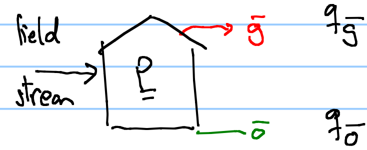
in P.E we use standard condition volumetric rate

	oil	gas	
[kg/s]			
[moles/s]			
	stb/d	scf/d	field units
	Sm^3/d	Sm^3/d	SI units

↳ volume measured at s.c.
p_{sc} = 1.01325 bar
T_{sc} = 15.56 °C

p_{sc}, t_{sc} → ~ Sm^3/d

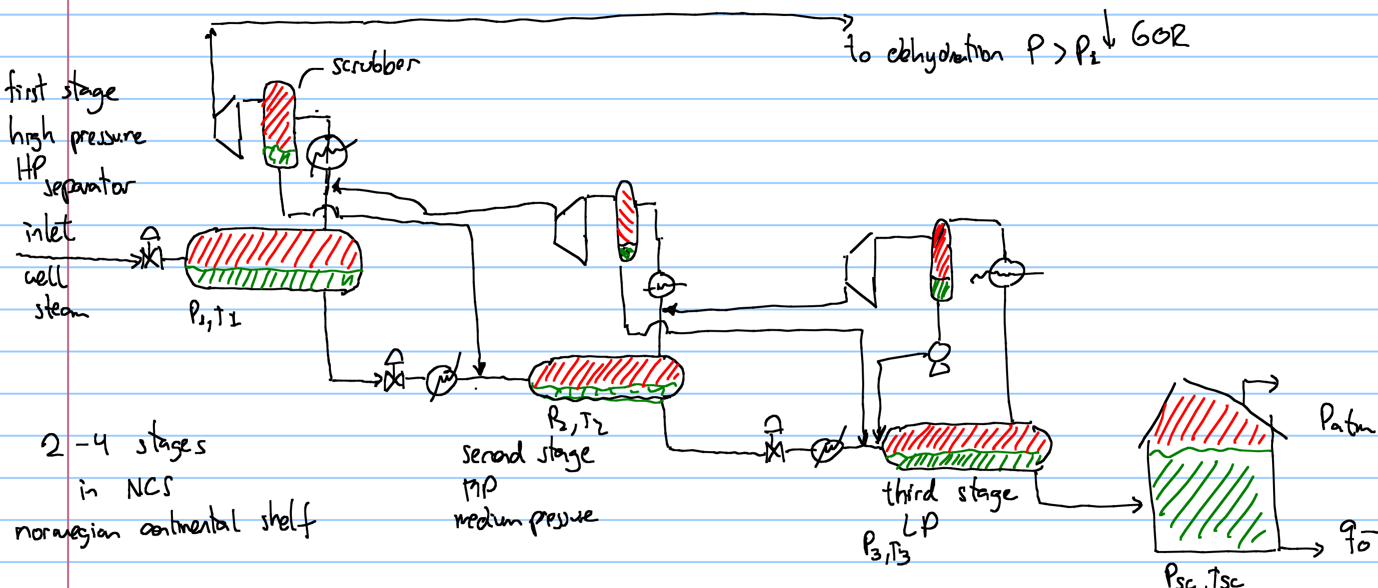
oil and gas separation and stabilization : functions
- mechanically separate oil-gas-water
- stabilize oil / gas
- increase the ratio between oil/gas



GOR gas-oil ratio

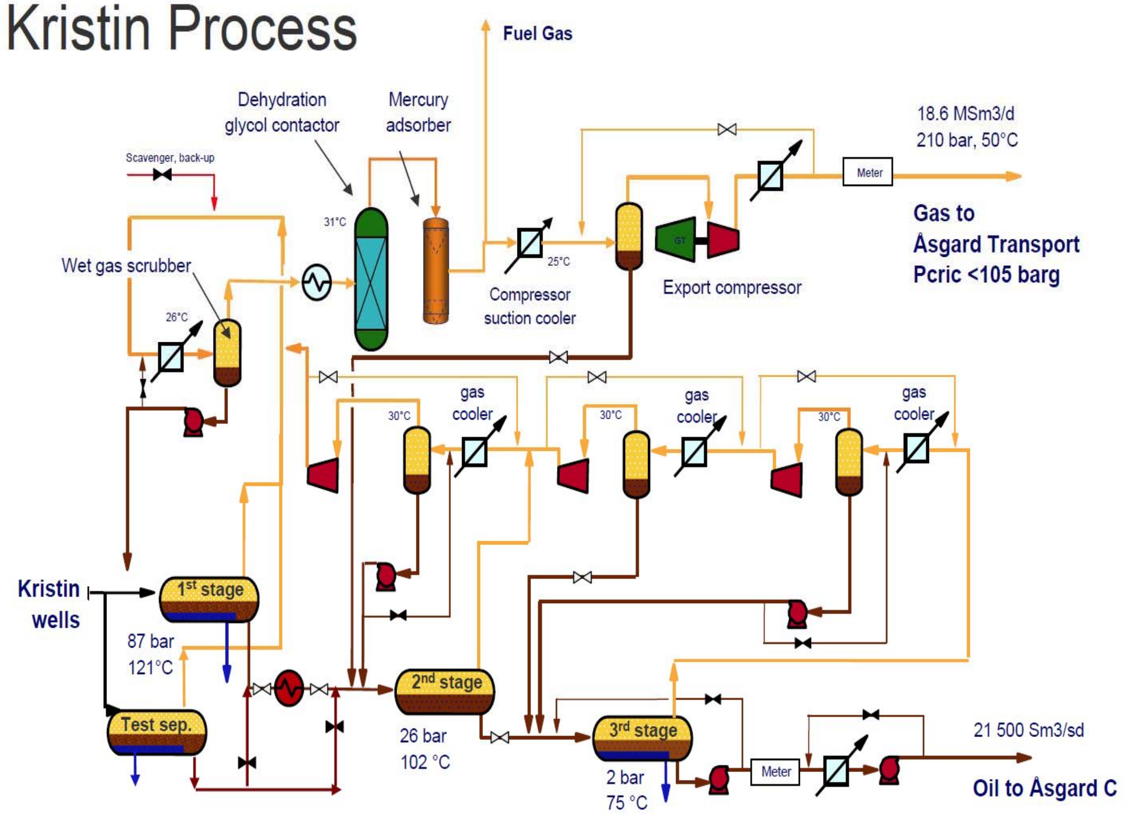
$$GOR = \frac{q_g}{q_o}$$

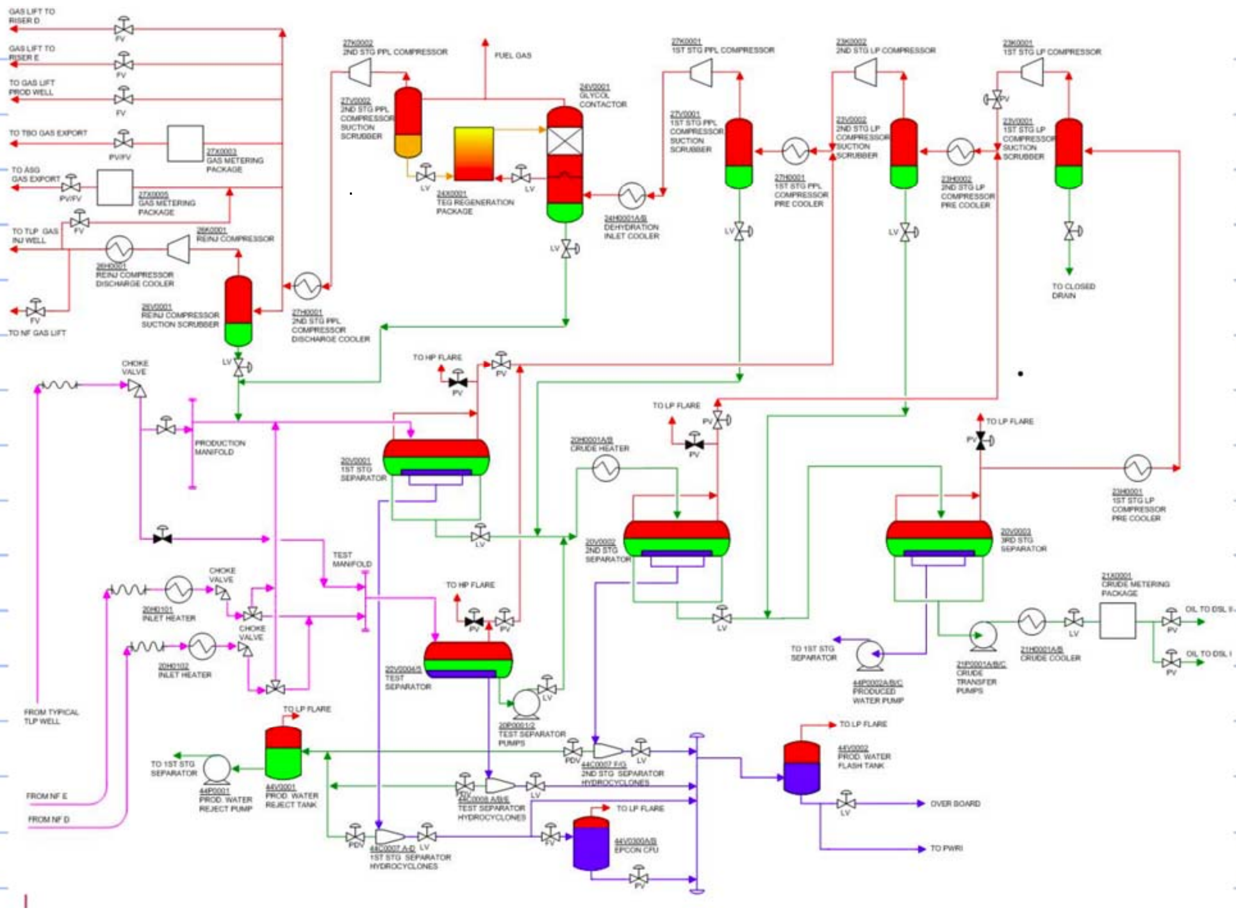
a processing train



2-4 stages
in NCS
norwegian continental shelf

Kristin Process





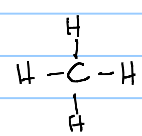
How do we study separation processes? → thermodynamics of mixtures (HC) hydrocarbon
↳ fluid behavior
phase behavior
PVT behavior
Pressure, volume, temperature

oil and gas consist of several pure components

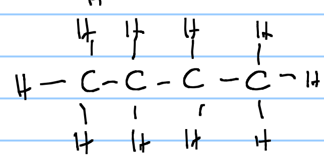
Non HC { CO_2, N_2, H_2S

Hydrocarbons {
- Methane (C_1)
- C_2
- C_3
- C_4
- i-C_4
- C_5
- i-C_5
- C_6
- C_7
- C_8 ⋮
- C_{50}

NGL (Methane to C_5); LNG (C_1–C_2); LPG (C_3–C_4)

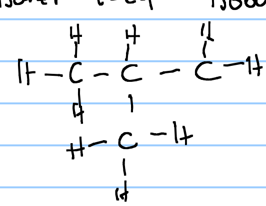


CH_4 alkanes C_nH_{2n+2}



C_4H_{10}

isomer i-C_4 isobutane



the oil and gas are characterized by molecular composition

mole fraction $z_i = \frac{\text{number of moles of pure component "i"}}{\text{total number of moles}}$

	z_i	w_i
C_1	0.4	
C_3	0.3	
C_8	0.3	

mass fraction $w_i = \frac{\text{mass of component "i"}}{\text{total mass}}$

Molecular weight (pure component) $= \frac{\text{mass}}{\text{nr. moles}}$ $\left[\frac{kg}{kmol}\right], \left(\frac{g}{mol}\right)$

molecular weight mixture $= \sum_{i=1}^{N} z_i \, MW_i$ (N = number compones)

relationship between w_i, z_i ?

$$w_i = \frac{\text{mass of component } i}{\text{total mass}} = \frac{\text{n moles of } i \cdot MW_i}{\text{total number of moles} \cdot MW_{mixture}} = z_i \frac{MW_i}{MW_{mixture}}$$