27. Excel Add-In Functions

27.1 Getting started

With HSC 6.0 Add-In Functions it is possible to use the HSC 6.0 database directly under MS Excel 2000 and in that way carry out several thermochemical calculations. In order to use these functions in Excel they must, however, first be activated. Three stages may be needed to activate HSC functions in Excel. The number of stages needed depends on the computer settings and Windows and Excel versions.

Activation Stage 1:

1. Open Excel 2000 (NOTE: HSC Add-Ins may not work under earlier Excel versions!)
2. Select **"Tools, Add-Ins..."** from the menu.
3. Select **"Browse…"** and locate **HSC6.XLL** from your **HSC6\AddIns** folder.
4. Select **"HSC 6.0 Functions"** and press **"OK"**, see Figure 1. It may be necessary to restart Excel in order for the add-in functions to work.

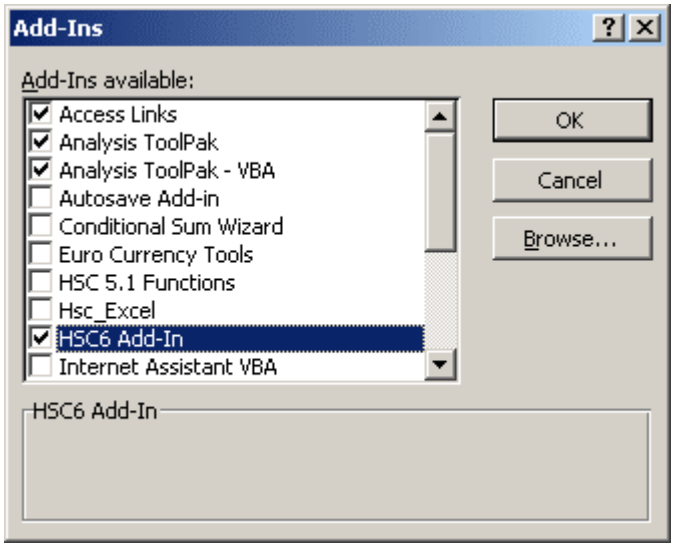


Figure 1: *Adding/removing HSC 6.0 Functions under Excel* ***Please do NOT select old HSC 5.1 Functions!***.

Activation Stage 2 (Optional):

If the installation is unsuccessful, the following steps may help:

1. Start the VBA Editor by pressing Alt+F11.
   (or select Tools, Macro, Visual Basic Editor, ...)
2. Select **"Tools, References"** from the menu.
3. Select **"Browse…"** and locate **HSC6.XLL** from your HSC directory (for example C:\HSC6\HSC6.XLL). It may be necessary to restart Excel in order for the add-in functions to work. HSC Add-In functions locate in HSC6.DLL, however, Excel calls these functions through HSC6.XLL interface.
4. See also stage 3 in Chapter 27.2 if needed.

The HSC installation routine automatically takes care of the HSC6.DLL registration.

Activation Stage 3 (Optional):

1. During opening, answer **No** when prompted by Excel to update all linked information (automatic link updates do not work due to some bug in MS Excel).
2. Select "**Edit, Links**" from the menu.
3. Choose the path containing **HSC6.XLL** from the listbox and press "**Change Source**".
4. Browse to your **HSC6\AddIns** folder and choose **HSC6.XLL**.

27.2 Updating XLS-Files which use old HSC 5.1 Add-In Functions

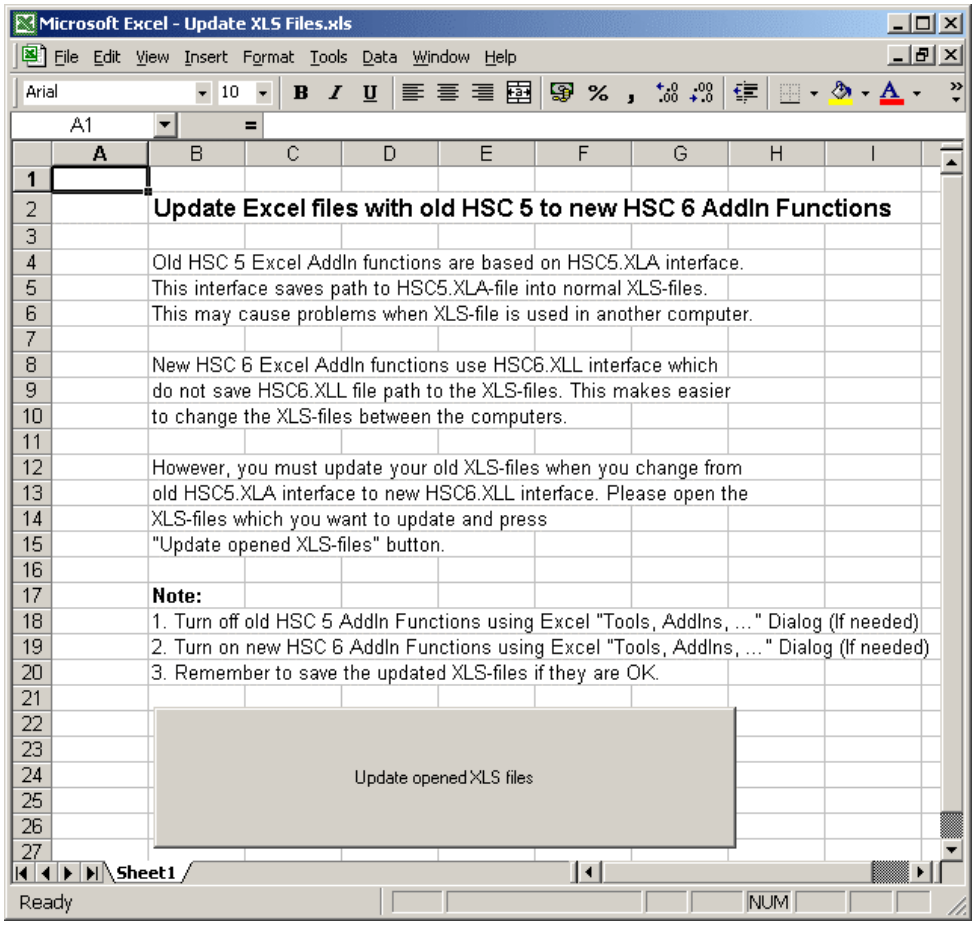


Figure 2: *Update XLS Files.xls macro may be used to update old Excel files with HSC 5.1 Add-In functions to HSC 6.0 Add-Ins.*

You must update old Excel files with HSC 5.1 Add-In functions. If you find following type formulas from your Excel spreadsheet then you must update:
='C:\HSC5\AddIns_BackUp\HSC5.xla'!H(D11;E11)

HSC 5.1 use old HSC5.XLA interface, HSC 6.0 Add-Ins use better HSC6.XLL interface which makes the use of these files much more easier because the path to the HSC6.XLL files is not saved into the XLS-file cells!

27.3 Brief Description of the Functions

The " AddInSample.xls" sample file offers the fastest way to start using HSC 6 Add-In functions, you may found it from HSC 6 folder, such as:
C:\HSC6\AddIns\AddInSample.xls

The add-in functions are used the same way as functions in general under MS Excel. For example by writing **"=H(A1;A2)"** the enthalpy for the species in cell A1 and at the temperature in cell A2, is returned. To view all existing functions simply select **"Insert, Function"** from the main menu and then choose **"User Defined"** from the left listbox. The right listbox will now give show all available HSC functions and their arguments. A complete description of the functions is given in the following tables 1 and 2.

A useful Excel example file is located in the catalogue "\AddIns" in your HSC installation directory. The example, called "AddInSample.xls", can be viewed after the add-ins have been made available (described in Chapter 27.1). Figure 3 shows what the example file should look like using MS Excel 2000.

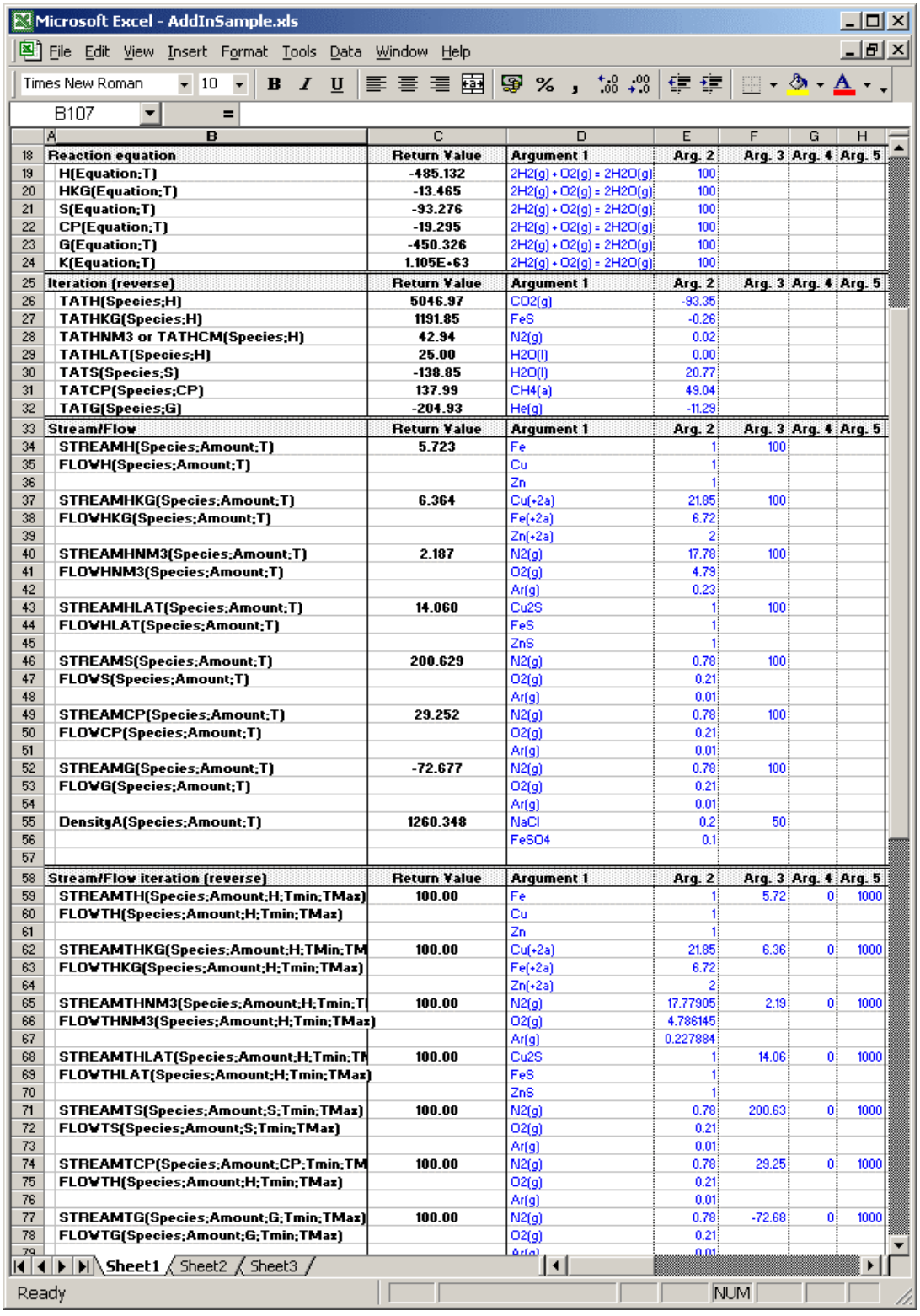
The functions are all collected in the column "Function" and their return values under "Return value". A red font indicates the input values with a short description of every function shown to the right. This example provides an easy method for testing the functions and also provides practice in learning how to use them.

HSC Add-In Functions - Species Based	
Functions	**Descriptions (Return values)**
General	**Description (Return value):**
UNITS(T;E)	Changes the temperature and energy units
BAL(Equation)	Balanced reaction equation
SPECIES(DBNo,Position)	Species formula in given database and record number
Species	**Description (Return value):**
H(Species;T)	Enthalpy (per kmol) of species at given temperature
HKG(Species;T)	Enthalpy (per kg) of species at given temperature
HNM3 or HCM(Species;T)	Enthalpy (per Nm³) of species at given temperature
HLAT(Species;T)	Enthalpy excluding phase transformations (per mol) of species at given temperature
S(Species;T)	Entropy (per Mmol) of species at given temperature
CP(Species;T)	Heat capacity (per Mmol) of species at given temperature
G(Species;T)	Gibbs energy (per kmol) of species at given temperature
Reaction equation	**Description (Return value):**
H(Equation;T)	Enthalpy difference (per kmol) of reaction equation at given temperature.
HKG(Equation;T)	Enthalpy difference (per kg) of reaction equation at given temperature
S(Equation;T)	Entropy difference (per Mmol) of reaction equation at given temperature
CP(Equation;T)	Heat capacity difference (per Mmol) of reaction equation at given temperature
G(Equation;T)	Gibbs energy difference (per kmol) of reaction equation at given temperature
K(Equation;T)	Equilibrium constant of reaction equation at given temperature
Iteration (reverse)	**Description (Return value):**
TATH(Species;H)	Temperature of species at given enthalpy (per kmol)
TATHKG(Species;H)	Temperature of species at given enthalpy (per kg)
TATHNM3 or TATHCM(Species;H)	Temperature of species at given enthalpy (per Nm3)
TATHLAT(Species;H)	Temperature of species (per kmol) at given enthalpy excluding phase transformations
TATS(Species;S)	Temperature of species at given entropy (per Mmol).
TATCP(Species;CP)	Temperature of species at given heat capacity (per Mmol)
TATG(Species;G)	Temperature of species at given Gibbs energy (per kmol)
Temp. independent	**Description (Return value):**
STRUCT(Species)	Structural formula of given species
CHNAME(Species)	Chemical name of given species
CONAME(Species)	Common name of given species
CAN(Species)	Chemical abstract number of given species
MW(Species)	Molecular weight of given species [kg/kmol]
DE(Species)	Density of given species [kg/l]
MP(Species)	Melting point of given species
BP(Species)	Boiling point of given species
PHASE(Species)	Phase type of given species
RGBCOLOR(Species)	RGB color code of given species
REF(Species)	Reference of given species
REL(Species)	Reliability class of given species
Percentage	**Description (Return value):**
MOLP(Species1;Species2)	Species 1 content in Species 2 in mol-%
WTP(Species1;Species2)	Species 1 content in Species 2 in wt-%
CP-function related	**Description (Return value):**
CPFUNCTION(Species)	Heat capacity (Cp) polynomial function of given species
CPA(Species)	A coefficient in Cp-function of given species
CPB(Species)	B coefficient in Cp-function of given species
CPC(Species)	C coefficient in Cp-function of given species
CPD(Species)	D coefficient in Cp-function of given species
TMIN(Species)	Lower limit of Cp-function temperature range
TMAX(Species)	Upper limit of Cp-function temperature range

Table 1: *Description of all currently available HSC Species based add-in functions.*

HSC Add-In Functions - Stream Based	
Functions	**Descriptions (Return values)**
Stream/Flow	**Description (Return value):**
STREAMH(Species;Amount;T) **FLOWH(Species;Amount;T)**	Enthalpy of the specified stream/flow (species in kmol) at given temperature
STREAMHKG(Species;Amount;T) **FLOWHKG(Species;Amount;T)**	Enthalpy of the specified stream/flow (species in kg) at given temperature
STREAMHNM3(Species;Amount;T) **FLOWHNM3(Species;Amount;T)**	Enthalpy of the specified stream/flow (species in Nm3) at given temperature
STREAMHLAT(Species;Amount;T) **FLOWHLAT(Species;Amount;T)**	Enthalpy excluding phase transformations of the specified stream/flow (species in kmol) at given temperature
STREAMS(Species;Amount;T) **FLOWS(Species;Amount;T)**	Entropy of specified stream/flow (species in Mmol) at given temperature
STREAMCP(Species;Amount;T) **FLOWCP(Species;Amount;T)**	Heat capacity of specified stream/flow (species in Mmol) at given temperature
STREAMG(Species;Amount;T) **FLOWG(Species;Amount;T)**	Gibbs energy of specified stream/flow (species in kmol) at given temperature
DensityA(Species;Amount;T)	Density of aqueous solution (kg/m3) Arg. 2 = Weight fractions, max = 1, Arg. 3 = temperature °C
Stream/Flow iteration (reverse)	**Description (Return value):**
STREAMTH(Species;Amount;H;Tmin;TMax) **FLOWTH(Species;Amount;H;Tmin;TMax)**	Temperature of stream/flow (species in kmol) at given enthalpy between Tmin and Tmax Outside range returns #VALUE!
STREAMTHKG(Species;Amount;H;TMin;TMax) **FLOWTHKG(Species;Amount;H;Tmin;TMax)**	Temperature of stream/flow (species in kg) at given enthalpy between Tmin and Tmax Outside range returns #VALUE!
STREAMTHNM3(Species;Amount;H;Tmin;TMax) **FLOWTHNM3(Species;Amount;H;Tmin;TMax)**	Temperature of stream/flow (species in Nm3) at given enthalpy between Tmin and Tmax Outside range returns #VALUE!
STREAMTHLAT(Species;Amount;H;Tmin;TMax) **FLOWTHLAT(Species;Amount;H;Tmin;TMax)**	Temperature of stream/flow (species in kmol) at given enthalpy excluding phase transformations between Tmin and Tmax Outside range returns #VALUE!
STREAMTS(Species;Amount;S;Tmin;TMax) **FLOWTS(Species;Amount;S;Tmin;TMax)**	Temperature of stream/flow (species in Mmol) at given entropy between Tmin and Tmax Outside range returns #VALUE!
STREAMTCP(Species;Amount;CP;Tmin;TMax) **FLOWTH(Species;Amount;H;Tmin;TMax)**	Temperature of stream/flow (species in Mmol) at given heat capacity between Tmin and Tmax Outside range returns #VALUE!
STREAMTG(Species;Amount;G;Tmin;TMax) **FLOWTG(Species;Amount;G;Tmin;TMax)**	Temperature of stream/flow (species in kmol) at given gibbs energy between Tmin and Tmax Outside range returns #VALUE!
Equilibrium Compositions	**Description (Return value):**
StreamEQ(Species;Input;Output, T, P)	Equlibrium amounts of species based on given amounts, temperature and pressure.

Table 2: *Description of all currently available HSC Stream based add-in functions.*

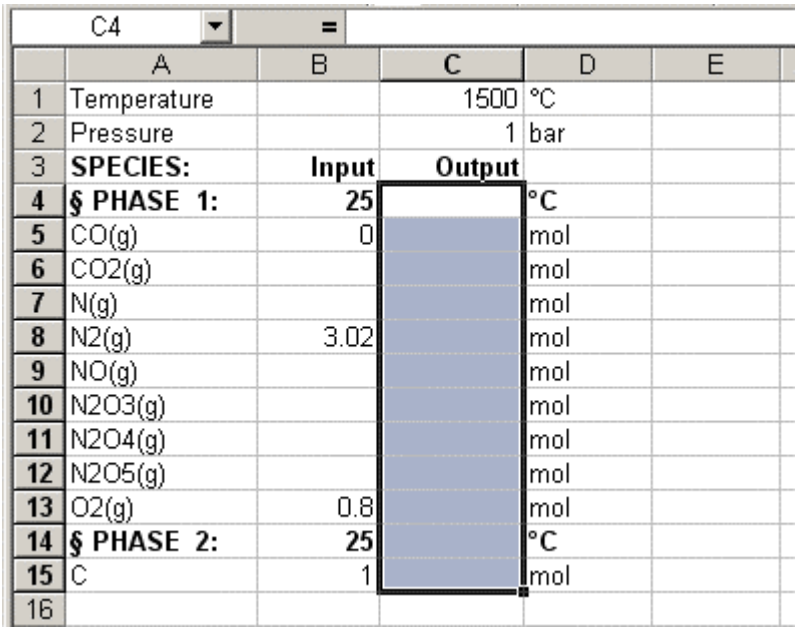


	A	B	C	D	E	F	G	H
18		Reaction equation	Return Value	Argument 1	Arg. 2	Arg. 3	Arg. 4	Arg. 5
19		H(Equation;T)	-485.132	2H2(g) + O2(g) = 2H2O(g)	100			
20		HKG(Equation;T)	-13.465	2H2(g) + O2(g) = 2H2O(g)	100			
21		S(Equation;T)	-93.276	2H2(g) + O2(g) = 2H2O(g)	100			
22		CP(Equation;T)	-19.295	2H2(g) + O2(g) = 2H2O(g)	100			
23		G(Equation;T)	-450.326	2H2(g) + O2(g) = 2H2O(g)	100			
24		K(Equation;T)	1.105E+63	2H2(g) + O2(g) = 2H2O(g)	100			
25		Iteration (reverse)	Return Value	Argument 1	Arg. 2	Arg. 3	Arg. 4	Arg. 5
26		TATH(Species;H)	5046.97	CO2(g)	-93.35			
27		TATHKG(Species;H)	1191.85	FeS	-0.26			
28		TATHNM3 or TATHCM(Species;H)	42.94	N2(g)	0.02			
29		TATHLAT(Species;H)	25.00	H2O(l)	0.00			
30		TATS(Species;S)	-138.85	H2O(l)	20.77			
31		TATCP(Species;CP)	137.99	CH4(a)	49.04			
32		TATG(Species;G)	-204.93	He(g)	-11.29			
33		Stream/Flow	Return Value	Argument 1	Arg. 2	Arg. 3	Arg. 4	Arg. 5
34		STREAMH(Species;Amount;T)	5.723	Fe	1	100		
35		FLOWH(Species;Amount;T)		Cu	1			
36				Zn	1			
37		STREAMHKG(Species;Amount;T)	6.364	Cu(+2a)	21.85	100		
38		FLOWHKG(Species;Amount;T)		Fe(+2a)	6.72			
39				Zn(+2a)	2			
40		STREAMHNM3(Species;Amount;T)	2.187	N2(g)	17.78	100		
41		FLOWHNM3(Species;Amount;T)		O2(g)	4.79			
42				Ar(g)	0.23			
43		STREAMHLAT(Species;Amount;T)	14.060	Cu2S	1	100		
44		FLOWHLAT(Species;Amount;T)		FeS	1			
45				ZnS	1			
46		STREAMS(Species;Amount;T)	200.629	N2(g)	0.78	100		
47		FLOWS(Species;Amount;T)		O2(g)	0.21			
48				Ar(g)	0.01			
49		STREAMCP(Species;Amount;T)	29.252	N2(g)	0.78	100		
50		FLOWCP(Species;Amount;T)		O2(g)	0.21			
51				Ar(g)	0.01			
52		STREAMG(Species;Amount;T)	-72.677	N2(g)	0.78	100		
53		FLOWG(Species;Amount;T)		O2(g)	0.21			
54				Ar(g)	0.01			
55		DensityA(Species;Amount;T)	1260.348	NaCl	0.2	50		
56				FeSO4	0.1			
57								
58		Stream/Flow iteration (reverse)	Return Value	Argument 1	Arg. 2	Arg. 3	Arg. 4	Arg. 5
59		STREAMTH(Species;Amount;H;Tmin;TMax)	100.00	Fe	1	5.72	0	1000
60		FLOWTH(Species;Amount;H;Tmin;TMax)		Cu	1			
61				Zn	1			
62		STREAMTHKG(Species;Amount;H;TMin;TM	100.00	Cu(+2a)	21.85	6.36	0	1000
63		FLOWTHKG(Species;Amount;H;Tmin;TMax)		Fe(+2a)	6.72			
64				Zn(+2a)	2			
65		STREAMTHNM3(Species;Amount;H;Tmin;T	100.00	N2(g)	17.77905	2.19	0	1000
66		FLOWTHNM3(Species;Amount;H;Tmin;TMax)		O2(g)	4.786145			
67				Ar(g)	0.227884			
68		STREAMTHLAT(Species;Amount;H;Tmin;TM	100.00	Cu2S	1	14.06	0	1000
69		FLOWTHLAT(Species;Amount;H;Tmin;TMax)		FeS	1			
70				ZnS	1			
71		STREAMTS(Species;Amount;S;Tmin;TMax)	100.00	N2(g)	0.78	200.63	0	1000
72		FLOWTS(Species;Amount;S;Tmin;TMax)		O2(g)	0.21			
73				Ar(g)	0.01			
74		STREAMTCP(Species;Amount;CP;Tmin;TM	100.00	N2(g)	0.78	29.25	0	1000
75		FLOWTH(Species;Amount;H;Tmin;TMax)		O2(g)	0.21			
76				Ar(g)	0.01			
77		STREAMTG(Species;Amount;G;Tmin;TMax)	100.00	N2(g)	0.78	-72.68	0	1000
78		FLOWTG(Species;Amount;G;Tmin;TMax)		O2(g)	0.21			
79				Ar(g)	0.01			

Figure 3: *Example including all available Excel add-in functions (AddInSample.xls).*

27.4 Stream Equilibrium Function (Array Functions)

The array functions are created in different way than normal spreadsheet functions. The most important array function of HSC-Sim is **StreamEQ** which calculates the amounts of species in the equilibrium state at given temperature and pressure.



	A	B	C	D	E
1	Temperature		1500	°C	
2	Pressure		1	bar	
3	**SPECIES:**	**Input**	**Output**		
4	**§ PHASE 1:**	**25**		**°C**	
5	CO(g)	0		mol	
6	CO2(g)			mol	
7	N(g)			mol	
8	N2(g)	3.02		mol	
9	NO(g)			mol	
10	N2O3(g)			mol	
11	N2O4(g)			mol	
12	N2O5(g)			mol	
13	O2(g)	0.8		mol	
14	**§ PHASE 2:**	**25**		**°C**	
15	C	1		mol	
16					

Fig. 4. Selection for array function.

You may create array function in MS Excel and HSC-Sim using the same procedure:

1. Create continuos list of phases and species in one column. Important: The phase name string must always start with **§**-character, Fig. 4.
2. Specify temperatures of the phases into the next column on the §-phase-row.
3. Specify the input amounts (moles) of the species into the next column.
4. Select array function cell range, see Fig. 4.
5. Type array function: =StreamEQ(A4:A15;B4:B15;C1;C2), Fig. 5.
6. Keep Crtl + Shift keys down and press Enter, Fig. 6.
7. The array function is ready if it is within brackets, Fig. 6.

Please note that the array function cell range must be continuous, it is like a solid and fixed block within spreadsheet. Do not brake off this cell range with uncontinuous copy-paste, insert rows, delete rows, etc. operations.

SUM | =StreamEQ(A4:A15;B4:B15;C1;C2)

	A	B	C	D	E
1	Temperature		1500	°C	
2	Pressure		1	bar	
3	**SPECIES:**	**Input**	**Output**		
4	**§ PHASE 1:**	**25**	C1;C2)	**°C**	
5	CO(g)	0		mol	
6	CO2(g)			mol	
7	N(g)			mol	
8	N2(g)	3.02		mol	
9	NO(g)			mol	
10	N2O3(g)			mol	
11	N2O4(g)			mol	
12	N2O5(g)			mol	
13	O2(g)	0.8		mol	
14	**§ PHASE 2:**	**25**		**°C**	
15	C	1		mol	
16					

Fig. 5. Type array function.

C4 | {=StreamEQ(A4:A15;B4:B15;C1;C2)}

	A	B	C	D	E
1	Temperature		1500	°C	
2	Pressure		1	bar	
3	**SPECIES:**	**Input**	**Output**		
4	**§ PHASE 1:**	**25**	**1500**	**°C**	
5	CO(g)	0	0.400008	mol	
6	CO2(g)		0.599992	mol	
7	N(g)		7.841E-11	mol	
8	N2(g)	3.02	3.0199962	mol	
9	NO(g)		7.531E-06	mol	
10	N2O3(g)		4.736E-23	mol	
11	N2O4(g)		2.878E-30	mol	
12	N2O5(g)		1.32E-36	mol	
13	O2(g)	0.8	2.171E-07	mol	
14	**§ PHASE 2:**	**25**	**1500**	**°C**	
15	C	1	0	mol	
16					

Fig. 6. Keep Crtl + Shift keys down and press Enter.

27.5 HSC AddIn Functions

Some of the AddIn functions are available on in HSC Chemistry streadsheets but not in MS Excel. Currently the StreamX is such a function:

Function	**StreamX**
Syntax	StreamX(StremName;ParticlesRange;Variable)
Examples	StreamX(E$6;$E$56:$E$97;$B8) StreamX("ROM";$E$56:$E$97;"SiO2")
Explanation	Returns the value of the variable, e.g. SiO2 content of the stream calculated according to particles. Note that particle data can be corrected to be in harmony with chemical and mineral composition of the bulk feed.
Applications	StreamX functions is used in Mineral Based Models

Other HSC AddIn functions are StreamX, **RecoveryX, ParticleRecX, FractionX, MineralX**. These are described in more details in chapter "57. Mineral Based Models".

27.6 More about registering DLL Files

The HSC 6.0 installation routine should take care of all necessary DLL registrations. When selecting/deselecting the HSC 6.0 add-in using Excel, HSC6.DLL is automatically registered/unregistered. However, it is also possible to register/unregister the HSC6.DLL file manually. The program to achieve this is called Regsvr32.exe*) and registration is completed using the following method:

Note: For other HSC6 installation paths than C:\HSC6, simply use your path instead in the instuctions below.

1. Select **"Start, Run..."** from the Windows menu.
2. Type **"regsvr32 C:\HSC6\HSC6.dll"** for registering HSC 6.0 add-in functions.

Alternatively it can be achieved using the following method:

1. Double-click the file **"HSC6.DLL"** in your HSC directory.
2. If the file is *not* registered automatically, which is indicated by an **"Open With"**-dialog box, choose **"Other…"** in the dialog window.
3. Select **"Regsvr32.exe"** from your Windows System directory. Now double-click the file again and it should register automatically.

When unregistering files follow the same procedure, but add the **/u** switch before the file name, i.e. **"regsvr32 /u C:\HSC6\HSC6.DLL"** for unregistering HSC6.dll.

***Description of Regsvr32.exe**

To add .ocx and certain .dll files, it will be necessary to run REGSVR32.EXE from the Run option in the Start menu. The following are the commands and switches needed: *regsvr32* [/u] [/s] [n] [i [:cmdline]] *dll name* or *ocx name*

/u (unregistered server)
/s (silent; display no message boxes)
/c (console output)
/i Call dll or ocx install passing it an optional [cmdline];
when used with /u calls dll or ocx uninstall
/n Do not call dll RegisterServer; this option must be used with /I