

## 1 Variables

### 2 root

	var	symbol	documentation	type	units	eqs
8	$F_{N,A}$	F_N_A	fudamental incidence matrix	network		
5	$t$	t	time	frame	s	
6	$t^o$	to	starting time	frame	s	4
7	$t^e$	te	end time	frame	s	5
1	#	value	numerical value	constant		
2	1	one	numerical value one	constant		1
3	0	zero	numerical value zero	constant		2
4	0.5	onehalf	numerical value one half	constant		3

### 3 physical

	var	symbol	documentation	type	units	eqs
9	$P_{N,A}$	P_N_A	projection from node to arc for arc properties	projection		
32	$P_{NS,AS}$	P_NS_AS	projection node species to arc species	projection		
33	$P_{K,NK}$	P_K_NK	projection of conversion to node conversion	projection		
34	$P_{S,NS}$	P_S_NS	projection species to node species	projection		
35	$P_{N,NK}$	P_N_NK	projection node to node conversion	projection		
36	$P_{NS,KS}$	P_NS_KS	projection node species to conversion species	projection		
37	$P_{A,NS}$	P_A_NS	projection arc to node species for conductivity	projection		
65	$P_{NK,KS}$	P_NK_KS	projection node conversion to conversion species	projection		
10	$r_{xN}$	r_x	x-coordinate	frame	$m$	
11	$r_{yN}$	r_y	y-coordinate	frame	$m$	
12	$r_{zN}$	r_z	z coordinate	frame	$m$	
13	$U_N$	U	fundamental state – internal energy	state	$kg\,m^2\,s^{-2}$	
14	$S_N$	S	fundamental state – entropy	state	$kg\,m^2\,K^{-1}\,s^{-2}$	
15	$V_N$	V	fundamental state – volume	state	$m^3$	
16	$n_{NS}$	n	fundamental state – molar mass	state	$mol$	86
20	$H_N$	H	enthalpy	state	$kg\,m^2\,s^{-2}$	9 87
21	$A_N$	A	Helmholtz energy	state	$kg\,m^2\,s^{-2}$	10
22	$G_N$	G	Gibbs free energy	state	$kg\,m^2\,s^{-2}$	11
23	$C_N$	charge	fundamental state – charge	state	$A\,s$	
24	$A^v$	Avogadro	Avogadro number	constant	$mol^{-1}$	
25	$k^B_N$	Boltzmann	Boltzmann constant	constant	$kg\,m^2\,K^{-1}\,s^{-2}$	12
26	$R_N$	GasConstant	gas constant	constant	$kg\,m^2\,mol^{-1}\,K^{-1}\,s^{-2}$	13
17	$p_N$	p	thermodynamic pressure	effort	$kg\,m^{-1}\,s^{-2}$	6

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	var	symbol	documentation	type	units	eqs
18	$T_N$	<b>T</b>	temperature	effort	$K$	<b>7</b>
19	$\mu_{NS}$	<b>chemPot</b>	chemical potential	effort	$kg\,m^2\,mol^{-1}\,s^{-2}$	<b>8</b>
27	$Ue_N$	<b>Ue</b>	electrical potential – voltage	effort	$kg\,m^2\,A^{-1}\,s^{-3}$	<b>14 95</b>
28	$v_{xN}$	<b>v_x</b>	velocity in x-direction	secondaryState	$ms^{-1}$	<b>15</b>
29	$v_{yN}$	<b>v_y</b>	velocity in y-direction	secondaryState	$ms^{-1}$	<b>16</b>
30	$v_{zN}$	<b>v_z</b>	velocity in z-direction	secondaryState	$ms^{-1}$	<b>17</b>

## 4 control

	var	symbol	documentation	type	units	eqs
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## 5 reactions

	var	symbol	documentation	type	units	eqs
31	$N_{S,K}$	N	stoichiometric matrix	constant		
38	$K^o_K$	Ko	Arrhenius frequency factor	constant	$m^{-3} mol s^{-1}$	
62	$E^a_{NK}$	Ea	Arrhenius activation energy	constant	$kg m^2 mol^{-1} s^{-2}$	41
63	$K_{NK}$	K_NK	Arrhenius reaction 'constant'	constant	$m^{-3} mol s^{-1}$	42
64	$N_{NS,NK}$	N_NS_NK	stoichiometric block matrix node species and node reaction	constant		43
60	$T_{NK}$	T_NK	temperature of the reactive system	effort	$K$	39
68	$c_K S_{KS}$	c_KS	concentrations associated with reactions	secondaryState	$m^{-3} mol$	46
69	$co_K S_{KS}$	co_KS	normalizing concentrations	secondaryState	$m^{-3} mol$	47

## 6 material

	var	symbol	documentation	type	units	eqs
40	$\lambda_S$	Mm	species molecular mass	constant	$kg\ mol^{-1}$	
112	$\xi$	additive	fraction of additives	constant		88
42	$C_{pN}$	Cp	total heat capacity at constant pressure	property	$kg\ m^2\ K^{-1}\ s^{-2}$	21
43	$C_{VN}$	Cv	total heat capacity at constant volume	property	$kg\ m^2\ K^{-1}\ s^{-2}$	22
44	$k_{xN}^q$	kq_x	thermal conductivity in x-direction	property	$kg\ K^{-1}\ s^{-3}$	23
45	$k_{yN}^q$	kq_y	thermal conductivity in y-direction	property	$kg\ K^{-1}\ s^{-3}$	24
46	$k_{zN}^q$	kq_z	thermal conductivity in z-direction'	property	$kg\ K^{-1}\ s^{-3}$	25
47	$kq_N$	kq	thermal conductivity	property	$kg\ K^{-1}\ s^{-3}$	26
48	$k_{xN}^c$	kc_x	convective mass conductivity in x-direction	property	$m^{-1}\ s$	27
49	$k_{yN}^c$	kc_y	convective mass conductivity in y-direction	property	$m^{-1}\ s$	28
50	$k_{zN}^c$	kc_z	convective mass conductivity in z-direction	property	$m^{-1}\ s$	29
51	$k_N^c$	kc	convective mass conductivity	property	$m^{-1}\ s$	30
52	$k_{xNS}^d$	kd_x	diffusional mass conductivity in x-direction	property	$kg^{-1}\ m^{-4}\ mol^2\ s$	31
53	$k_{yNS}^d$	kd_y	diffusional mass conductivity in y-direction	property	$kg^{-1}\ m^{-4}\ mol^2\ s$	32
54	$k_{zNS}^d$	kd_z	diffusional mass conductivity in z-direction	property	$kg^{-1}\ m^{-4}\ mol^2\ s$	33
55	$k_{NS}^d$	kd	diffusional mass conductivity	property	$kg^{-1}\ m^{-4}\ mol^2\ s$	34
56	$h_{NS}$	h	partial molar enthalpies	property	$kg\ m^2\ mol^{-1}\ s^{-2}$	35
59	$\rho_N$	density	density	property	$kg\ m^{-3}$	38
115	$R_N^e$	elResist	electrical resistant	property	$kg\ m^2\ A^{-2}\ s^{-3}$	91 92
116	$k^{e,\xi}_N$	elConductC	simple model for the electrical conductivity as a function of the additive	property	$kg^{-1}\ m^{-2}\ A^2\ s^3$	93

## 7 macroscopic

	var	symbol	documentation	type	units	eqs
92	$\hat{V}_A$	fV	volumetric flow	transport	$m^3 s^{-1}$	67
93	$\hat{n}_{AS}^d$	fnd_AS	diffusional mass flow in a given stream	transport	$mol s^{-1}$	68
94	$\hat{n}_{NS}^d$	fnd	net diffusional mass flow	transport	$mol s^{-1}$	69
95	$\hat{H}_{AS}^d$	fHd_A	enthalpy flow per diffusional mass stream	transport	$kg m^2 s^{-3}$	70
96	$\hat{H}_N^d$	fHd	net enthaply stream due to diffusion	transport	$kg m^2 s^{-3}$	71
97	$d_A$	d	flow direction of convectional flow	transport		72
102	$\hat{H}_{AS}^c$	fHc_A	convective enthalpy flow for given stream	transport	$kg m^2 s^{-3}$	77
103	$\hat{H}_N^c$	fHc	net convectional enthalpy stream	transport	$kg m^2 s^{-3}$	78
104	$\hat{w}_A$	fw_A	sample work stream	transport	$kg m^2 s^{-3}$	79
105	$fw_N$	fw	net work stream	transport	$kg m^2 s^{-3}$	80
106	$\hat{q}_{xA}$	fq_A_x	heat flow in x-direction for given stream	transport	$kg m^2 s^{-3}$	81
107	$\hat{q}_N$	fq	net heat flow	transport	$kg m^2 s^{-3}$	82
121	$im_N$	im	also a fix	transport	A	101
71	$A_{yzN}$	Ayz	cross sectional area yz	geometry	$m^2$	48
72	$A_{xzN}$	Axz	cross sectional area xz	geometry	$m^2$	49
73	$A_{xyN}$	Axy	cross sectional area xy	geometry	$m^2$	50
70	$F_{NS,AS}$	F_NS_AS	species related incidence matrix	network		
90	$D_{N,A}$	D	difference operator	differenceOperator		
91	$D_{NS,AS}$	D_NS_AS	difference operator for species topology	differenceOperator		
109	$H_N^o$	Ho	initial enthalpy	state	$kg m^2 s^{-2}$	84
110	$n_{NS}^o$	no	initial species	state	mol	85
57	$m_N$	m	total mass	secondaryState	kg	36
66	$c_{NS}$	c	molar composition	secondaryState	$m^{-3} mol$	44

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	var	symbol	documentation	type	units	eqs
98	$c_{AS}$	<b>c_AS</b>	concentration in convectional flow	secondaryState	$m^{-3} mol$	<b>73</b>
99	$\hat{n}^c_{AS}$	<b>fnc_AS</b>	molar convetional mass flow in the given stream	secondaryState	$mol s^{-1}$	<b>74</b>
100	$\hat{n}^c_{NS}$	<b>fnc</b>	net molar convectional mass flow	secondaryState	$mol s^{-1}$	<b>75</b>
101	$\dot{n}_{NS}$	<b>dndt</b>	differential species balance	diffState	$mol s^{-1}$	<b>76</b>
108	$\dot{H}_N$	<b>dHdt</b>	differential enthalpy balance	diffState	$kg m^2 s^{-3}$	<b>83</b>
118	$\dot{U}^e_N$	<b>dUedt</b>	Kirkhoff first law	diffState	$kg m^2 A^{-1} s^{-3}$	<b>96 97</b> <b>98</b>
113	$I_N$	<b>i</b>	electrical current definition	internalTransport	$A$	<b>89</b>



## 8 solid

	var	symbol	documentation	type	units	eqs
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## 9 fluid

	var	symbol	documentation	type	units	eqs
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## 10 liquid

	var	symbol	documentation	type	units	eqs
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## 11 gas

	var	symbol	documentation	type	units	eqs
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## 12 control-control

	var	symbol	documentation	type	units	eqs
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## 13 gas–liquid

	var	symbol	documentation	type	units	eqs
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## 14 gas–gas

	var	symbol	documentation	type	units	eqs
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## 15 liquid–liquid

	var	symbol	documentation	type	units	eqs
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## 16 gas–solid

	var	symbol	documentation	type	units	eqs
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## 17    solid–solid

	var	symbol	documentation	type	units	eqs
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## 18 liquid–solid

	var	symbol	documentation	type	units	eqs
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## 19 material–material

	var	symbol	documentation	type	units	eqs
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## 20 reactions-reactions

	var	symbol	documentation	type	units	eqs
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## 21 control-reactions

	var	symbol	documentation	type	units	eqs
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## 22 reactions-control

	var	symbol	documentation	type	units	eqs
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## 23 control-material

	var	symbol	documentation	type	units	eqs
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## 24 material-control

	var	symbol	documentation	type	units	eqs
124	$\xi$	additive	link variable additive to interface material » > control	get		104

## 25 control-macroscopic

	var	symbol	documentation	type	units	eqs
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## 26 macroscopic-control

	var	symbol	documentation	type	units	eqs
119	$I_N$	i	link variable i to interface macroscopic »> control	get	$A$	99
123	$I_{mN}$	im	link variable im to interface macroscopic »> control	get	$A$	103

## 27 reactions-material

	var	symbol	documentation	type	units	eqs
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## 28 material-reactions

	var	symbol	documentation	type	units	eqs
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## 29 reactions–macroscopic

	var	symbol	documentation	type	units	eqs
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## 30 macroscopic-reactions

	var	symbol	documentation	type	units	eqs
67	$c_{NS}$	<b>c</b>	link variable c to interface macroscopic »> reactions	get	$m^{-3} mol$	45

### 31 material–macroscopic

	var	symbol	documentation	type	units	eqs
41	$\lambda_S$	Mm	link variable Mm to interface material »> macroscopic	get	$kg\,mol^{-1}$	20
74	$\rho_N$	density	link variable density to interface material »> macroscopic	get	$kg\,m^{-3}$	51
75	$h_{NS}$	h	link variable h to interface material »> macroscopic	get	$kg\,m^2\,mol^{-1}\,s^{-2}$	52
76	$k_{xN}^q$	kq_x	link variable kq x to interface material »> macroscopic	get	$kg\,K^{-1}\,s^{-3}$	53
77	$Cv_N$	Cv	link variable Cv to interface material »> macroscopic	get	$kg\,m^2\,K^{-1}\,s^{-2}$	54
78	$k_{yN}^q$	kq_y	link variable kq y to interface material »> macroscopic	get	$kg\,K^{-1}\,s^{-3}$	55
79	$k_{zN}^q$	kq_z	link variable kq z to interface material »> macroscopic	get	$kg\,K^{-1}\,s^{-3}$	56
80	$k_N^q$	kq	link variable kq to interface material »> macroscopic	get	$kg\,K^{-1}\,s^{-3}$	57
81	$k_{xN}^c$	kc_x	link variable kc x to interface material »> macroscopic	get	$m^{-1}\,s$	58
82	$Cp_N$	Cp	link variable Cp to interface material »> macroscopic	get	$kg\,m^2\,K^{-1}\,s^{-2}$	59
83	$k_{yN}^c$	kc_y	link variable kc y to interface material »> macroscopic	get	$m^{-1}\,s$	60
84	$k_{zN}^c$	kc_z	link variable kc z to interface material »> macroscopic	get	$m^{-1}\,s$	61
85	$k_N^c$	kc	link variable kc to interface material »> macroscopic	get	$m^{-1}\,s$	62
86	$k_{xNS}^d$	kd_x	link variable kd x to interface material »> macroscopic	get	$kg^{-1}\,m^{-4}\,mol^2\,s$	63
87	$k_{yNS}^d$	kd_y	link variable kd y to interface material »> macroscopic	get	$kg^{-1}\,m^{-4}\,mol^2\,s$	64
88	$k_{zNS}^d$	kd_z	link variable kd z to interface material »> macroscopic	get	$kg^{-1}\,m^{-4}\,mol^2\,s$	65

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	var	symbol	documentation	type	units	eqs
89	$k^d_{NS}$	<b>kd</b>	link variable kd to interface material »> macroscopic	get	$kg^{-1} m^{-4} mol^2 s$	<b>66</b>
117	$R^e_N$	<b>elConductC</b>	link variable elConductC to interface material »> macroscopic	get	$kg^{-1} m^{-2} A^2 s^3$	<b>94</b>

## 32 macroscopic-material

	var	symbol	documentation	type	units	eqs
58	$m_N$	m	link variable m to interface macroscopic »> material	get	$kg$	37
114	$i_N$	i	link variable i to interface macroscopic »> material	get	$A$	90

### 33 Equations

### 34 Generic

no	equation	documentation	layer
1	$1 := \text{Instantiate}(\#, \#)$	numerical value 1	root
2	$0 := \text{Instantiate}(\#, \#)$	numerical value zero	root
3	$0.5 := \text{Instantiate}(\#, \#)$	numerical value one half	root
4	$t^o := \text{Instantiate}(t, \#)$	starting time	root
5	$t^e := \text{Instantiate}(t, \#)$	end time	root
6	$p_N := \left(-\frac{\partial U_N}{\partial V_N}\right)$	thermodynamic pressure	physical
7	$T_N := \frac{\partial U_N}{\partial S_N}$	temperature	physical
8	$\mu_{NS} := \frac{\partial U_N}{\partial n_{NS}}$	chemical potential	physical
9	$H_N := U_N - p_N \cdot V_N$	enthalpy	physical
10	$A_N := U_N - T_N \cdot S_N$	Helmholtz energy	physical
11	$G_N := U_N + p_N \cdot V_N - T_N \cdot S_N$	Gibbs free energy	physical
12	$k^B_N := \text{Instantiate}(S_N, \#)$	Boltzmann constant	physical
13	$R_N := A^v \cdot k^B_N$	gas constant	physical
14	$Ue_N := (C_N)^{-1} \cdot U_N$	electrical potential – voltage	physical
15	$v_{xN} := \frac{\partial r_{xN}}{\partial t}$	velocity in x-direction	physical
16	$v_{yN} := \frac{\partial r_{yN}}{\partial t}$	velocity in y direction	physical

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no	equation	documentation	layer
17	$v_{zN} := \frac{\partial r_{zN}}{\partial t}$	velocity in z-direction	physical
21	$C_{pN} := \frac{\partial H_N}{\partial T_N}$	total heat capacity at constant pressure	material
22	$C_{VN} := \frac{\partial U_N}{\partial T_N}$	total heat capacity at constant volume	material
23	$k_{xN}^q := (V_N)^{-1} \cdot \frac{\partial U_N}{\partial T_N} \cdot v_{xN}$	thermal conductivity in x-direction	material
24	$k_{yN}^q := (V_N)^{-1} \cdot \frac{\partial U_N}{\partial T_N} \cdot v_{yN}$	thermal conductivity in y-direction	material
25	$k_{zN}^q := (V_N)^{-1} \cdot \frac{\partial U_N}{\partial T_N} \cdot v_{zN}$	thermal conductivity in z-direction'	material
26	$kq_N := \text{Stack}(k_{xN}^q, k_{yN}^q, k_{zN}^q)$	thermal conductivity	material
27	$k_{xN}^c := \left( \lambda_S^{S \in NS} \star (\mu_{NS})^{-1} \right) \cdot (V_N)^{-1} \cdot \frac{\partial U_N}{\partial p_N} \cdot v_{xN}$	convective mass conductivity in x-direction	material
28	$k_{yN}^c := \left( \lambda_S^{S \in NS} \star (\mu_{NS})^{-1} \right) \cdot (V_N)^{-1} \cdot \frac{\partial U_N}{\partial p_N} \cdot v_{yN}$	convective mass conductivity in y-direction	material
29	$k_{zN}^c := \left( \lambda_S^{S \in NS} \star (\mu_{NS})^{-1} \right) \cdot (V_N)^{-1} \cdot \frac{\partial U_N}{\partial p_N} \cdot v_{zN}$	convective mass conductivity in z-direction	material
30	$k^c_N := \text{Stack}(k_{xN}^c, k_{yN}^c, k_{zN}^c)$	convective mass conductivity	material
31	$k_{xNS}^d := (\mu_{NS})^{-1} \cdot \left( v_{xN} \odot \left( (V_N)^{-1} \odot \frac{\partial U_N}{\partial \mu_{NS}} \right) \right)$	diffusional mass conductivity in x-direction	material
32	$k_{yNS}^d := (\mu_{NS})^{-1} \cdot \left( v_{yN} \odot \left( (V_N)^{-1} \odot \frac{\partial U_N}{\partial \mu_{NS}} \right) \right)$	diffusional mass conductivity in y-direction	material
33	$k_{zNS}^d := (\mu_{NS})^{-1} \cdot \left( v_{zN} \odot \left( (V_N)^{-1} \odot \frac{\partial U_N}{\partial \mu_{NS}} \right) \right)$	diffusional mass conductivity in z-direction	material
34	$k^d_{NS} := \text{Stack}(k_{xNS}^d, k_{yNS}^d, k_{zNS}^d)$	diffusional mass conductivity	material

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no	equation	documentation	layer
35	$h_{NS} := H_N \odot (n_{NS})^{-1}$	partial molar enthalpies	material
36	$m_N := \lambda_S \overset{S \in NS}{\star} n_{NS}$	total mass	macroscopic
38	$\rho_N := m_N \cdot (V_N)^{-1}$	density	material
39	$T_{NK} := P_{N,NK} \overset{N}{\star} T_N$	temperature of the reactive system	reactions
41	$E^a_{NK} := \text{Instantiate}(P_{N,NK} \overset{N}{\star} R_N \cdot T_{NK}, \#)$	Arrhenius activation energy	reactions
42	$K_{NK} := K^o_K \odot \exp((-E^a_{NK}) \cdot (R_N \overset{N}{\star} P_{N,NK} \cdot T_{NK})^{-1})$	Arrhenius reaction 'constant'	reactions
43	$N_{NS,NK} := P_{S,NS} \overset{S}{\star} (P_{K,NK} \overset{K}{\star} N_{S,K})$	soichiometric block matrix node species and node reaction	reactions
44	$c_{NS} := (V_N)^{-1} \odot n_{NS}$	molar composition	macroscopic
46	$c_K S_{KS} := c_{NS} \overset{NS}{\star} P_{NS,KS}$	concentrations associated with reactions	reactions
47	$co_K S_{KS} := \text{Instantiate}(c_K S_{KS}, \#)$	norming concentrations	reactions
48	$A_{yzN} := r_{yN} \cdot r_{zN}$	cross sectional area yz	macroscopic
49	$A_{xzN} := r_{xN} \cdot r_{zN}$	cross sectional area xz	macroscopic
50	$A_{xyN} := r_{xN} \cdot r_{yN}$	cross sectional area xy	macroscopic
67	$\hat{V}_A := (\rho_N)^{-1} \cdot k_{xN}^c \cdot A_{yzN} \cdot D_{N,A} \overset{N}{\star} p_N$	volumetric flow	macroscopic
68	$\hat{n}_{AS}^d := A_{yzN} \odot (-k_{xNS}^d) \cdot D_{NS,AS} \overset{NS}{\star} \mu_{NS}$	diffusional mass flow in a given stream	macroscopic
69	$\hat{n}_{NS}^d := F_{NS,AS} \overset{AS}{\star} \hat{n}_{AS}^d$	net diffusional mass flow	macroscopic

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no	equation	documentation	layer
70	$\hat{H}^d_A := \left( F_{NS,AS} \overset{NS}{\star} h_{NS} \right) \overset{S \in AS}{\star} \hat{n}^d_{AS}$	enthalpy flow per diffusional mass stream	macroscopic
71	$\hat{H}^d_N := F_{N,A} \overset{A}{\star} \hat{H}^d_A$	net enthaply stream due to diffusion	macroscopic
72	$d_A := \text{sign} \left( F_{N,A} \overset{N}{\star} p_N \right)$	flow direction of convectional flow	macroscopic
73	$c_{AS} := (0.5 \cdot (F_{NS,AS} - d_A \odot  F_{NS,AS} )) \overset{NS}{\star} c_{NS}$	concentration in convectional flow	macroscopic
74	$\hat{n}^c_{AS} := \hat{V}_A \odot c_{AS}$	molar convetional mass flow in the given stream	macroscopic
75	$\hat{n}^c_{NS} := F_{NS,AS} \overset{AS}{\star} \hat{n}^c_{AS}$	net molar convectional mass flow	macroscopic
76	$\dot{n}_{NS} := \hat{n}^c_{NS} + \hat{n}^d_{NS}$	differential species balance	macroscopic
77	$\hat{H}^c_A := \left( F_{NS,AS} \overset{NS}{\star} h_{NS} \right) \overset{S \in AS}{\star} \hat{n}^c_{AS}$	convective enthalpy flow for given stream	macroscopic
78	$\hat{H}^c_N := F_{N,A} \overset{A}{\star} \hat{H}^c_A$	net convectional enthalpy stream	macroscopic
79	$\hat{w}_A := \text{Instantiate}(\hat{H}^c_A, \#)$	sample work stream	macroscopic
80	$fw_N := F_{N,A} \overset{A}{\star} \hat{w}_A$	net work stream	macroscopic
81	$\hat{q}_{xA} := A_{yzN} \cdot k_{xN}^q \cdot D_{N,A} \overset{N}{\star} T_N$	heat flow in x-direction for given stream	macroscopic
82	$\hat{q}_N := F_{N,A} \overset{A}{\star} \hat{q}_{xA}$	net heat flow	macroscopic
83	$\dot{H}_N := \hat{H}^c_N + \hat{H}^d_N + \hat{q}_N + fw_N$	differential enthalpy balance	macroscopic
84	$H^o_N := \text{Instantiate}(H_N, \#)$	initial enthalpy	macroscopic
85	$n^o_{NS} := \text{Instantiate}(n_{NS}, \#)$	initial species	macroscopic
86	$n_{NS} := \int_{t^o}^{t^e} \dot{n}_{NS} dt$	fundamental state – molar mass	macroscopic

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no	equation	documentation	layer
87	$H_N := \int_{t_o}^{t^e} \dot{H}_N \, dt$	enthalpy	macroscopic
88	$\xi := \text{Instantiate}(\xi, \#)$	fraction of additives	material
89	$I_N := \frac{dC_N}{dt}$	electrical current definition	macroscopic
91	$R^e_N := (i_N)^{-1} \cdot Ue_N$	electrical resistant	material
92	$R^e_N := \text{Instantiate}(R^e_N, \#)$	electrical resistant	material
93	$k^{e,\xi}_N := (R^e_N)^{-1} \cdot \xi$	simple model for the electrical conductivity as a function of the additive	material
95	$Ue_N := (R^e_N)^{-1} \cdot I_N$	electrical potential – voltage	macroscopic
96	$\dot{U}^e_N := 1 \cdot Ue_N$	Kirkhoff first law	macroscopic
97	$\dot{U}^e_N := \text{Root}(Ue_N)$	Kirkhoff first law	macroscopic
98	$\dot{U}^e_N := \text{Instantiate}(\dot{U}^e_N, 0)$	Kirkhoff first law	macroscopic
101	$im_N := 1 \cdot I_N$	also a fix	macroscopic

## 35 Interface Link Equation

no	equation	documentation	layer
20	$\lambda_S := \lambda_S$	interface equation	material -> macroscopic
37	$m_N := m_N$	interface equation	macroscopic -> material
45	$c_{NS} := c_{NS}$	interface equation	macroscopic -> reactions
51	$\rho_N := \rho_N$	interface equation	material -> macroscopic
52	$h_{NS} := h_{NS}$	interface equation	material -> macroscopic
53	$k_{xN}^q := k_{xN}^q$	interface equation	material -> macroscopic
54	$Cv_N := Cv_N$	interface equation	material -> macroscopic
55	$k_{yN}^q := k_{yN}^q$	interface equation	material -> macroscopic
56	$k_{zN}^q := k_{zN}^q$	interface equation	material -> macroscopic
57	$k_N^q := k_N^q$	interface equation	material -> macroscopic
58	$k_{xN}^c := k_{xN}^c$	interface equation	material -> macroscopic

*Continued on next page*



no	equation	documentation	layer
59	$Cp_N := Cp_N$	interface equation	material → macroscopic
60	$k_{yN}^c := k_{yN}^c$	interface equation	material → macroscopic
61	$k_{zN}^c := k_{zN}^c$	interface equation	material → macroscopic
62	$k_N^c := k_N^c$	interface equation	material → macroscopic
63	$k_{xNS}^d := k_{xNS}^d$	interface equation	material → macroscopic
64	$k_{yNS}^d := k_{yNS}^d$	interface equation	material → macroscopic
65	$k_{zNS}^d := k_{zNS}^d$	interface equation	material → macroscopic
66	$k_{NS}^d := k_{NS}^d$	interface equation	material → macroscopic
90	$i_N := i_N$	interface equation	macroscopic → material
94	$R_N^e := R_N^e$	interface equation	material → macroscopic
99	$I_N := I_N$	interface equation	macroscopic → control
103	$I_{mN} := I_{mN}$	interface equation	macroscopic → control

*Continued on next page*

no	equation	documentation	layer
104	$\xi := \xi$	interface equation	material $\rightarrow$ control