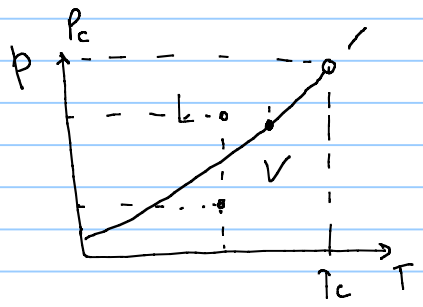
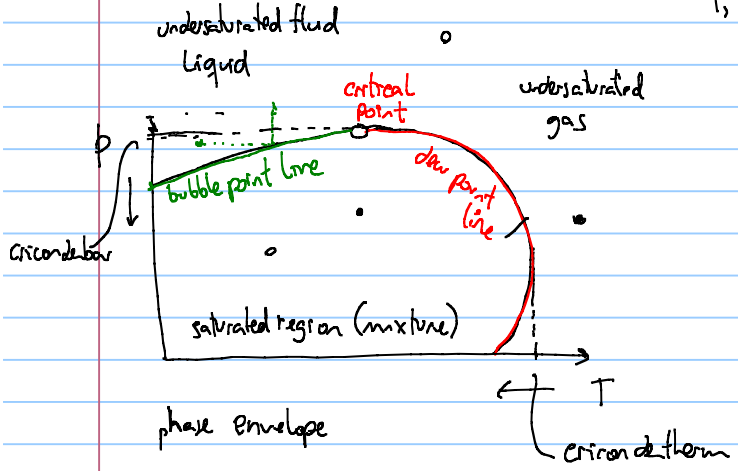
Class 3

Phase diagram
pure component
/single component

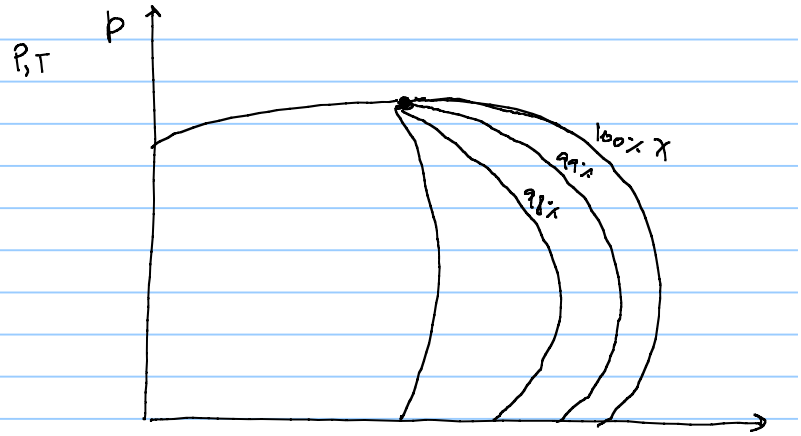


multicomponent
mixture

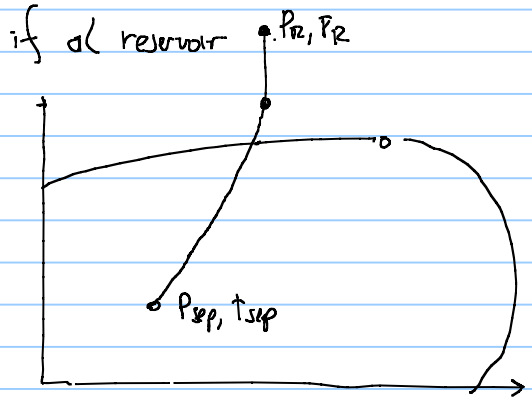
for a given composition

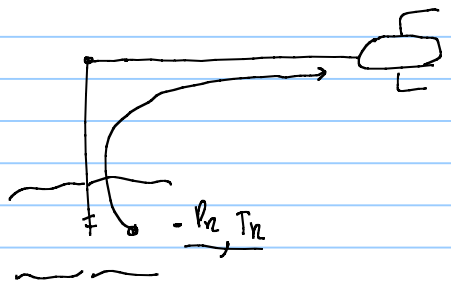


phase envelope

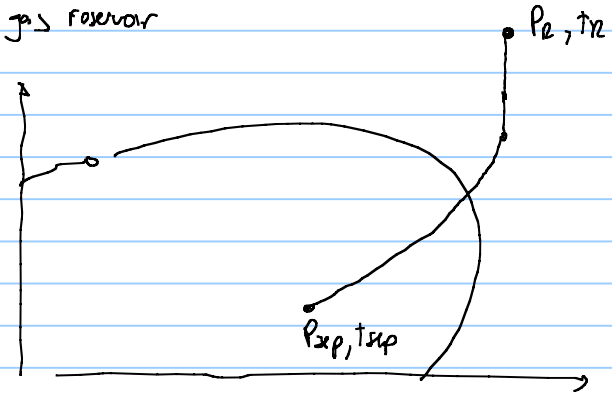


$$x = \frac{n_V}{n_T}$$





if gas reservoir



- Methods for performing flash calculations

equilibrium

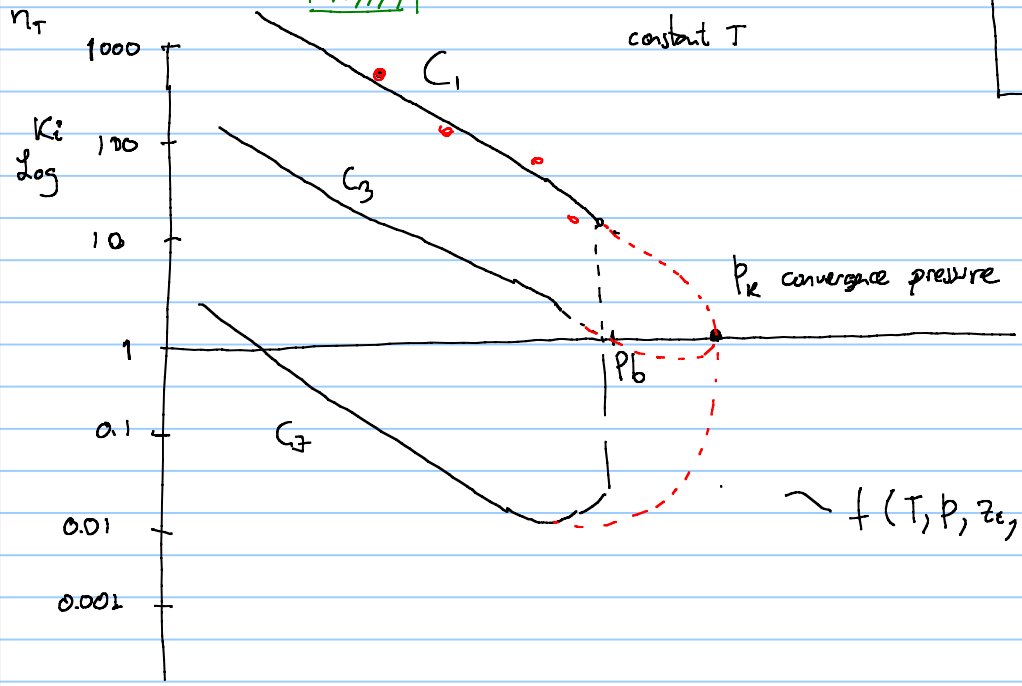
equilibrium ratio $K_i = \frac{y_i}{x_i}$

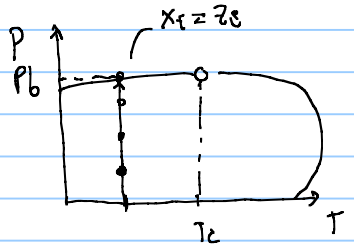
↑ for component "i"

z_i { $\frac{n_{c_1}}{n_v} = y_{c_1}$

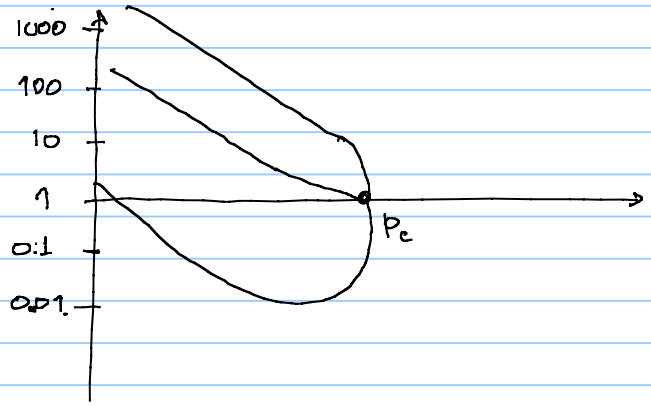
$\frac{n_{c_1}}{n_L} = x_{c_1}$

$z_{c_1} = \frac{n_{c_1}}{n_T}$





if the plot is made at T_c



Given $p, T \rightarrow K_i$. $\frac{x_i}{y_i}$ if N components $(2-N)$ unknowns

z_i

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

$\sum_{i=1}^{N} y_i = 1$ 1 eq

$\sum_{i=1}^{N} x_i = 1$ 1 eq

z_i y_i x_i

$n_i = n_{vi} + n_{Li}$

divide n_T $\frac{n_i}{n_T} = \frac{n_{vi}}{n_T} + \frac{n_{Li}}{n_T}$ vapor fraction $\frac{n_v}{n_T} = f_v \sim 0 \text{ -- } 1$

$z_i = f_v \underbrace{\frac{n_{vi}}{n_v}}_{y_i} + \frac{n_{Li}}{n_L}(1-f_v)$

$n_T = \frac{n_v}{f_v}$

$\frac{n_L}{n_T} = (1-f_v)$

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

N eq

1 unknown

	Unknowns	equation
$K_i = \frac{y_i}{x_i}$	2-N	N
$\sum y_i = 1$	0	1
$z_i = f_v y_i + (1-f_v) x_i$	1	N
	(2-N+1)	2-N+1

Rachford-Rice

$$z_i = f_v y_i + (1-f_v) x_i \qquad K_i = \frac{y_i}{x_i} \qquad y_i = K_i x_i$$

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

$$z_i = x_i \cdot (f_v K_i + 1 - f_v)$$

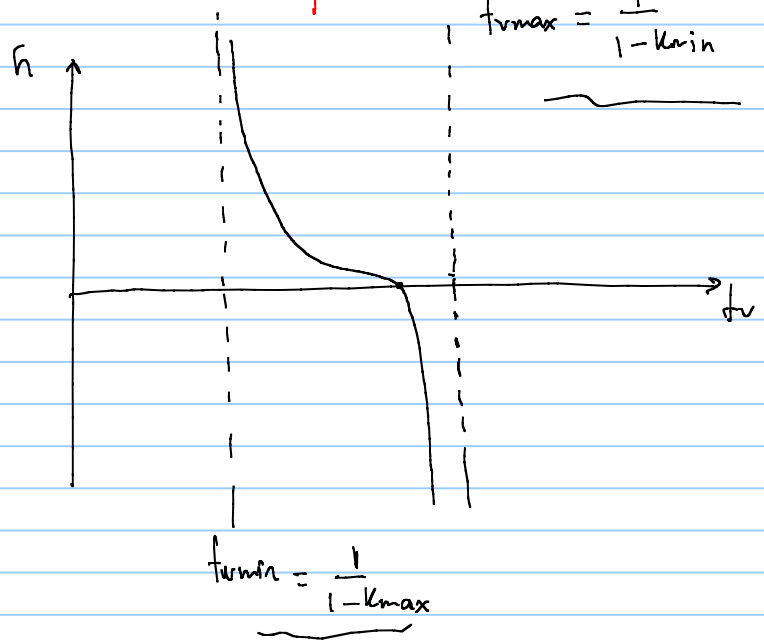
$$x_i = \frac{z_i}{f_v K_i + 1 - f_v}$$

$$\sum_{i=1}^{N} x_i = 1 \qquad \sum_{i=1}^{N} (y_i - x_i) = 0$$

$$\sum_{i=1}^{N} y_i = 1 \qquad y_i = K_i \cdot x_i$$

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

$$\sum_{i=1}^{N} (K_i - 1) x_i = 0 = \sum_{i=1}^{N} \frac{(K_i - 1) z_i}{f_v K_i + 1 - f_v} \qquad h(f_v)$$



RR could give $0 < f_v < 1$ in mixture

$f_v = 0$ saturated liquid

$f_v = 1$ saturated gas

$f_v < 0$ liquid

$f_v > 1$ undersaturated gas

EX: MULTISTAGE SEPARATION FLASH. By Prof. Milan Stanko (NTNU)

SEPARATION PROCESS

Stage	p	T	z-C1	z-C3	z-N-C10	x-C1	x-C3	x-N-C10	y-C1	y-C3	y-N-C10	fv
[-]	bara	C	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]
1-HP	50	70	0.5	0.2	0.3	0.07679	0.22803	0.69518	0.81955	0.17884	0.00162	0.56978
2-MP	35	50	0.07679	0.22803	0.69518							
3-LP	1.01325	15.56	0.00000	0.00000	0.00000							

COMPONENT PROPERTIES

Pk	[bara]	689	
Comp	**Tc**	**pc**	**AF (ω)**
	[K]	**[bara]**	
C1	190.6	46.1	0.0115
C3	369.8	42.5	0.1454
N-C10	617.7	21.0	0.4902

FLASH CALCULATIONS

p	[bara]	50	
T	[C]	70	
		fvmin	-0.103
		fvmax	1.002
		fv	0.5698

Comp	zi	Ki (T)	RR_term	xi	yi
C1	0.5	10.6723	7.43E-01	0.07679	0.81955
C3	0.2	0.7843	-4.92E-02	0.22803	0.17884
N-C10	0.3	0.0023	-6.94E-01	0.69518	0.00162
		SUM=	-7.40E-09	1.00000	1.00000