
Markov-Chain

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Markov-Chain

Markov-Chain

Markov-Chain :

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Markov-Chain

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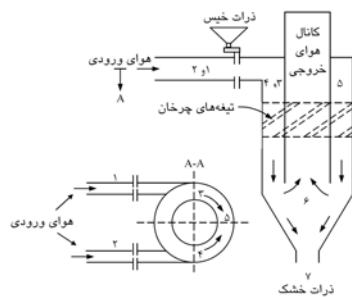
[] Rahimi Niksiar

Markov-Chain

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(RTD)



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$$-N_A M_A A_p^* \Delta t \lambda \Big|_{out} = 0$$

$$G'_y (H_{y,in} - H_{y,out}) - h A_p^* \Delta t (T_a - T_p) \Big|_{out} \quad ()$$

$$+ N_A M_A A_p^* \Delta t \lambda \Big|_{out} = 0$$

$$G'_y (y'_{A,in} - y'_{A,out}) + N_A M_A A_p^* \Delta t \Big|_{out} = 0 \quad ()$$

$$\Delta t \left(A_p^* = \frac{6W_p}{\rho_p d_p} \right)$$

N_A

Markov-Chain

$$N_A = k_y (y_A^* - y_A) \quad ()$$

$$k_y \quad y_A^* \quad y_A$$

$$\frac{1}{r^2} \frac{\partial}{\partial r} \left(D_{CD} r^2 \frac{\partial X_C}{\partial r} \right) - \frac{\partial X_C}{\partial t} = 0 \quad ()$$

N_A

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$$N_A = -D_{CD} \rho_B \frac{\partial X_C}{\partial r} \Big|_{r=R_p} \quad ()$$

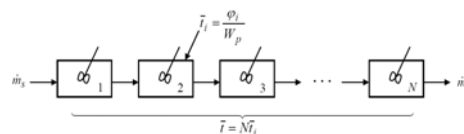
D_{CD}

t r

X_C

مدل تانک‌های همزده سری

$$\bar{X}_C = \frac{3}{R_p^3} \int_0^{R_p} X_C(r,t) r^2 dr \quad ()$$



کاربرد داده‌های زمان ماند برای تعیین پارامترهای
 مدل تانک‌های همزده سری

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معادلات حاکم در مدل تانک‌های همزده سری

σ_{model}^2

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$$\bar{t}_{model} E = \left(\frac{t}{\bar{t}_{model}} \right)^{N-1} \frac{N^N}{(N-1)!} e^{-tN/\bar{t}_{model}} \quad ()$$

$$\dot{m}_s (X_{A,in} - X_{A,out}) - N_A M_A A_p^* \Delta t \Big|_{out} = 0 \quad ()$$

$$\dot{m}_s (H_{x,in} - H_{x,out}) + h A_p^* \Delta t (T_a - T_p) \Big|_{out} \quad ()$$

$$\sigma_{model}^2(t) = \frac{\bar{t}_{model}}{N} \quad ()$$

$$S(m+1) = S(m).P \quad ()$$

$$\sigma_{exp}^2 = \sigma_{model}^2 \quad ; \quad \bar{t}_{exp} = \bar{t}_{model} \quad ()$$

$$s_j(m+1) = \sum_{i=1}^N s_i(m) p_{ij} \quad m = 1, 2, 3, \dots \quad ()$$

$$\sigma_{exp}^2(t) = \frac{\int_0^\infty (t - \bar{t}_{exp})^2 C dt}{\int_0^\infty C dt} \quad ()$$

$$\bar{t}_{exp} = \frac{\int_0^\infty t C dt}{\int_0^\infty C dt} \quad ()$$

$$\sum_{i=1}^N s_i(m) = 1 \quad ; \quad \sum_{j=1}^N p_{ij} = 1 \quad ()$$

RTD

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Markov

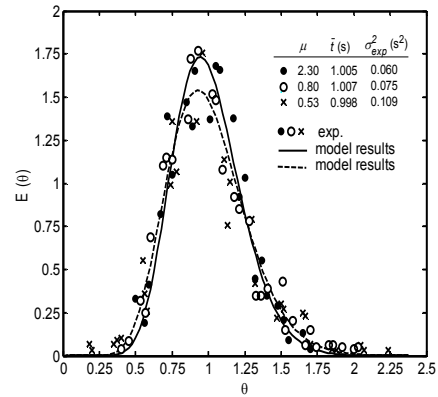
$$Markov \quad ()$$

$$Markov \quad ()$$

$$Markov \quad ()$$

$$\Delta\theta \quad (r/\dot{m}_s)$$

$$P_{ii} \quad () \quad Markov$$



$$(n = 14; \sigma_{model}^2 = 0.071 \text{ ---} \quad n = 18; \sigma_{model}^2 = 0.056 \text{ ----})$$

Markov-Chain مدل احتمال

Markov-Chain

$$P = \begin{bmatrix} 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & e^{-0.5n_p\Delta\theta(1+R)} & 0 & \frac{R}{R+1}(1-e^{-0.5n_p\Delta\theta(1+R)}) & \frac{1}{R+1}(1-e^{-0.5n_p\Delta\theta(1+R)}) & 0 \\ 0 & 0 & 0 & e^{-0.5n_p\Delta\theta(1+R)} & \frac{R}{R+1}(1-e^{-0.5n_p\Delta\theta(1+R)}) & \frac{1}{R+1}(1-e^{-0.5n_p\Delta\theta(1+R)}) & 0 \\ 0 & 0 & 0.5(1-e^{-n_p\Delta\theta R}) & 0.5(1-e^{-n_p\Delta\theta R}) & e^{-n_p\Delta\theta R} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \quad ()$$

$$\frac{dy'_A}{dz} = \frac{N_A M_A A_p^*}{U_p G'_y} \quad ()$$

$$\frac{dT_a}{dz} = - \frac{h A_p^* (T_a - T_p)}{(C_{pa} + y'_A C_{pA}) G'_y U_p} \quad ()$$

$$(m_p = \frac{\pi}{6} d_p^3 \rho_p) \quad A'_p \quad m_p \quad (A'_p = \frac{\pi}{4} d_p^2)$$

کاربرد داده‌های زمان ماند برای تعیین پارامترهای

مدل Markov-Chain

$$s_6(m) \quad ()$$

m

$$t \quad s_6(m)$$

RTD $(m\Delta t)$

$$E(t) = RTD = \frac{s_6(t)}{\int_0^\infty s_6(t) dt} \quad ()$$

$\Delta\theta \quad R$

RTD

$\Delta\theta \quad R$

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$$t_i = i\Delta t \quad s_6(m) = C_{6,m} / \sum_{i=1}^m C_{6,m}$$

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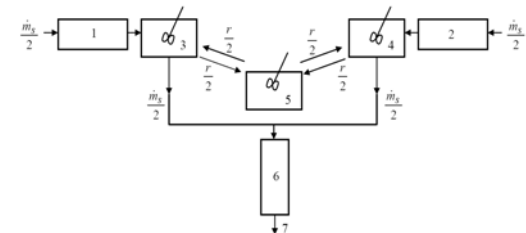
$$\sigma_{model}^2 = \sum_{i=1}^m s_6(i) [i(i\Delta\theta - 1)]^2 \quad ()$$

$$1 = \Delta\theta \sum_{i=1}^m i s_6(i) \quad ()$$

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Markov

$$S(0) = [0.5 \quad 0.5 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0] \quad ()$$



شکل ۴: آرایش مخازن مربوط به آنالیز Markov-Chain، ۱، ۲ و ۶ جریان قالبی ایده‌ال، ۳، ۴ و ۵ مخلوط‌شونده ایده‌ال.

معادلات حاکم در مدل احتمال Markov-Chain

$$\frac{dX_A}{dz} = - \frac{N_A M_A A_p^*}{U_p \dot{m}_s} \quad ()$$

Markov

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$$\frac{dU_p}{dz} = \frac{1}{m_p U_p (1 + \bar{X}_C + X_A)} \quad ()$$

$$\left[-\frac{1}{2} C_f \rho_a A'_p |U_p - U_a| (U_p - U_a) \right]$$

$$\frac{dT_p}{dz} = \frac{h A_p^* (T_a - T_p) - N_A M_A A_p^* \lambda_0}{\dot{m}_s U_p (C_{ps} + y'_A C_{pw})} \quad ()$$

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RTD

$$Re_p = \frac{U_a d_p}{\nu_a} \quad ()$$

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:($Sh_p = Nu_p$)

$\bar{t} = l / s$ Markov

$$h = \frac{k_a}{d_p} Nu_p$$

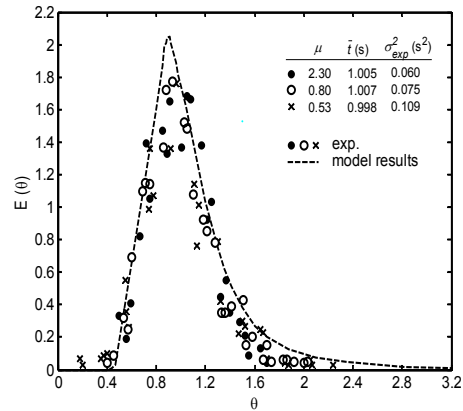
$R = l$ Markov

$\Delta\theta = l$

$$k_y = k_g \frac{p_t}{RT_a} = \frac{D_{AB}}{d_p} \frac{p_t}{RT_a} Sh_p \quad ()$$

RTD

سطح تماس موثر



Tamir .

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Markov

$$A_{eff} = 6 \frac{V_r}{d_p} \frac{W_a}{W_p} \frac{\rho_a}{\rho_p} \quad ()$$

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($R = 0.052; \Delta\theta = 0.44; \sigma_{model}^2 = 0.283s^2$ ---)

A_{eff}

Nu_{eff}

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$$Nu_{eff} = 1.386 \times 10^{-8} Re_p^{3.46} \quad (r = 0.983)$$

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آنتالپی جریان های گاز و جامد

H_x H_y () ()

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$$H_y = (C_{pa} + y'_A C_{pv})(T_a - T_0) + y'_A \lambda_0$$

$$H_x = (C_{ps} + X_A C_{pw})(T_p - T_0) \quad ()$$

(Hold-up)

ضرایب انتقال جرم و حرارت

A_{eff}

($A_p^* \Delta t$)

$$Nu_{eff} = h_{eff} d_p / k_a$$

V_r A_{eff}

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$$Nu_p = 1.59 Re_p^{0.55} \quad : \beta_u < 0.9 \times 10^{-3}$$

$$Nu_p = 0.173 Re_p^{0.55} \beta_u^{-0.61} : 0.9 \times 10^{-3} < \beta_u < 2.1 \times 10^{-3}$$

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β_u

$$W_p = l \cdot \text{kg/s}$$

$$V_r = l \cdot \text{m}^3$$

ضریب نفوذ

$$D_{AB} \cdot (D_{AB})$$

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$$D_{AB} = 4.56 \times 10^{-9} T_a^{1.5} \quad ()$$

[] $y'_A = l$

$$(D_{CD})$$

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$$D_{CD} = 0.32 \times 10^{-2} \exp(4.35 \times 10^{-12} T_p) \times \exp\{7.1 \exp[-1.8 \times 10^{-4} (T_p - 77.2)^2] X_C\} \quad ()$$

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ضریب دراگ

$$C_f ()$$

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Markov

$$C_f = 24 / \text{Re}_p \quad : \quad \text{Re}_p < 2$$

$$C_f = 18.5 / \text{Re}_p^{0.6} \quad : \quad 2 < \text{Re}_p < 1000$$

$$C_f = 0.44 \quad : \quad \text{Re}_p > 1000$$

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نتایج حاصل از مدل تانک‌های همزده سری

$$(\lambda \quad y_A^* \quad C_p \quad v_a \quad \rho_a \quad k_a \quad)$$

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$$() \quad i$$

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$$() ()$$

$$e_i = \frac{(\eta_{\text{exp}, i} - \eta_{\text{calc}, i})^2}{\eta_{\text{exp}, i}^2} \times 100 \quad ()$$

$$() ()$$

[] Tamir

$$X_0 = l$$

$$m \quad (\quad) \quad X_C = l$$

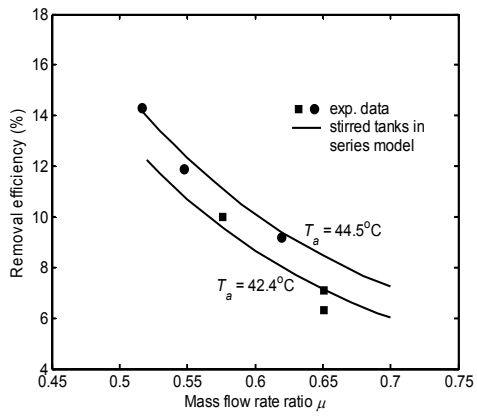
$$\rho_p = \text{kg/m}^3 \quad d_p = l^*$$

$$X_{\text{out}} = l^* (- l) = l \quad \%$$

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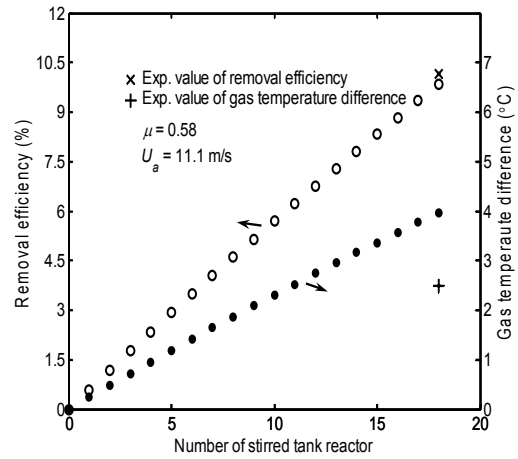
Tamir

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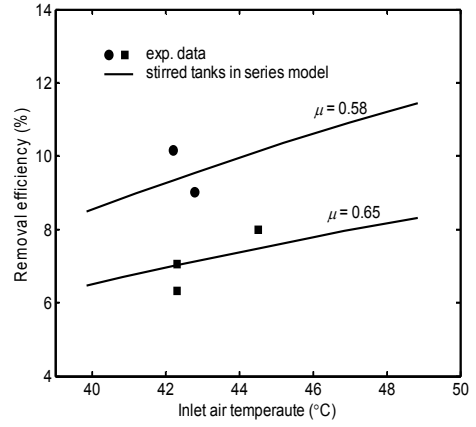
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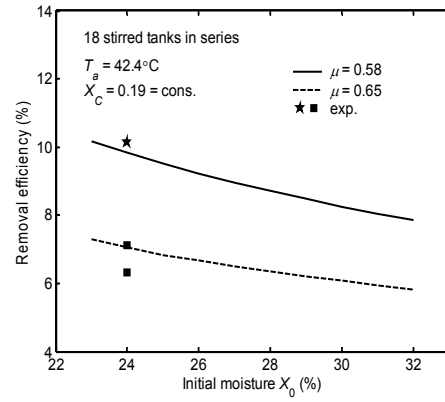


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Markov Sohrabi



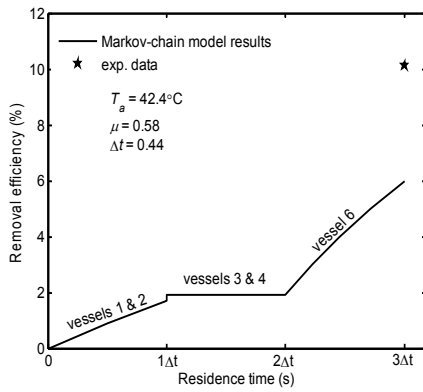
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نتایج حاصل از مدل Markov

Markov

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Markov

$$(\sigma^2 / \bar{i})_{model} = (\sigma^2 / \bar{i})_{exp}$$

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Markov

Markov

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(s)

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Markov

$T_{dry,in}$ (°C)	$T_{wet,in}$ (°C)	$\mu = \frac{W_p}{W_a}$	U_a m/s	[]	Markov				
				η (%)	η (%)	e (%)	η (%)	e (%)	
				5.98	5.75	0.15	3.02	24.50	
42.4	21.1	0.65	9.8	6.33	7.12	1.58	4.21	11.22	
42.4	21.1	0.65	9.8	7.07	7.12	0.01	4.18	16.71	
44.5	22.1	0.63	10.4	9.16	9.35	0.04	7.03	5.41	
42.4	21.1	0.58	11.1	10.11	9.84	0.07	6.05	16.13	
42.9	21.6	0.58	11.1	8.91	9.55	0.52	7.12	4.04	
44.1	21.8	0.55	11.7	11.48	12.87	1.47	8.81	5.41	
44.5	22.1	0.52	12.5	14.31	14.27	0.00	9.76	10.11	
						$\bar{e} = 0.48$		$\bar{e} = 11.69$	

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Markov

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Markov-Chain

فهرست علائم

m^2 / s	:	A_p^*	
m^2	:	A_p'	Markov
m^2	:	A_{eff}	
	:	C_f	
J/ kg. K	:	C_p	
()	:	C	

		s	:	t			
		m/s	:	U	m^2/s	:	D_{AB}
m^3			:	V_r	m^2/s	:	D_{CD}
kg/s ()			:	W_p		m	d_p
kg/s ()			:	W_a	s^{-1} (RTD)	:	E
kg/kg			:	X_A	kg/s ()	:	G'_y
kg/kg			:	X_C	W/m ² .K	:	h
kg/kg			:	\bar{X}_C	W/m ² .	:	h_{eff}
	kg/kg		:	y'_A		K	K_y
			:	y_A	mol/m ² .s	:	k_a
			:	y_A^*	W/m.K	:	M_A
	(m ³ /m ³)		:	β_u	kg/mol	:	\dot{m}_s
	kg/m ³		:	ρ	kg/s ()	:	m_p
	%		:	η	kg	:	m
	(kg/kg)		:	μ		Markov	N_A
	J/kg		:	λ	mol/m ² .s	:	N
			:	Δt		:	n_v
		s Markov	:	σ^2	Markov	:	P
		s ²	:	φ	i	:	p_{ii}
	kg		:	v_a		:	p_{ij}
	N. s/m ²		:	A	j i	:	Q
			:	a		:	R
			:	0	m^3/s	:	r
			:	p	J/mol.K	:	S(0)
			:	in	kg/s Markov	:	S(m)
			:	out		:	$s_p(m)$
			:	dry	m	:	
			:	v	S(m)	:	
			:	wet		:	
			:	w		:	
			:			K	T
			:				\bar{t}
			:			s	

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