1   Variables

2   root

	var	symbol	documentation	type	units	tokens	eqs
1	$F_{N,A}$	F	incidence matrix of directed graph	network		[]	
2	t	t	time	frame	s	[]	
3	$\#$	value	numerical value	constant		[]	
4	1	one	numerical value 1	constant		[]	1
5	0	zero	numerical value 0	constant		[]	2
6	1/2	onehalf	numerical value 1/2	constant		[]	3
58	t^o	to	starting time	constant	s	[]	41
59	t^e	te	end time	constant	s	[]	42

3   physical

	var	symbol	documentation	type	units	tokens	eqs
15	r_{xN}	r_x	x-coordinate	frame	m	[]	
16	r_{yN}	r_y	y-coordinate	frame	m	[]	
17	r_{zN}	r_z	z-coordinate	frame	m	[]	
18	n_{NS}	n	foundation state – species mass	state	mol	[]	119
19	U_N	U	foundation state – internal energy	state	$kg\,m^2\,s^{-2}$	[]	
20	S_N	S	foundation state – entropy	state	$kg\,m^2\,K^{-1}\,s^{-2}$	[]	
21	V_N	V	foundation state – volume	state	m^3	[]	
29	H_N	H	enthalpy	state	$kg\,m^2\,s^{-2}$	[]	13 122
30	A_N	A	Helmholtz energy	state	$kg\,m^2\,s^{-2}$	[]	14

Continued on next page

1

	var	symbol	documentation	type	units	tokens	eqs
31	G_N	G	Gibbs energy	state	$kg\,m^2\,s^{-2}$	[]	15
27	B_N	B	Boltzmann constant	constant	$kg\,m^2\,K^{-1}\,s^{-2}$	[]	11
101	$A^v{}_N$	Av	Avogadro number	constant	mol^{-1}	[]	
102	R_N	R	Gas constant	constant	$kg\,m^2\,mol^{-1}\,K^{-1}\,s^{-2}$	[]	82
22	p_N	p	thermodynamic pressure	effort	$kg\,m^{-1}\,s^{-2}$	[]	7
23	T_N	T	temperature	effort	K	[]	8
24	μ_{NS}	chem_pot	chemical potential	effort	$kg\,m^2\,mol^{-1}\,s^{-2}$	[]	9
36	v_{xN}	v_x	velocity in x-direction	seconaryState	ms^{-1}	[]	20
37	v_{yN}	v_y	velocity in y-direction	seconaryState	ms^{-1}	[]	21
38	v_{zN}	v_z	velocity in z-direction	seconaryState	ms^{-1}	[]	22
39	v_N	v	velocity vector	seconaryState	ms^{-1}	[]	23

4   control

	var	symbol	documentation	type	units	tokens	eqs
141	x_N	x	state	state		[]	131
142	xo_N	xo	initial state	state		[]	123
139	$A_{N,D}$	A	dynamic matrix	constant	s^{-1}	[]	
140	$B_{A,D}$	B	input gain matrix	constant	s^{-1}	[]	
156	$I_{N,D}$	I_N_D	map D –> N – used in integration	constant		[]	
157	u_{sA}	u_s	setpoint in terms of the measurement	constant		[]	
158	T_{IN}	T_I	integrator time constant	constant	s	[]	
155	$\dot{x}_D$	dxdt	controller dynamics	diffState	s^{-1}	[]	130
153	u_A	u	controller input	input		[]	128

5 reactions

	var	symbol	documentation	type	units	tokens	eqs
98	$N_{S,K}$	N	stoichiometric matrix	constant		[]	
104	E_{aNK}	Ea	Arrhenius's activation energy	constant	$kg\,m^2\,mol^{-1}\,s^{-2}$	[]	84
105	$K^o{}_K$	Ko	Arrhenius's frequency factor	constant	$m^{-3}\,mol\,s^{-1}$	[]	
108	$c^o{}_{KS}$	co_KS	standardisation of concentration	constant	$m^{-3}\,mol$	[]	87
106	K_{NK}	K_NK	Arrhenius reaction constants	seconaryState	$m^{-3}\,mol\,s^{-1}$	[]	85
109	ϕ_{KS}	phi_KS	propabilities to meet	seconaryState		[]	88

6 material

	var	symbol	documentation	type	units	tokens	eqs
40	λ_S	Mm	species molecular masses	constant	$kg\,mol^{-1}$	[]	
41	C_{pN}	Cp	total heat capacity at constant pressure	constant	$kg\,m^2\,K^{-1}\,s^{-2}$	[]	24
42	C_{vN}	Cv	total heat capacity at constant volume	constant	$kg\,m^2\,K^{-1}\,s^{-2}$	[]	25
43	c_{pS}	cp	specific heat capacity at constant pressure	constant	$m^2\,mol^2\,K^{-1}\,s^{-2}$	[]	26 133
44	c_{vS}	cv	specific heat capacity at constant volume	constant	$m^2\,mol^2\,K^{-1}\,s^{-2}$	[]	27 134
45	k^q_{xN}	kq_x	thermal conductivity in x-direction	seconaryState	$kg\,K^{-1}\,s^{-3}$	[]	28
46	k^q_{yN}	kq_y	thermal conductivity in y-direction	seconaryState	$kg\,K^{-1}\,s^{-3}$	[]	29
47	k^q_{zN}	kq_z	thermal conductivity in z-direction	seconaryState	$kg\,K^{-1}\,s^{-3}$	[]	30
48	k^q_N	kq	Carthesian thermal conductivity vector	seconaryState	$kg\,K^{-1}\,s^{-3}$	[]	31
49	k^c_{xN}	kc_x	convective mass convectivity in x-direction	seconaryState	$m^{-1}\,s$	[]	32
50	k^c_{yN}	kc_y	convective mass convectivity in y-direction	seconaryState	$m^{-1}\,s$	[]	33
51	k^c_{zN}	kc_z	convective mass convectivity in z-direction	seconaryState	$m^{-1}\,s$	[]	34

Continued on next page

	var	symbol	documentation	type	units	tokens	eqs
52	k^c_N	kc	Cartesian convective mass convectivity vector	seconaryState	$m^{-1}\,s$	[]	35
53	$k^d_{x\,NS}$	kd_x	diffusional mass conductivity in x-direction	seconaryState	$kg^{-1}\,m^{-4}\,mol^2\,s$	[]	36
54	$k^d_{y\,NS}$	kd_y	diffusional mass conductivity in y-direction	seconaryState	$kg^{-1}\,m^{-4}\,mol^2\,s$	[]	37
55	$k^d_{z\,NS}$	kd_z	diffusional mass conductivity in z-direction	seconaryState	$kg^{-1}\,m^{-4}\,mol^2\,s$	[]	38
56	k^d_{NS}	kd	Cartesian diffusional mass conductivity vector	seconaryState	$kg^{-1}\,m^{-4}\,mol^2\,s$	[]	39
60	h_{NS}	h	partial molar enthalpies	seconaryState	$kg\,m^2\,mol^{-1}\,s^{-2}$	[]	43

7 macroscopic

	var	symbol	documentation	type	units	tokens	eqs
78	d_A	d	direction of convective flow	transport		[]	61
80	$A_{y,z\,N}$	Ayz	cross sectional area in x-direction	transport	m^2	[]	63
83	$\hat{V}_A$	fV	convective volumetric flow	transport	$m^3\,s^{-1}$	[]	66
84	c_{AS}	c_AS	molar species concentration in convective flow	transport	$m^{-3}\,mol$	[]	67
85	$\hat{n}^c_{AS}$	fnc_AS	convective mass flow by stream	transport	$mol\,s^{-1}$	[]	68
86	$\hat{n}^c_{NS}$	fnc	net convective mass flow	transport	$mol\,s^{-1}$	[]	69
115	$\hat{m}_A$	fm_A	mass flow in arc	transport	$kg\,s^{-1}$	[]	94
125	$\hat{H}^c_A$	fHc_A	enthalpy flow due to convection	transport	$kg\,m^2\,s^{-3}$	[]	104
127	$\hat{H}^c_N$	fHc	net enthalpy flow due to convection	transport	$kg\,m^2\,s^{-3}$	[]	106
128	$\hat{n}^d_{AS}$	fnd_AS	diffusional mass transfer in arc	transport	$mol\,s^{-1}$	[]	107
129	$\hat{n}^d_{NS}$	fnd	net diffusional mass transfer	transport	$mol\,s^{-1}$	[]	108
130	$\hat{H}^d_A$	fHd_A	enthalpy flow due to mass diffusion	transport	$kg\,m^2\,s^{-3}$	[]	109
131	$\hat{H}^d_N$	fHd	net enthalpy flow due to diffusion	transport	$kg\,m^2\,s^{-3}$	[]	110
135	$\hat{w}_A$	fw_A	example of work flow	transport	$kg\,m^2\,s^{-3}$	[]	114
136	$\hat{w}_N$	fw	net work flow	transport	$kg\,m^2\,s^{-3}$	[]	115

	var	symbol	documentation	type	units	tokens	eqs
10	$F_{NS,AS}$	F_NS_AS	blick incidence matrix of directed species graph	network		[]	6
9	$P_{NS,AS}$	P_NS_AS	node species to arc species projection	projection		[]	
11	$P_{K,NK}$	P_K_NK	projection of conversion to node x conversion	projection		[]	
12	$P_{S,NS}$	P_S_NS	projection species to conversion x species	projection		[]	
13	$P_{N,NK}$	P_N_NK	projection node to node x conversion	projection		[]	
14	$P_{NK,KS}$	P_NK_KS	projection node x conversion to conversion x species	projection		[]	
95	$P_{NS,KS}$	P_NS_KS	projection node x species to conversion x species	projection		[]	
137	$n^o{}_{NS}$	no	initial condition for species mass	state	mol	[]	118
138	$H^o{}_N$	Ho	initial condition for enthalpy	state	$kg\,m^2\,s^{-2}$	[]	120
159	X	X	state for nodes with mass and energy	state		[]	132
92	1_{NK}	one_NK	one with energy	effort		[]	75
79	c_{NS}	c	molar concentration	seconaryState	$m^{-3}\,mol$	[]	62
81	m_N	m	mass in kg	seconaryState	kg	[]	64
82	ρ_N	density	density	seconaryState	$kg\,m^{-3}$	[]	65
91	T_{NK}	T_NK	temperature in reactive systems	conversion	K	[]	74
96	c_{KS}	c_KS	concentration in the reactive systems	conversion	$m^{-3}\,mol$	[]	78
112	ξ_{NK}	xi	extent of reaction	conversion	$m^{-3}\,mol\,s^{-1}$	[]	91
113	$N_{NS,NK}$	N_NS_NK	extended stoichiometry	conversion		[]	92
114	$\tilde{n}_{NS}$	pn	production term	conversion	$mol\,s^{-1}$	[]	93
132	$\dot{n}_{NS}$	dndt	species mass accumulation	diffState	$mol\,s^{-1}$	[]	111
133	$\dot{H}_N$	dHdt	differential enthalpy balance	diffState	$kg\,m^2\,s^{-3}$	[]	116

8 solid

	var	symbol	documentation	type	units	tokens	eqs

9   fluid

	var	symbol	documentation	type	units	tokens	eqs

10   liquid

	var	symbol	documentation	type	units	tokens	eqs

11   gas

	var	symbol	documentation	type	units	tokens	eqs

12   control–reactions

	var	symbol	documentation	type	units	tokens	eqs

13   reactions–control

	var	symbol	documentation	type	units	tokens	eqs

14   control–material

	var	symbol	documentation	type	units	tokens	eqs

15   material–control

	var	symbol	documentation	type	units	tokens	eqs

16   control–macroscopic

	var	symbol	documentation	type	units	tokens	eqs

17   macroscopic–control

	var	symbol	documentation	type	units	tokens	eqs
143	$T^n{}_N$	T_n	norming temperature	constant	K	[]	
144	$p^n{}_N$	p_n	norming pressure	constant	$kg\,m^{-1}\,s^{-2}$	[]	
145	$c^n{}_{NS}$	c_n	norming concentration	constant	$m^{-3}\,mol$	[]	
146	$F_{N,A}$	F_N_A	projection N –> A	constant		[]	
151	$F_{A,NS}$	F_A_NS	projection NS –> A	constant		[]	
148	s_{TA}	s_T	normed temperature signal	transform		[]	125
149	s_{pA}	s_p	normed pressure signal	transform		[]	126
152	s_{cA}	s_c	noremed concentration signal vector	transform		[]	127

18   reactions–material

	var	symbol	documentation	type	units	tokens	eqs

19   material–reactions

	var	symbol	documentation	type	units	tokens	eqs

20   reactions–macroscopic

	var	symbol	documentation	type	units	tokens	eqs
107	K_{NK}	K_NK	link	transform	$m^{-3}\,mol\,s^{-1}$	[]	86
110	ϕ_{KS}	phi_KS	link	transform		[]	89
111	$N_{S,K}$	N	link	transform		[]	90

21   macroscopic–reactions

	var	symbol	documentation	type	units	tokens	eqs
94	T_{NK}	T_NK	temperature of reacive systems	transform	K	[]	77
97	c_{KS}	c_KS	link	transform	$m^{-3}\,mol$	[]	79
103	$P_{N,NK}$	P_N_NK	link	transform		[]	83

22   material–macroscopic

	var	symbol	documentation	type	units	tokens	eqs
61	λ_S	Mm	link to molar masses	transform	$kg\,mol^{-1}$	[]	44
62	k^q_{xN}	kq_x	link	transform	$kg\,K^{-1}\,s^{-3}$	[]	45

	var	symbol	documentation	type	units	tokens	eqs
63	k^q_{yN}	kq_y	link	transform	$kg\,K^{-1}\,s^{-3}$	[]	46
64	k^q_{zN}	kq_z	link	transform	$kg\,K^{-1}\,s^{-3}$	[]	47
65	k^q_{N}	kq	link	transform	$kg\,K^{-1}\,s^{-3}$	[]	48
66	k^c_{xN}	kc_x	link	transform	$m^{-1}\,s$	[]	49
67	k^c_{yN}	kc_y	link	transform	$m^{-1}\,s$	[]	50
68	k^c_{zN}	kc_z	link	transform	$m^{-1}\,s$	[]	51
69	k^c_{N}	kc	link	transform	$m^{-1}\,s$	[]	52
70	k^d_{xNS}	kd_x	link	transform	$kg^{-1}\,m^{-4}\,mol^2\,s$	[]	53
73	k^d_{yNS}	kd_y	link	transform	$kg^{-1}\,m^{-4}\,mol^2\,s$	[]	56
74	k^d_{zNS}	kd_z	link	transform	$kg^{-1}\,m^{-4}\,mol^2\,s$	[]	57
75	k^d_{NS}	kd	link	transform	$kg^{-1}\,m^{-4}\,mol^2\,s$	[]	58
76	c_{pS}	cp	link	transform	$m^2\,mol^2\,K^{-1}\,s^{-2}$	[]	59
77	c_{vS}	cv	link	transform	$m^2\,mol^2\,K^{-1}\,s^{-2}$	[]	60
119	h_{NS}	h	link	transform	$kg\,m^2\,mol^{-1}\,s^{-2}$	[]	98

23 macroscopic–material

	var	symbol	documentation	type	units	tokens	eqs

24 gas–liquid

	var	symbol	documentation	type	units	tokens	eqs
160	μ^{α}_{NS}	chem_pot_left	left chemical potential	effort	$kg\,m^2\,mol^{-1}\,s^{-2}$	[]	135
161	μ^{β}_{NS}	chem_pot_right	right chemical potential	effort	$kg\,m^2\,mol^{-1}\,s^{-2}$	[]	136

25   gas–solid

	var	symbol	documentation	type	units	tokens	eqs

26   liquid–solid

	var	symbol	documentation	type	units	tokens	eqs

27 Equations

27.1 Model equations

no	equation	documentation	layer
1	$1 := Set(\#, \#)$	numerical value 1	root
2	$0 := Set(\#, \#)$	numerical value 1	root
3	$1/2 := Set(\#, \#)$	numerical value 1/2	root
6	$F_{NS,AS} := F_{N,A} \odot P_{NS,AS}$	blick incidence matrix of directed species graph	physical
7	$p_N := \frac{\partial U_N}{\partial V_N}$	thermodynamic pressure	physical
8	$T_N := \frac{\partial U_N}{\partial S_N}$	temperature	physical
9	$\mu_{NS} := \frac{\partial U_N}{\partial n_{NS}}$	chemical potential	physical
11	$B_N := Set(S_N, \#)$	Boltzmann constant	physical
13	$H_N := U_N + p_N \cdot V_N$	enthalpy	physical
14	$A_N := U_N - T_N \cdot S_N$	Helmholtz energy	physical
15	$G_N := U_N + p_N \cdot V_N - T_N \cdot S_N$	Gibbs energy	physical
20	$v_{xN} := \frac{\partial r_{xN}}{\partial t}$	velocity in x-direction	physical
21	$v_{yN} := \frac{\partial r_{yN}}{\partial t}$	velocity in y-direction	physical
22	$v_{zN} := \frac{\partial r_{zN}}{\partial t}$	velocity in z-direction	physical
23	$v_N := Stack\left(v_{xN}, v_{yN}, v_{zN}\right)$	velocity vector	physical

no	equation	documentation	layer
24	$C_{pN} := \frac{\partial H_N}{\partial T_N}$	total heat capacity at constant pressure	material
25	$C_{vN} := \frac{\partial U_N}{\partial T_N}$	total heat capacity at constant volume	material
26	$c_{pS} := C_{pN} \cdot (\lambda_S)^{-1} \overset{N \in NS}{\underset{\star}{}} n_{NS}$	specific heat capacity at constant pressure	material
27	$c_{vS} := C_{vN} \cdot (\lambda_S)^{-1} \overset{N \in NS}{\underset{\star}{}} n_{NS}$	specific heat capacity at constant volume	material
28	$k^q_{xN} := (V_N)^{-1} \cdot \frac{\partial U_N}{\partial T_N} \cdot v_{xN}$	thermal conductivity in x-direction	material
29	$k^q_{yN} := (V_N)^{-1} \cdot \frac{\partial U_N}{\partial T_N} \cdot v_{yN}$	thermal conductivity in y-direction	material
30	$k^q_{zN} := (V_N)^{-1} \cdot \frac{\partial U_N}{\partial T_N} \cdot v_{zN}$	thermal conductivity in z-direction	material
31	$k^q_N := Stack\left(k^q_{xN}, k^q_{yN}, k^q_{zN}\right)$	Carthesian thermal conductivity vector	material
32	$k^c_{xN} := \left(\lambda_S \overset{S \in NS}{\underset{\star}{}} (\mu_{NS})^{-1}\right) \cdot (V_N)^{-1} \cdot \frac{\partial U_N}{\partial p_N} \cdot v_{xN}$	convective mass convectivity in x-direction	material
33	$k^c_{yN} := \left(\lambda_S \overset{S \in NS}{\underset{\star}{}} (\mu_{NS})^{-1}\right) \cdot (V_N)^{-1} \cdot \frac{\partial U_N}{\partial p_N} \cdot v_{yN}$	convective mass convectivity in y-direction	material
34	$k^c_{zN} := \left(\lambda_S \overset{S \in NS}{\underset{\star}{}} (\mu_{NS})^{-1}\right) \cdot (V_N)^{-1} \cdot \frac{\partial U_N}{\partial p_N} \cdot v_{zN}$	convective mass convectivity in z-direction	material
35	$k^c_N := Stack\left(k^c_{xN}, k^c_{yN}, k^c_{zN}\right)$	Cartesian convective mass convectivity vector	material
36	$k^d_{xNS} := (\mu_{NS})^{-1} \cdot \left(v_{xN} \odot \left((V_N)^{-1} \odot \frac{\partial U_N}{\partial \mu_{NS}}\right)\right)$	diffusional mass conductivity in x-direction	material
37	$k^d_{yNS} := (\mu_{NS})^{-1} \cdot \left(v_{yN} \odot \left((V_N)^{-1} \odot \frac{\partial U_N}{\partial \mu_{NS}}\right)\right)$	diffusional mass conductivity in y-direction	material

no	equation	documentation	layer
38	$k^d_{zNS} := (\mu_{NS})^{-1} \cdot \left(v_{zN} \odot \left((V_N)^{-1} \odot \frac{\partial U_N}{\partial \mu_{NS}} \right) \right)$	diffusional mass conductivity in z-direction	material
39	$k^d_{NS} := Stack \left(k^d_{xNS}, k^d_{yNS}, k^d_{zNS} \right)$	Cartesian diffusional mass conductivity vector	material
41	$t^o := Set(t, t)$	starting time	root
42	$t^e := Set(t, t)$	end time	root
43	$h_{NS} := H_N \odot (n_{NS})^{-1}$	partial molar enthalpies	material
44	$\lambda_S := \lambda_S$	link to molar masses	material »> macro-scopic
45	$k^q_{xN} := k^q_{xN}$	link	material »> macro-scopic
46	$k^q_{yN} := k^q_{yN}$	link	material »> macro-scopic
47	$k^q_{zN} := k^q_{zN}$	link	material »> macro-scopic
48	$k^q_N := k^q_N$	link	material »> macro-scopic
49	$k^c_{xN} := k^c_{xN}$	link	material »> macro-scopic
50	$k^c_{yN} := k^c_{yN}$	link	material »> macro-scopic
51	$k^c_{zN} := k^c_{zN}$	link	material »> macro-scopic

no	equation	documentation	layer
52	$k^c{}_N := k^c{}_N$	link	material »> macroscopic
53	$k^d_{x\,NS} := k^d_{x\,NS}$	link	material »> macroscopic
56	$k^d_{y\,NS} := k^d_{y\,NS}$	link	material »> macroscopic
57	$k^d_{z\,NS} := k^d_{z\,NS}$	link	material »> macroscopic
58	$k^d{}_{NS} := k^d{}_{NS}$	link	material »> macroscopic
59	$c_{p\,S} := c_{p\,S}$	link	material »> macroscopic
60	$c_{v\,S} := c_{v\,S}$	link	material »> macroscopic
61	$d_A := \mathrm{sign}\left(F_{N,A} \overset{N}{\star} p_N\right)$	direction of convective flow	macroscopic
62	$c_{NS} := (V_N)^{-1} \odot n_{NS}$	molar concentration	macroscopic
63	$A_{y,z\,N} := r_{y\,N} \cdot r_{z\,N}$	cross sectional area in x-direction	macroscopic
64	$m_N := \lambda_S \overset{S \in NS}{\star} n_{NS}$	mass in kg	macroscopic
65	$\rho_N := (V_N)^{-1} \cdot m_N$	density	macroscopic
66	$\hat{V}_A := (\rho_N)^{-1} \cdot k^c_{x\,N} \cdot A_{y,z\,N} \cdot F_{N,A} \overset{N}{\star} p_N$	convective volumetric flow	macroscopic
67	$c_{AS} := (1/2 \cdot (F_{NS,AS} - d_A \odot |F_{NS,AS}|)) \overset{NS}{\star} c_{NS}$	molar species concentration in convective flow	macroscopic

no	equation	documentation	layer
68	$\hat{n}^c_{AS} := \hat{V}_A \odot c_{AS}$	convective mass flow by stream	macroscopic
69	$\hat{n}^c_{NS} := F_{NS,AS} \overset{AS}{\star} \hat{n}^c_{AS}$	net convective mass flow	macroscopic
74	$T_{NK} := P_{N,NK} \overset{N}{\star} T_N$	temperature in reactive systems	macroscopic
75	$1_{NK} := (T_{NK})^{-1} . T_{NK}$	one with energy	macroscopic
77	$T_{NK} := T_{NK}$	temperature of reacive systems	macroscopic »> re-actions
78	$c_{KS} := c_{NS} \overset{NS}{\star} P_{NS,KS}$	concentration in the reactive systems	macroscopic
79	$c_{KS} := c_{KS}$	link	macroscopic »> re-actions
82	$R_N := A^v{}_N . B_N$	Gas constant	physical
83	$P_{N,NK} := P_{N,NK}$	link	macroscopic »> re-actions
84	$E_{aNK} := Set(P_{N,NK} \overset{N}{\star} R_N . T_{NK}, \#)$	Arrhenius's activation energy	reactions
85	$K_{NK} := K^o{}_K \odot exp((-E_{aNK}) . \left(R_N \overset{N}{\star} P_{N,NK} . T_{NK} \right)^{-1})$	Arrhenius reaction constants	reactions
86	$K_{NK} := K_{NK}$	link	reactions »> macroscopic
87	$c^o{}_{KS} := Set(c_{KS}, \#)$	standardisation of concentration	reactions
88	$\phi_{KS} := \prod \left(c_{KS} . (c^o{}_{KS})^{-1} \right)$	propabilities to meet	reactions
89	$\phi_{KS} := \phi_{KS}$	link	reactions »> macroscopic

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no	equation	documentation	layer
90	$N_{S,K} := N_{S,K}$	link	reactions $\gg$ macroscopic
91	$\xi_{NK} := K_{NK} \, . \, P_{NK,KS} \overset{KS}{\star} \phi_{KS}$	extent of reaction	macroscopic
92	$N_{NS,NK} := P_{S,NS} \overset{S}{\star} \left(\left(P_{K,NK} \, . \, T_{NK} \, . \, (T_{NK})^{-1} \right) \overset{K}{\star} N_{S,K} \right)$	extended stoichiometry	macroscopic
93	$\tilde{n}_{NS} := V_N \odot \left(N_{NS,NK} \overset{NK}{\star} \xi_{NK} \right)$	production term	macroscopic
94	$\hat{m}_A := \lambda_S \overset{S \in AS}{\star} \hat{n}_{AS}^c$	mass flow in arc	macroscopic
98	$h_{NS} := h_{NS}$	link	material $\gg$ macroscopic
104	$\hat{H}_A^c := \left(F_{NS,AS} \overset{NS}{\star} h_{NS} \right) \overset{S \in AS}{\star} \hat{n}_{AS}^c$	enthalpy flow due to convection	macroscopic
106	$\hat{H}_N^c := F_{N,A} \overset{A}{\star} \hat{H}_A^c$	net enthalpy flow due to convection	macroscopic
107	$\hat{n}_{AS}^d := A_{y,z \, N} \odot \left(-k_{x \, NS}^d \right) \, . \, F_{NS,AS} \overset{NS}{\star} \mu_{NS}$	diffusional mass transfer in arc	macroscopic
108	$\hat{n}_{NS}^d := F_{NS,AS} \overset{AS}{\star} \hat{n}_{AS}^d$	net diffusional mass transfer	macroscopic
109	$\hat{H}_A^d := \left(F_{NS,AS} \overset{NS}{\star} h_{NS} \right) \overset{S \in AS}{\star} \hat{n}_{AS}^d$	enthalpy flow due to mass diffusion	macroscopic
110	$\hat{H}_N^d := F_{N,A} \overset{A}{\star} \hat{H}_A^d$	net enthalpy flow due to diffusion	macroscopic
111	$\dot{n}_{NS} := \hat{n}_{NS}^c + \hat{n}_{NS}^d + \tilde{n}_{NS}$	species mass accumulation	macroscopic

no	equation	documentation	layer	
114	$\hat{w}_A := Set(\hat{H}^c_A, \#)$	example of work flow	macroscopic	
115	$\hat{w}_N := F_{N,A} \overset{A}{\star} \hat{w}_A$	net work flow	macroscopic	
116	$\dot{H}_N := \hat{H}^c_N + \hat{H}^d_N + \hat{w}_N$	differential enthalpy balance	macroscopic	
118	$n^o{}_{NS} := Set(n_{NS}, \#)$	initial condition for species mass	macroscopic	
119	$n_{NS} := \int_{t^o}^{t^e} \dot{n}_{NS} \, dt + n^o{}_{NS}$	foundation state $-$ species mass	macroscopic	
120	$H^o{}_N := Set(H_N, \#)$	initial condition for enthalpy	macroscopic	
122	$H_N := \int_{t^o}^{t^e} \dot{H}_N \, dt + H^o{}_N$	enthalpy	macroscopic	
123	$xo_N := Set(x_N, \#)$	initial state	control	
125	$s_{TA} := F_{N,A} \overset{N}{\star} \left(T_N \, . \, (T^n{}_N)^{-1} \right)$	normed temperature signal	macroscopic control	$\gg>$
126	$s_{pA} := F_{N,A} \overset{N}{\star} \left(p_N \, . \, (p^n{}_N)^{-1} \right)$	normed pressure signal	macroscopic control	$\gg>$
127	$s_{cA} := F_{A,NS} \overset{NS}{\star} \left(c_{NS} \, . \, (c^n{}_{NS})^{-1} \right)$	noremed concentration signal vector	macroscopic control	$\gg>$
128	$u_A := Stack\left(s_{TA}, s_{pA}, s_{cA} \right)$	controller input	control	

no	equation	documentation	layer
130	$\dot{x}_D := A_{N,D} \overset{N}{\star} x_N + B_{A,D} \overset{A}{\star} u_A$	controller dynamics	control
131	$x_N := \int_{t^o}^{t^e} I_{N,D} \overset{D}{\star} \dot{x}_D \ dt$	state	control
132	$X := MixedStack\,(n_{NS}, H_N)$	state for nodes with mass and energy	macroscopic
133	$c_{pS} := Set(c_{pS}, \#)$	specific heat capacity at constant pressure	material
134	$c_{vS} := Set(c_{vS}, \#)$	specific heat capacity at constant volume	material
135	$\mu^\alpha{}_{NS} := \mu_{NS}^{-\epsilon}$	left chemical potential	gas »> liquid
136	$\mu^\beta{}_{NS} := \mu_{NS}^{+\epsilon}$	right chemical potential	gas »> liquid