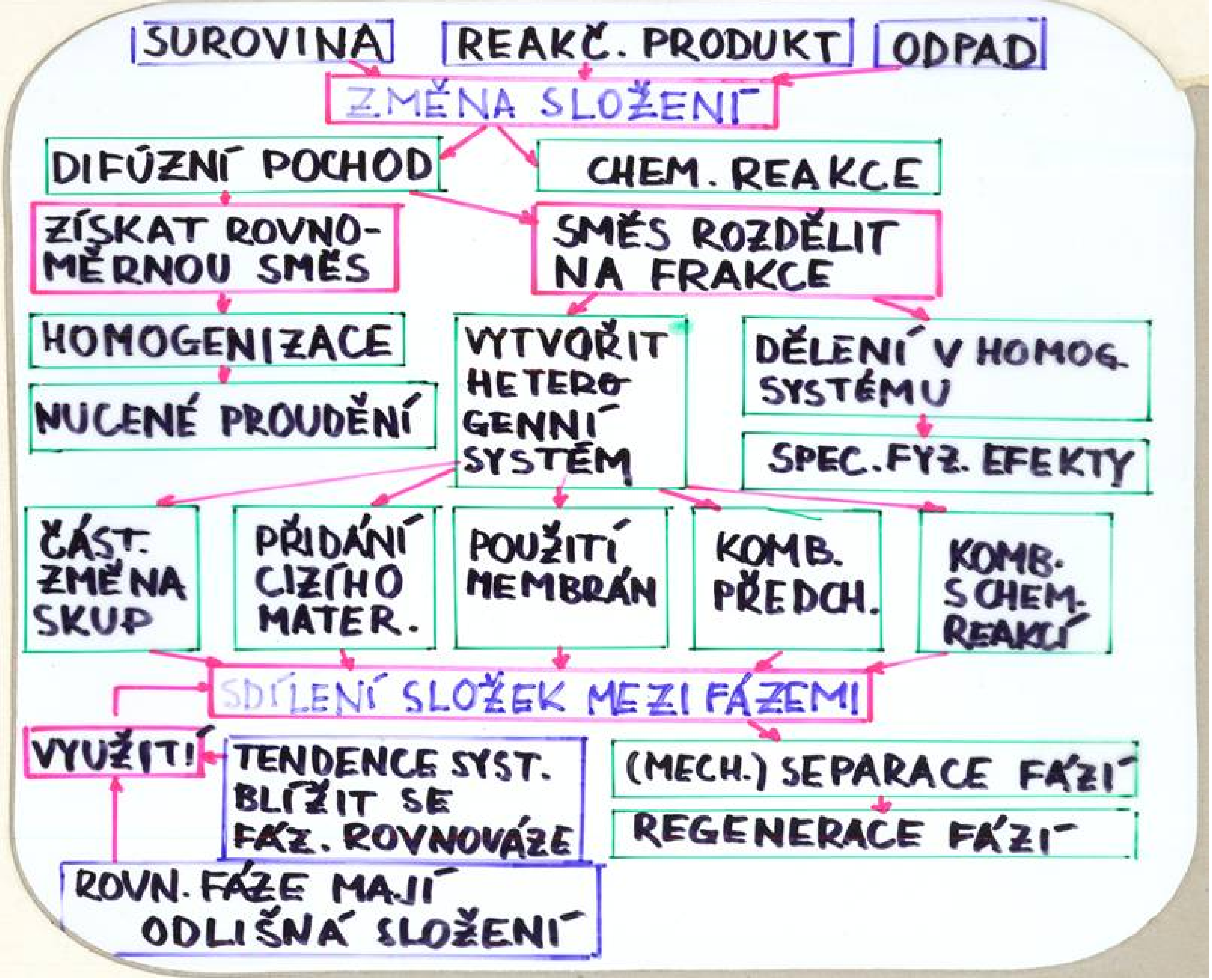


SUROVINA
REAKČ. PRODUKT
ODPAD
ZMĚNA SLOŽENÍ
DIFÚZNÍ POCHOD
CHEM. REAKCE
ZÍSKAT ROVNOMĚRNOU SMĚS
SMĚS ROZDĚLIT NA FRAKCE
HOMOGENIZACE
NUCENÉ PROUDĚNÍ
VYTVOŘIT HETEROGENNÍ SYSTÉM
DĚLENÍ V HOMOG. SYSTÉMU
SPEC. FYZ. EFEKTY
ČÁST. ZMĚNA SKUP
PŘIDÁNÍ CIZÍHO MATER.
POUŽITÍ MEMBRÁN
KOMB. PŘEDCH.
KOMB. S CHEM. REAKCÍ
SDÍLENÍ SLOŽEK MEZI FÁZEMI
VYUŽITÍ!
TENDENCE SYST. BLÍŽIT SE FÁZ. ROVNOVÁZE
(MECH.) SEPARACE FÁZÍ
REGENERACE FÁZÍ
ROVN. FÁZE MAJÍ ODLIŠNÁ SLOŽENÍ

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

$$\boxed{\alpha_{ij} = \frac{K_i}{K_j}} = \frac{y_i}{x_i}\,\frac{x_j}{y_j} = \frac{y_i}{x_i}\,\frac{1}{K_j}$$

3f: $y_i = K_i' x_i$

$y_i = K_i'' z_i$

$\left(z_i = K_i''' y_i , \; K_i''' = \frac{K_i'}{K_i''} \right)$

$\alpha_{ii} = 1$

$\alpha_{ij} = 1/\alpha_{ji}$

$\alpha_{ij} = \alpha_{ik}\,\alpha_{kj}$

$K_i = K_i(t, p, x_1, \dots, x_c, y_1, \dots, y_c)$

$* \; K_i = K_i(t, p)$

GIBBS $\boxed{N_v = c - f + 2}$

$f = 2: \; N_v = c$

prom.: $t, p, x_1, \dots x_c, y_1, \dots y_c$ $\qquad 2c+2$

$$\left.\begin{array}{ll} \text{rovn.:} & y_i = K_i x_i \quad (i = 1, \dots, c) \\ \text{vaz. p.:} & \sum x_i = 1, \quad \sum y_i = 1 \end{array}\right\} \qquad c+2$$

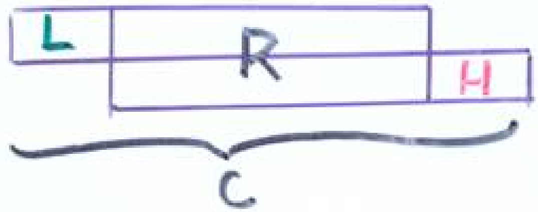
VAZNÉ PODM.

$y_i = K_i x_i$ $\qquad x_i = y_i / K_i$ $\qquad y_i = K_j \alpha_{ij} x_i$ $\qquad x_i = \frac{1}{K_j} \alpha_{ji} y_i$

$\boxed{1 = \sum K_i x_i}$ $\qquad \boxed{1 = \sum y_i / K_i}$ $\qquad \boxed{\frac{1}{K_j} = \sum \alpha_{ij} x_i}$ $\qquad \boxed{K_j = \sum \alpha_{ji} y_i}$

$$y_i = \frac{K_i x_i}{\sum K_j x_j} \qquad x_i = \frac{y_i / K_i}{\sum y_j / K_j} \qquad y_i = \frac{\alpha_{ij} x_i}{\sum \alpha_{kj} x_k} \qquad x_i = \frac{\alpha_{ji} y_i}{\sum \alpha_{jk} y_k}$$

$K_L \to \infty$



$K_H \to 0$ y_i x_i

$$\sum_R K_i x_i = \sum_R y_i = 1 - \sum_L y_i \qquad \sum_R \frac{y_i}{K_i} = \sum_R x_i = 1 - \sum_H x_i$$

$$\sum_R \frac{K_i}{\sum_R y_i} \frac{\sum_R x_i}{\sum_R x_i} x_i = 1 \qquad X_i^R = \frac{x_i}{\sum_R x_i} \qquad Y_i^R = \frac{y_i}{\sum_R y_i}$$

$$\sum_R K_i^R X_i^R = 1 \qquad K_i^R = K_i \frac{\sum_R x_i}{\sum_R y_i} = K_i \frac{1 - \sum_H x_i}{1 - \sum_L y_i}$$

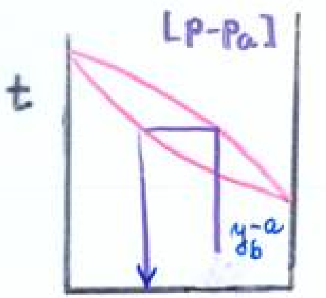
KOND.:

a	b	c	V
	b	c	L

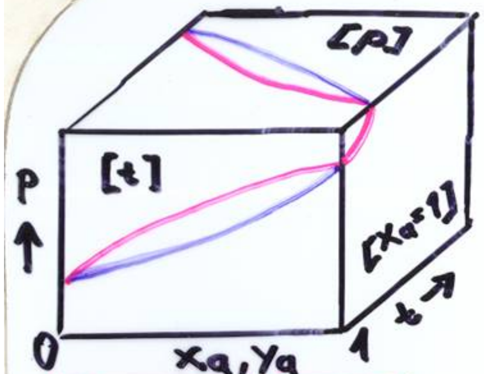
$$\sum_{i \neq a} \frac{y_i}{K_i} = 1 \qquad \sum_{i \neq a} \frac{y_i^{-a}}{K_i^R} = 1$$

$$y_i^{-a} = \frac{y_i}{1 - y_a} \qquad K_i^R = \frac{K_i}{1 - y_a}$$

$$K_i|_p \cdot \frac{p}{p - p_a} = K_i|_{p - p_a}$$

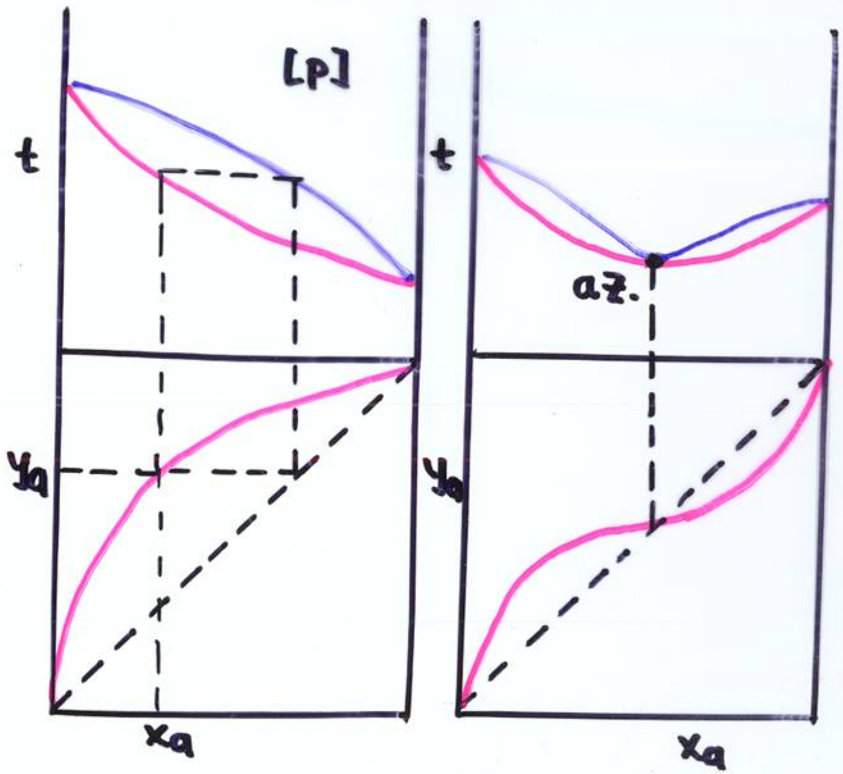


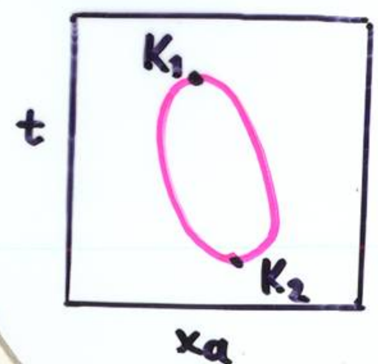
$x_b^{-a} = x_b$



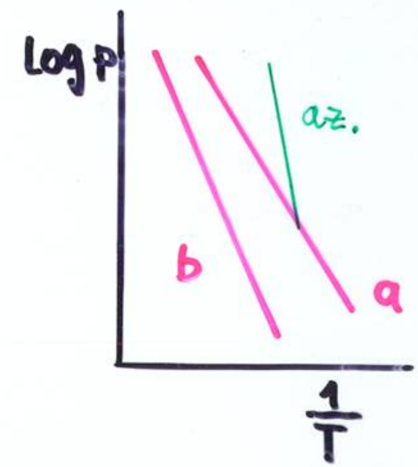
$$\boxed{N_v = c - N_f + 2}$$

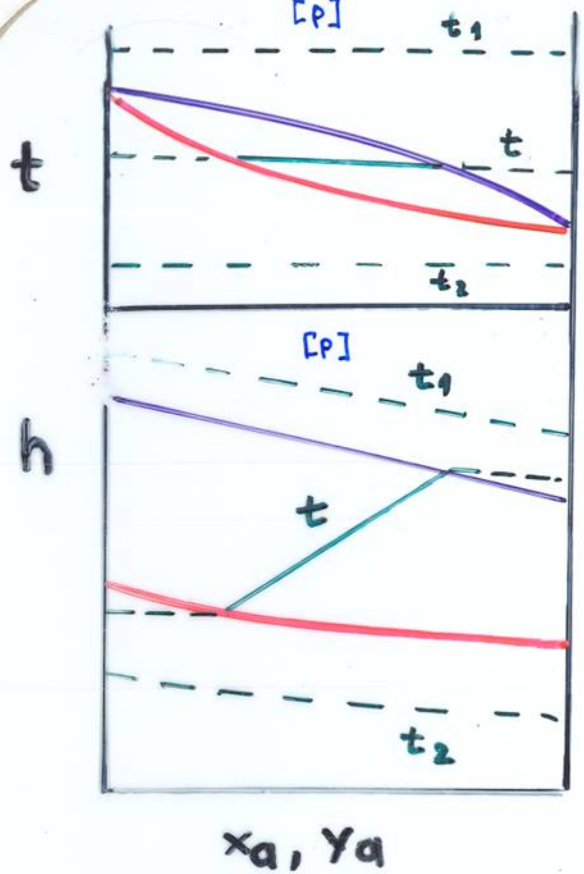
c	N_f	[ ]	N_v
2	1	–	3
		[p]	2
	2	–	2
		[p]	1





1. $x_i = 1$
2. $x_i' = x_i''$
3. $x_i' \equiv x_i''$





$$h(t) = h_0 + \bar{c}_p (t - t_0)$$

$$\bar{c}_p = \frac{h - h_0}{t - t_0} = \frac{1}{t - t_0} \int_{t_0}^{t} c_p(t)\, dt$$

směs:

1. $h = \sum_i x_i \bar{h}_i$

2. $h = \sum_i x_i h_i + \Delta h_s$

$$\Delta h_s = \sum_i x_i q_{si}$$

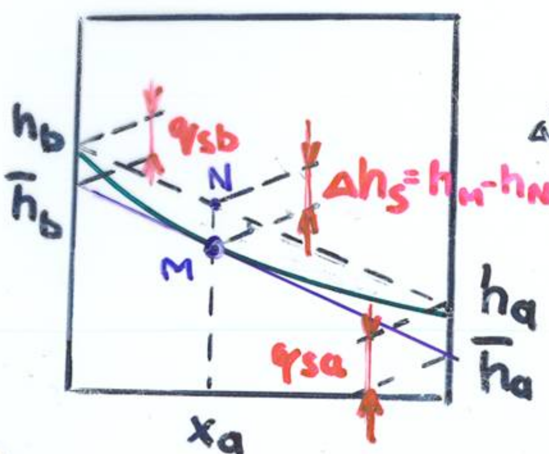
$$q_{si} = \bar{h}_i - h_i$$

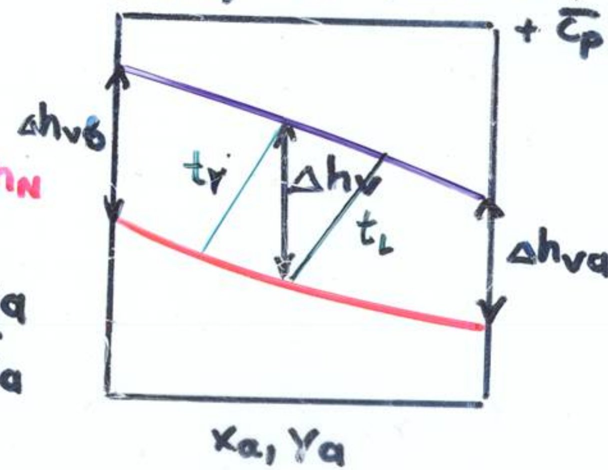
$$c = 2 \quad \bar{h}_i = h + (1 - x_i)\left(\frac{\partial h}{\partial x_i}\right)_{p,T}$$

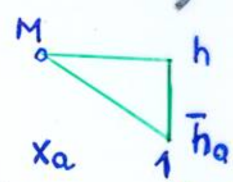
$$q_i = h - h_i + (1 - x_i)\left(\frac{\partial h}{\partial x_i}\right)_{p,T}$$

fáz. přeměna:

$$h(t) = h_0 + \bar{c}_{p1}(t_1 - t_0) + \Delta h_1(t_1) + \bar{c}_{p2}(t - t_1)$$







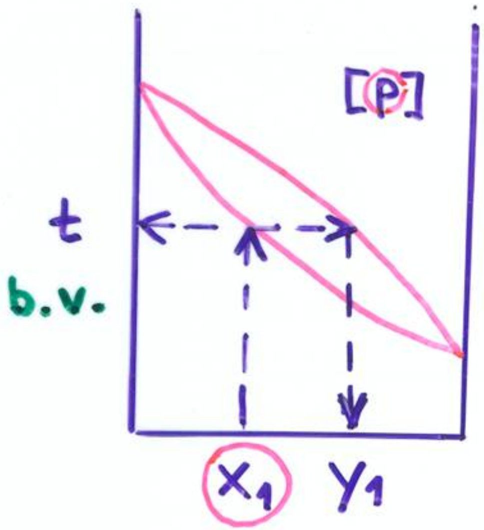
$$\left(\frac{\partial h}{\partial x_a}\right)_{p,T} = \frac{\bar{h}_a - h}{1 - x_a}$$

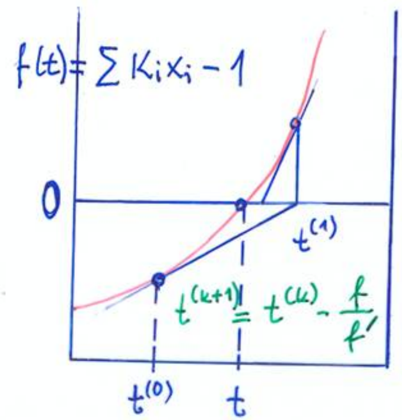
$$y_i = \frac{K_i x_i}{\sum K_i x_i} \longrightarrow y_1, \ldots, y_{c-1}, y_c \qquad t,\ p$$

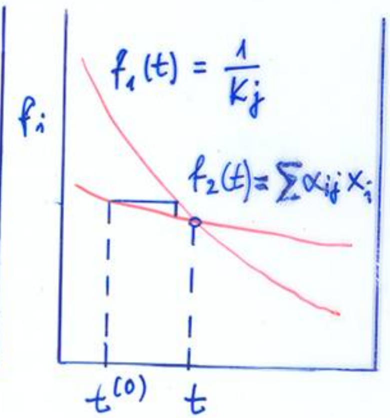
$$\left(y_i = \frac{\alpha_{ij} x_i}{\sum \alpha_{ij} x_i} \right) \qquad x_1, \ldots, x_{c-1}, x_c$$

$$\sum x_i = 1 \qquad \sum K_i x_i = 1$$

$$\left(\sum \alpha_{ij} x_i = \frac{1}{K_j} \right)$$







$$K_i = \frac{\gamma_{iL}}{p} \exp\left(A_i - \frac{B_i}{C_i + t} \right)$$

$$\gamma_{iL} = \gamma_{iL}(x_1, \ldots, x_c)$$

$$\sum y_i = 1$$

$$y_1, \ldots, y_{c-1}, y_c$$

$$x_1, \ldots, x_{c-1}, x_c$$

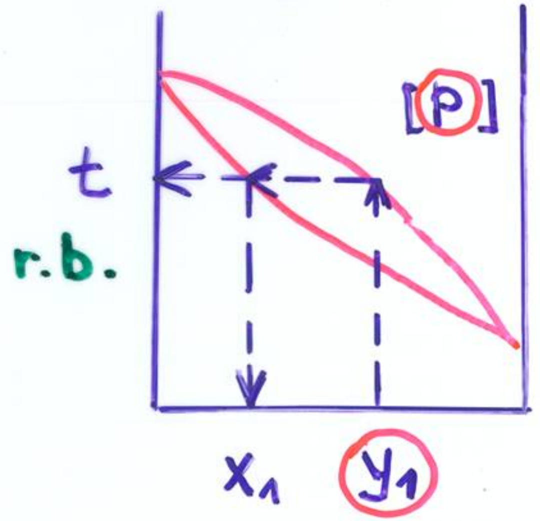
$$t, p$$

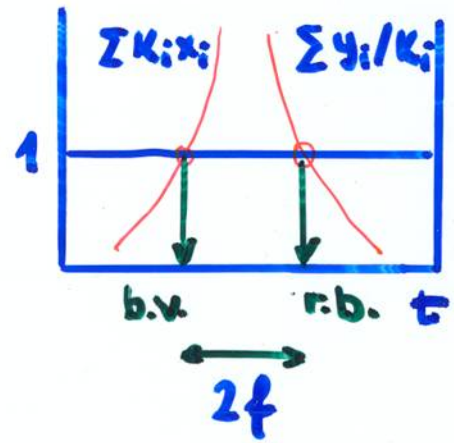
$$x_i = \frac{y_i / K_i}{\sum y_i / K_i}$$

$$\left(x_i = \frac{\alpha_{ji}\, y_i}{\sum \alpha_{ji}\, y_i} \right)$$

$$\sum y_i / K_i = 1$$

$$\left(\sum \alpha_{ji}\, y_i = K_j \right)$$



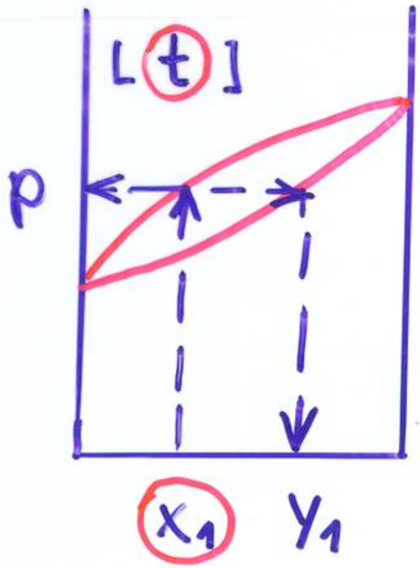


$$f(t) = \sum y_i / K_i(t) - 1 = 0$$

$y_1, \ldots\ldots, y_{c-1}, y_c$ $\quad t, p$

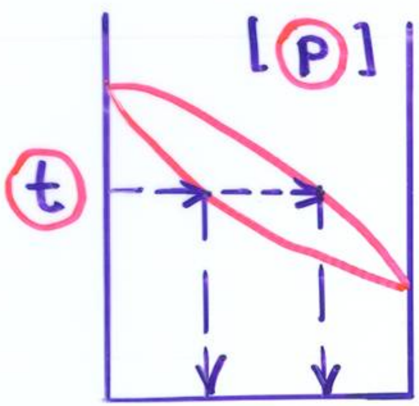
$x_1, \ldots\ldots, x_{c-1}, x_c$

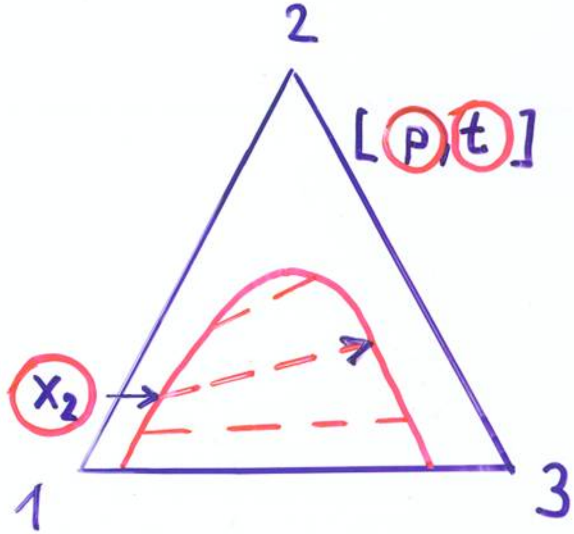
$\sum K_i x_i = 1$



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

$$\sum K_i x_i = 1 \longrightarrow \begin{array}{l} y_1, \ldots, y_{c-1}, y_c \quad t, p \\ x_1, \ldots, x_{c-1}, x_c \end{array}$$





$$f(x_1) = \sum K_i x_i - 1$$
$$= K_1 x_1 + \ldots + K_{c-1} x_{c-1} + K_c (1 - x_1 - \ldots - x_{c-1}) - 1$$
$$= (K_1 - K_c) x_1 + \sum_{2}^{c-1} (K_i - K_c) x_i - 1$$

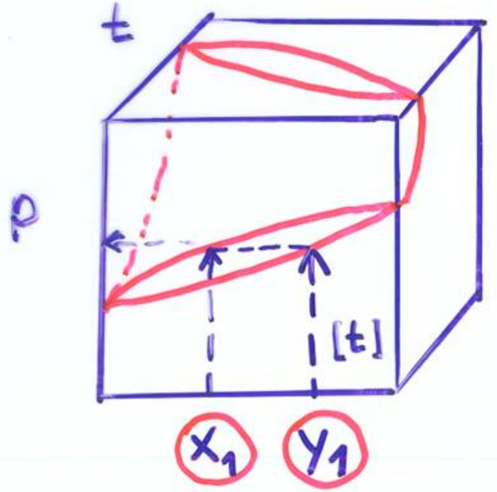
$$\sum \alpha_{i1} x_i = \frac{x_1}{y_1}$$

$y_1, \ldots\ldots, y_{c-1}, y_c$

$x_1, \ldots., x_{c-1}, x_c$

$t, \; p$

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



$$f_1(t, p) = \sum K_i x_i - 1$$

$$f_2(t, p) = K_1 - y_1/x_1$$

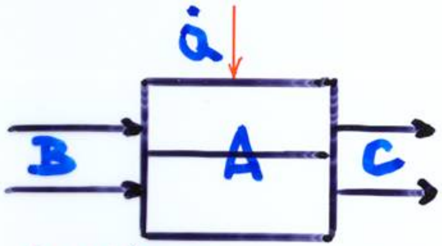
$$\frac{\partial f_1}{\partial t} \Delta t + \frac{\partial f_1}{\partial p} \Delta p = -f_1$$

$$\frac{\partial f_2}{\partial t} \Delta t + \frac{\partial f_2}{\partial p} \Delta p = -f_2$$

$$\begin{bmatrix} \frac{\partial f_1}{\partial t} & \frac{\partial f_1}{\partial p} \\ \frac{\partial f_2}{\partial t} & \frac{\partial f_2}{\partial p} \end{bmatrix} \begin{bmatrix} \Delta t \\ \Delta p \end{bmatrix} = - \begin{bmatrix} f_1 \\ f_2 \end{bmatrix}$$

$y_1, \ldots\ldots, y_{c-1}, y_c$	t, p
$x_1, \ldots\ldots, x_{c-1}, x_c$	

BILANCE



$\emptyset$ CHR

$$\tau:\ \overbrace{\sum_B \dot n_{iB}(\tau) = \sum_C \dot n_{iC}(\tau)}^{\emptyset\ \text{vsád.}} + \overbrace{\sum_A \dot n_{iA}(\tau)}^{\emptyset\ \text{ust. st.}}$$

$$\sum_B \dot n_B(\tau) = \sum_C \dot n_C(\tau) + \sum_A \dot n_A(\tau)$$

$$0-\tau_b:\ \overbrace{\sum_B n_{iB}(\tau_b) = \sum_C n_{iC}(\tau_b)}^{\emptyset\ \text{vsád.}} + \overbrace{\underbrace{\sum_A n_{iA}(\tau_b) - \sum_A n_{iA}(0)}_{\sum_A \Delta n_{iA}}}^{\emptyset\ \text{ust. st.}}$$

$$\int_0^{\tau_b} \dot n_{iJ}(\tau)\,d\tau = \int_0^{\tau_b} \frac{dn_{iJ}}{d\tau}\,d\tau = \int_{n_{iJ}(0)}^{n_{iJ}(\tau_b)} dn_{iJ} = n_{iJ}(\tau_b) - n_{iJ}(0)$$

$$\Downarrow$$

$$\emptyset\quad J = B, C$$

$$\Uparrow$$

$$\bar{\dot n}_{iJ} = \frac{1}{\tau_b}\int_0^{\tau_b} \dot n_{iJ}\,d\tau = \frac{n_{iJ}(\tau_b) - n_{iJ}(0)}{\tau_b}$$

stř. $0-\tau_b$ ust. st.

$$\sum_B \bar{\dot n}_{iB} = \sum_C \bar{\dot n}_{iC}$$

$$\sum_B \bar{\dot n}_B = \sum_C \bar{\dot n}_C$$

B, C - píst. tok (∅ ax. disp.), A - id. mîsič

$$\tau: \quad \sum_B x_{iB}(\tau)\dot{n}_B(\tau) = \sum_C x_{iC}(\tau)\dot{n}_C(\tau) + \sum_A \frac{d[x_{iA}(\tau)\,n_A(\tau)]}{d\tau}$$

$$0-\tau_b: \quad \underbrace{\sum_B \bar{x}_{iB}\, n_B(\tau_b) = \sum_C \bar{x}_{iC}\, n_C(\tau_b)}_{\text{∅ vsd.}} + \underbrace{\sum_A x_{iA}(\tau_b)\,n_A(\tau_b) - \sum_A x_{iA}(0)\,n_A(0)}_{\text{∅ ust. st.}}$$

$$\int_0^{\tau_b} x_{iJ}(\tau)\dot{n}_J\,d\tau = \bar{x}_{iJ}\int_0^{\tau_b}\dot{n}_J(\tau)\,d\tau = \bar{x}_{iJ}\,n_J(\tau_b) = n_{iJ}(\tau_b) \qquad J = B, C$$

$$\int_0^{\tau_b} \frac{d(x_{iA}n_A)}{d\tau}\,d\tau = \int_{x_{iA}(0)n_A(0)}^{x_{iA}(\tau_b)n_A(\tau_b)} d(x_{iA}n_A) = x_{iA}(\tau_b)\,n_A(\tau_b) - x_{iA}(0)\,n_A(0)$$

str. ust. st.

$$0-\tau_b \qquad \sum_B \bar{x}_{iB}\,\bar{n}_B = \sum_C \bar{x}_{iC}\,\bar{n}_C$$

$$n_i = x_i^R\, n^R \qquad x_i^R = x_i / \sum_R x_j \qquad n^R = \sum_R n_i = n \sum_R x_i$$

$$n_i = c_i V \qquad c_i = x_i c$$

$$n = cV \qquad c = \sum_i c_i$$

$$\tau: \quad \sum_B \dot{H}_B + \dot{Q} = \sum_C \dot{H}_C + \sum_A \frac{dU_A}{d\tau} + \sum_A p_A \frac{dV_A}{d\tau}$$

$$+ \sum_A \frac{dH_A}{d\tau} - \sum_A V_A \frac{dp_A}{d\tau}$$

ZANEDB.:
změny E_{kin}, E_{pot}
jiné E
$\emptyset$ výkon na hřídeli mech. stroje

p rovn. $\quad p \sum \frac{dV_A}{d\tau} \quad V \frac{dp}{d\tau}$

$[V]$ $\quad \emptyset$

$[p]$ $\quad \emptyset$

$\dot{Q}$: stěnami, $\emptyset$ vedení v proudech

$$0\text{–}\tau_b: \quad \sum_B H_B(\tau_b) + Q(\tau_b) = \sum_C H_C(\tau_b) + \sum_A \Delta U_A + \sum_A \int p_A \frac{dV_A}{d\tau}\, d\tau$$

$$+ \sum_A \Delta H_A - \sum_A \int V_A \frac{dp_A}{d\tau}\, d\tau$$

$$\Delta U_A = U_A(\tau_b) - U_A(0), \quad \Delta H_A = H_A(\tau_b) - H_A(0)$$

stř. $0\text{–}\tau_b$ $\qquad$ ustál.

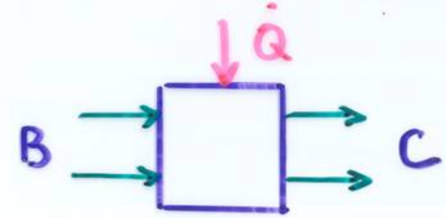
$$\sum_B \bar{\dot{H}}_B + \bar{\dot{Q}} = \sum_C \bar{\dot{H}}_C$$

$$\sum_B \bar{h}_B \bar{\dot{n}}_B + \bar{\dot{Q}} = \sum_C \bar{h}_C \bar{\dot{n}}_C$$

$U_A = u_A n_A$, $H_A = h_A n_A$

$\dot{H}_J = h_J \dot{n}_J \quad (J = B, C)$

STUPNĚ VOLNOSTI



P $\rightarrow$ $\dot{n}, x_1, \ldots x_{c-1}, t, p$

$\rightarrow$ $\dot{Q}$

$P_m = c+2$

$P_Q = 1$

$P = N_m(c+2) + N_Q$

V B $\sum_B x_{iB}\dot{n}_B = \sum_C x_{iC}\dot{n}_C$ $(i = 1, \ldots c)$

$\sum_B h_B \dot{n}_B + \sum_Q \dot{Q} = \sum_C h_C \dot{n}_C$

$B_m = c$

$B_n = 1$

$B = c+1$

R $t_K = t_L$ 1. ($N_Q > 0$ nebo $N_{mt} < N_m$) $R_t = N_{mt} - 1$

2. $N_Q = 0, N_{mt} = N_m$) $R_t = N_{mt} - 2$

$p_K = p_L$ $R_p = N_{mp} - 1$

$x_{iK} = K_i x_{iL}$ ($2f: c$, $3f: 2c$) $R_f = c(f-1)$

$\left.\begin{matrix} R_t \\ R_p \\ R_f \end{matrix}\right\}$ f.r.

$x_{iK} = x_{iL}$ 1. $N_{ms} < N_m$ $R_S = (N_{ms} - 1)(c-1)$

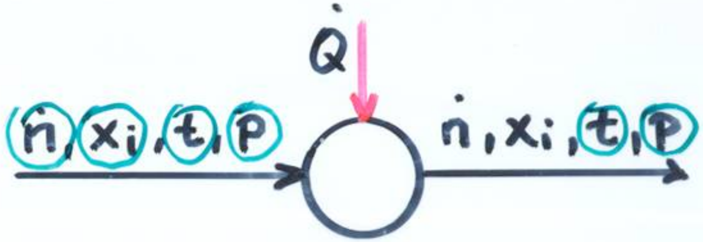
2. $N_{ms} = N_m$ $R_S = (N_{ms} - 2)(c-1)$

$N_V = P - \underbrace{B - R}_{V}$

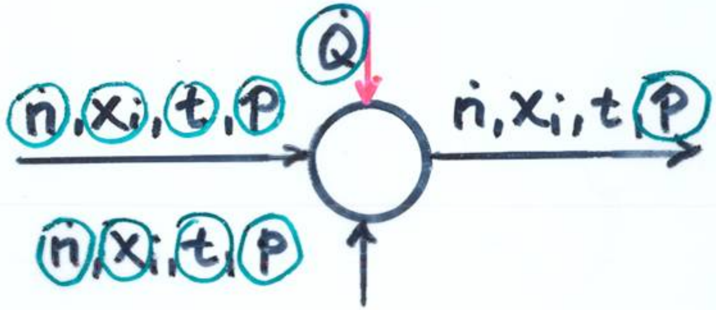
$S < N_V$ $N_{Vr} = N_V - S$

$S = N_V$ $N_{Vr} = 0$

OHŘÍVAČ
CHLADIČ



MÍSIČ

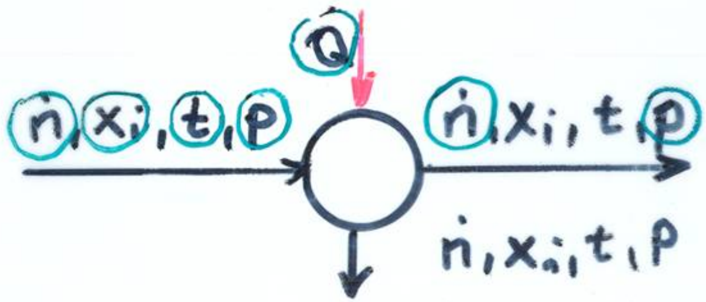


$P = 3(c+2)+1$

$V = c+1$

$N_v = 2c+6$

DĚLIČ
(MECH.)

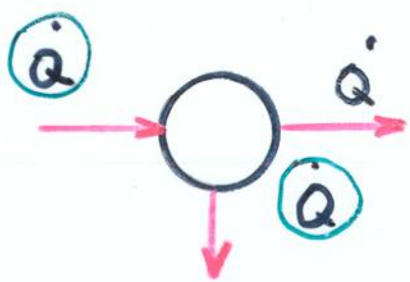


$P = 3(c+2)+1$

$V = c+1+c-1+$
$+1+1 =$
$= 2c+2$

$N_v = c+5$

DĚLIČ
TEP. TOKŮ

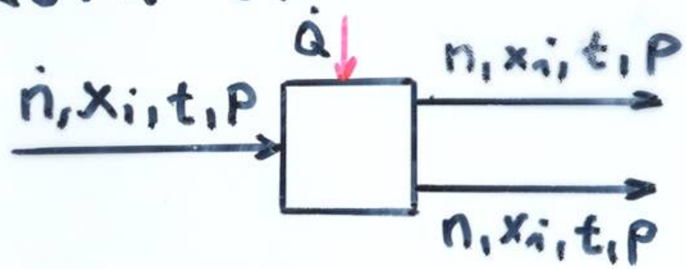


$P = 3$

$V = 1$

$N_v = 2$

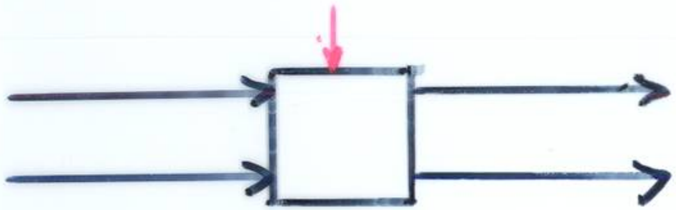
ROVN. STUPNĚ



$P = 3(c+2)+1$

$V = c+1+c+1+1 =$
$= 2c+3$

$N_v = c+4$



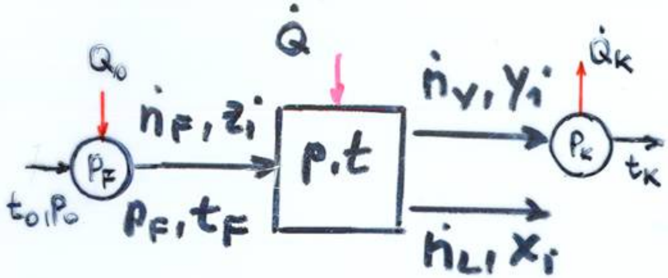
$P = 4(c+2)+1$

$V = 2c+3$

$N_v = 2c+6$

atd.

ROVN. DESTILACE



$\left.\begin{array}{ll} \dot{n}_F, z_i & c \\ p_F & 1 \end{array}\right\} S = c+1$

$N_{vr} = (c+4) - (c+1) = 3$

1

3

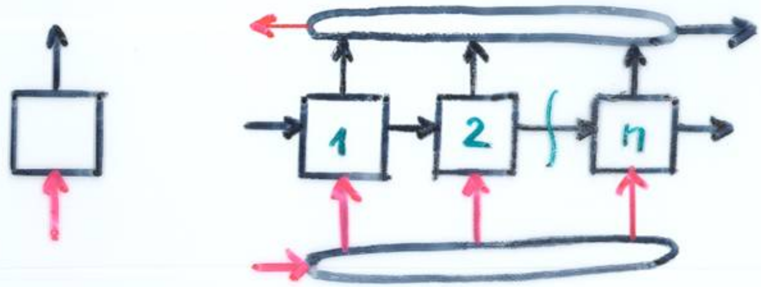
$N_v = (c+4) - (c+2) + (c+4) = c+6$

$S: \dot{n}_F, z_i, p_F, p_0, \dot{Q} \Rightarrow N_{vr} = 3$

$\dot{Q}, p, t, t_F, \dot{n}_V, y_j, \dot{n}_{Vj}$

$\dot{Q}_0$ $\quad \dot{n}_L, x_j, \dot{n}_{Lj}$

NEUSTÁLENÉ PROCESY



$$\left.\begin{aligned} P &= (n+1)(c+2)+1 \\ v &= c+1 \end{aligned}\right\}$$
$$N_v = n(c+2)+2$$

$$N_i = n(c+2)$$

$$\left.\begin{aligned} \Sigma N^e &= n(c+4) \\ -N_i &= -(n-1)(c+2) \\ N_0 &= 1 \end{aligned}\right\}$$
$$N_v = 2n+c+3$$

$$N_i = n$$

$$\left.\begin{aligned} P &= n+1 \\ v &= 1 \end{aligned}\right\}$$
$$N_v = n$$

$$N_v = 2n+c+5$$

DIF. DEST.

$Q_K = Q/n$	$n-1$	
P_K	$n-1$	$N_{vr} = c+6$
$n \to \infty$	1	
P, Q míšič	2	$c+4$
$L(0)$	$c+2$	2
P	1	
Q	1	0

$\Rightarrow v, \bar{y}, t(\tau)$

$L(\tau), x_i(\tau)$