

Thermo Utilities v3.0, MS EXCEL Add-ins

Functions for properties of steam/water

When you activate STMXL.XLA, you have access to all steam/water functions. By pressing *fx* button in MS Excel a dialog over all function comes up. Select "User Defined" and you will have a list over all user defined functions. When you pick a function, a brief description of the function appears at the bottom of the dialog box. If you press "Next", Excel will continue with a dialog box that asks for the necessary inputs for the function. In case, you press "Enter" button, you should fill all the parameters with numbers, cell reference, variable name and so on. These are the normal Excel functions behavior and is not specific for this program. If you need more help please see the on-line help of MS Excel or the user manual. The function names are compatible with the DLL version of steam properties. Those users who upgrade to this version from DLL version of steam properties will find several new functions. There are some simple rules that will help you to remind function names. Here, you have a complete list of functions for properties of steam and water. A print of this page will be helpful if you are new to this package.

Function	Description	Comment
STMCp	(P,T)-->Cp, Heat capacity	.
STMCpSS	(P)-->Cp for saturated steam	.
STMCpSW	(P)-->Cp for saturated water	.
STMDv	(V,T)-->Dv, Dynamic viscosity	.
STMPHQ	(P,H)-->Q, Dryness fraction	.
STMPHS	(P,H)-->S, Specific entropy	.
STMPHT	(P,H)-->T, Temperature	.
STMPHV	(P,H)-->V, Specific volume	.
STMPQH	(P,Q)-->H, Specific enthalpy	.
STMPQS	(P,Q)-->S	.
STMPQV	(P,Q)-->V	.
STMPSH	(P,S)-->H	.

Function	Description	Comment
STMP SQ	$(P,S) \rightarrow Q$	.
STMP ST	$(P,S) \rightarrow T$	.
STMP SV	$(P,S) \rightarrow V$	.
STMP T	$(P) \rightarrow T$, Saturation temperature	Should work in demo version
STMP TH	$(P,T) \rightarrow H$	.
STMP TS	$(P,T) \rightarrow S$	.
STMP TV	$(P,T) \rightarrow V$	.
STMP VH	$(P,V) \rightarrow H$	.
STMP VQ	$(P,V) \rightarrow Q$	.
STMP VS	$(P,V) \rightarrow S$	.
STMP VT	$(P,V) \rightarrow T$	.
STMP Tc	$(V,T) \rightarrow T_c$, Thermal conductivity	.
STMP P	$(T) \rightarrow P$, Saturation pressure	Should work in demo version
STMP QH	$(T,Q) \rightarrow H$	.
STMP QS	$(T,Q) \rightarrow S$	.
STMP QV	$(T,Q) \rightarrow V$	.

Functions for properties of air/flue gases

Functions for properties of air/flue gases are based on equations accepted by ASHRAE and are compatible with formulations accepted by CIBSE (Chartered Institute of Building Services Engineers). When you activate AIRXL.XLA, you have access to all air/flue gases functions. By pressing button **fx** in MS Excel a dialog over all function comes up. Select "User Defined" and you will have a list over all user defined functions. When you pick a function, a brief description of the function appears at the bottom of the dialog box. If you press "Next", Excel will continue with a dialog box that asks for the necessary inputs for the function. In case, you press "Enter" button, you should fill all the parameters with numbers, cell reference, variable name and so on. These are the normal Excel functions behavior and is not specific for this program. If you need

more help please see the on-line help of MS Excel or the user manual. The function names are compatible with the DLL version of Air and Exhaust Gas properties. Those users who upgrade to this version from DLL version of Air and Exhaust Gas will find several new functions. There are some simple rules that will help you to remind function names. Here, you have a complete list of functions for properties of Air and Exhaust Gas. A print of this page will be helpful if you are new to this package.

Function	Description	Comment
AirCpT	(mc,Cp)-->T, Temperature	.
AirDpt	(mc,P)--> Dpt, Dew point temperature	.
AirDv	(mc,P,T)-->Dv, Dynamic viscosity	.
AirGC	(mc)-->Gc, Gas constant	Should work in demo version
AirHT	(mc,H)-->T	.
AirMM	(mc)-->Mm, Molecular mass	Should work in demo version
AirST	(mc,S)-->T	.
AirTc	(mc,P,T)-->Tc, Thermal conductivity	.
AirTCp	(mc,T)-->Cp, Heat capacity at constant P	.
AirTCv	(mc,T)-->Cv, Heat capacity at constant V	.
AirTGamma	(mc,T)-->Gamma = Cp/Cv	.
AirTH	(mc,T)-->H, Specific enthalpy	.
AirTS	(mc,T)-->S, Specific entropy	.
FlueCpT	(Cp,%)-->T, Temperature	.
FlueDpt	(P,%)--> Dpt, Dew point temperature	.
FlueDv	(P,T,%)-->Dv, Dynamic viscosity	.
FlueGC	(%)-->Gc, Gas constant	Should work in demo version
FlueHT	(H,%)-->T	.

Function	Description	Comment
FlueMM	(%)-->Mm, Molecular mass	Should work in demo version
FlueST	(S,%)-->T	.
FlueTc	(P,T,%)-->Tc, Thermal conductivity	.
FlueTCp	(T,%)-->Cp, Heat capacity at constant P	.
FlueTCv	(T,%)-->Cv, Heat capacity at constant V	.
FlueTGamma	(T,%)-->Gamma = Cp/Cv	.
FlueTH	(T,%)-->H, Specific enthalpy	.
FlueTS	(T,%)-->S, Specific entropy	.
GasDensity	(P,T,Gc)-->Ro, Density	Should work in demo version
GasS	(P,Gc,Satm)-->S at pressure, P	Should work in demo version
GasSatm	(P,Gc,S)-->Satm = S at atmospheric pressure	Should work in demo version
ScreenPS	(DBT,WBT)-->PS, Percentage saturation	.
ScreenRH	(DBT,WBT)-->RH, Relative humidity	.
ScreenSH	(DBT,WBT)-->SH, Specific humidity	.
ScreenVWR	(DBT,WBT)-->VWR, Volumetric water ratio	.
SlingPS	(DBT,WBT)-->PS, Percentage saturation	.
SlingRH	(DBT,WBT)-->RH, Relative humidity	.
SlingSH	(DBT,WBT)-->SH, Specific humidity	.
SlingVWR	(DBT,WBT)-->VWR, Volumetric water ratio	.

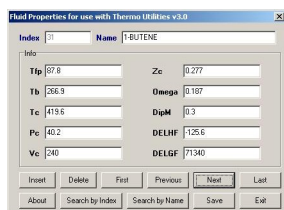
Fluid properties utility for use with Lee-Kesler method

The current version of Lee-Kesler method support 467 different chemical compounds. You can use the utility software "fluidpro.exe" to view, edit or add new entries to our database. When you edit or add new entries, you should use the units mentioned in ellipses below. This limitation

apply only to database entry, our software will use the default unit for input/output as you selected by "setunit.exe" as described before. The database supports the following:

- Normal freezing point (T_{fp}, K)
- Normal boiling point (T_b, K at 1 atmosphere)
- Critical temperature (T_c, K)
- Critical pressure (P_c, bar)
- Critical specific volume (V_c, cm³/mol)
- Critical compressibility factor (Z_c, no dimension)
- Pitzer's acentric factor (Omega, no dimension)
- Dipole moment (DipM, debyes)
- Standard enthalpy of formation (DELHF, J/mol)
- Standard Gibbs energy of formation (DELGF, J/mol)

A word of caution, in case you add/remove entries in the middle of database, the fluid index will be changed. Here is a screenshot of "fluidpro.exe".



Functions for Lee-Kesler method

These functions compute the thermodynamic properties of chemicals by using reduced pressure and temperature. When you activate LKXL.XLA, you have access to these functions. By pressing **fx** button in MS Excel a dialog over all function comes up. Select "User Defined" and you will have a list over all user defined functions. When you pick a function, a brief description of the function appears at the bottom of the dialog box. If you press "Next", Excel will continue with a dialog box that asks for the necessary inputs for the function. In case, you press "Enter" button, you should fill all the parameters with numbers, cell reference, variable name and so on. These are the normal Excel functions behavior and is not specific for this program. If you need more help please see the on-line help of MS Excel or the user manual. The function names are compatible with the DLL version of steam properties. Those users who upgrade to this version from DLL version of steam properties will find several new functions. There are some simple rules that will help you to remind function names. Here, you have a complete list of functions. A

print of this page will be helpful if you are new to this package.

Function	Description	Comment
FluidIndex	Fluid index in DB	Should work in demo version
DBTfb	Normal freezing point	Should work in demo version
DBTb	Normal boiling point	Should work in demo version
DBTc	Critical temperature	Should work in demo version
DBPc	Critical pressure	Should work in demo version
DBVc	Critical specific volume	Should work in demo version
DBZc	Critical compressibility factor	Should work in demo version
DBAF	Pitzer's acentric factor	Should work in demo version
DBDM	Dipole moment	Should work in demo version
DBDELHF	Standard enthalpy of formation	Should work in demo version
DBDELGF	Standard Gibbs energy of formation	Should work in demo version
LKPFT	(P,F)->T, reduced temperature	.
LKPHT	(P,H)->T, reduced temperature	.
LKPQF	(P,Q)->F, fugacity-pressure ratio	.
LKPQH	(P,Q)->H, residual enthalpy	.
LKPQS	(P,Q)->S, residual entropy	.
LKPQZ	(P,Q)->Z, compressibility factor	.
LKPST	(P,S)->T, reduced temperature	.
LKPZT	(P,Z)->T, reduced temperature	.
LKPT	(P)->T, reduced saturation temperature	Should work in demo version
LKPTF	(P,T)->F, fugacity-pressure ratio	.

Function	Description	Comment
LKPTH	(P,T)->H, residual enthalpy	.
LKPTS	(P,T)->S, residual entropy	.
LKPTZ	(P,T)->Z, compressibility factor	.
LKTP	(T)->P, reduced saturation pressure	.
LKTQF	(T,Q)->F, fugacity-pressure ratio	.
LKTQH	(T,Q)->H, residual enthalpy	.
LKTQS	(T,Q)->S, residual entropy	.
LKTQZ	(T,Q)->Z, compressibility factor	.

Simple rules to remind function names

All functions for steam/water properties start with **STM** then comes abbreviations for inputs needed and at last the output. Some examples are **STMPH** needs **P**, pressure and **T**, temperature and calculates **H**, specific enthalpy, **STMPHT** needs **P**, pressure and **H**, specific enthalpy and calculates **T**, temperature. The same rule applies to functions for dry air, moist air and flue gases. Functions for dry and moist air start with **Air** and functions for flue gases start with **Flue**. All functions for dry/moist air need mc, moisture content. Therefore it has been omitted from the function's name. The same is with the flue gas functions all of them need the volumetric or mole fraction of the gases. Functions for screen hygrometer start with **Screen** and functions for sling hygrometer start with **Sling**. These functions calculate **SH**, specific humidity, **RH**, relative humidity, **PS**, percentage saturation and **VWR**, volumetric water ratio.

Abbreviations:

- Cp: Specific heat capacity at constant pressure
- Cv: Specific heat capacity at constant volume
- Dv: Dynamic viscosity
- Gamma: Ratio of Cp/Cv
- GC: Gas constant
- H: Specific enthalpy
- mc: Moisture content

- MM: Molecular mass
- P: Pressure
- PS: Percentage saturation
- Q: Steam quality = dryness fraction = 1 - wetness fraction
- RH: Relative humidity
- S: Specific entropy
- SH: Specific humidity = moisture content
- T: Temperature
- Tc: Thermal conductivity
- V: Specific volume
- VWR: Volumetric water ratio

Molecular Weight Calculator

Molecular weight of any compound can be computed by using its chemical formula.

- This function supports all atoms in the periodic system.
- It should work even if you do not have any registration key.
- Fractional multipliers are allowed.
- Fractional numbers less than 1 should begin with 0.

Macro development and error handling

You can view our function prototypes and VBA interface by selecting "Tool", "Macro", "Visual Basic Editor" in Excel. By developing your own macros you can speed up your calculations and also make your own dialog boxes for input/output.

Error handling/reporting for Steam/water functions

All functions return large negative numbers in case of error. No function returns a negative number less than **-1000** no matter what units are used. The returned values and reasons are:

- -1001: The pressure is outside the acceptable range specified in IFC formulation for Industrial use!

$$0.01 \text{ bar} < P < 1000 \text{ bar}$$

- -1002: The temperature is outside the acceptable range specified in IFC formulation for Industrial use!

$$0\text{ C} < T < 800\text{ C}$$

- -1003: Dryness fraction should be within the following limits:

$$0.0 \leq Q \leq 1.0$$

- -1004: Pressure of the wet steam may not be more than 221.0 bar (pressure at critical point is 221.2 bar) i.e.

$$P \leq 221.0\text{ bar}$$

- -1005: Temperature of the wet steam may not be more than 374.0 C (temperature at critical point is 374.15 C) i.e.

$$T \leq 374.0\text{ C}$$

- -1012: It is impossible to find a point with the specified pressure [P] and specific entropy [s]!
- -1013: It is impossible to find a point with the specified pressure [P] and specific volume [v]!
- -1014: It is impossible to find a point with the specified pressure [P] and specific enthalpy [h]!
- -1015: Inputs are not enough to determine the state of the steam or water. Pressure and temperature are too close to wet steam data.
- -1016: Pressure and temperature are too close to critical point.
- -1017: Specific volume is too small.

Error handling/reporting for Air and flue gas functions

All functions return large negative numbers in case of error. No function returns a negative number less than -20E+9 no matter what units are used. The returned values and reasons are:

- -21E+9: Moisture content, mc, is not acceptable!

$$0 \leq mc < 0.30$$

- -22E+9: Volumetric compositions should be within the interval zero and one and the sum must be one.

- -23E+9: Temperature should be within the following limits:

$$-40\text{ C} < T < 1500\text{ C}$$

- -24E+9: It is impossible to find a temperature with the specified specific enthalpy.
- -25E+9: It is impossible to find a temperature with the specified specific entropy.
- -26E+9: It is impossible to find a temperature with the specified specific heat capacity.
- -27E+9: The wet bulb temperature is limited to:
 $-40\text{ C} < T < 70\text{ C}$
- -28E+9: The following condition should be satisfied:
 $\text{DryBulbT} \geq \text{WetBulbT}$
- -29E+9: This combination of dry and wet bulb temperatures are not possible!
- -30E+9: Pressure is outside the acceptable range:
 1. $\text{bar} < P < 20\text{ bar}$
- -31E+9: Gas constant is too small.

Error handling/reporting for Lee-Kesler functions

All functions return large negative numbers in case of error. No function returns a negative number less than **-2000**. No matter what units are used. The returned values and reasons are:

- -2001: The pressure is outside the acceptable range!
 $0.01 < P_r < 10$
 $P_r = \text{Reduced pressure} = P/P_{cr}$
 $P_{cr} = \text{Critical pressure}$
 $P = \text{Pressure}$
- -2002: The temperature is outside the acceptable range!
 $0.3 < T_r < 4.0$
 $T_r = \text{Reduced temperature} = T/T_{cr}$
 $T_{cr} = \text{Critical temperature}$
 $T = \text{Temperature}$
- -2003: Dryness fraction should be within the following limits:
 $0.0 = Q \leq 1.0$

- -2004: Pressure of wet vapor may not be more than P_{cr} i.e.

$$P_r \leq 1.0$$

- -2005: Temperature of wet vapor may not be more than T_{cr} i.e.

$$T_r \leq 1.0$$

- -2012: It is impossible to find a point with the specified reduced pressure $[P_r]$ and reduced specified entropy $[s_r]$!
- -2013: It is impossible to find a point with the specified reduced pressure $[P_r]$ and compressibility factor $[Z]$!

$$Z = (V \cdot P) / (R \cdot T)$$

V = Specific volume

$$R = \text{Gas Constant} = 8.3144 \text{ J/(mol.K)} = 10.732 \text{ psia.ft}^2/(\text{lb-mol.R})$$

- -2014: It is impossible to find a point with the specified reduced pressure $[P_r]$ and reduced specific enthalpy $[h]$!
- -2015: Inputs are not enough to determine the state of the fluid. Pressure and temperature are too close to wet vapor data.
- -2016: It is impossible to find a point with the specified reduced pressure $[P_r]$ and reduced fugacity-pressure ratio $[f]$!
- -2020: Acentric factor is out of acceptable range.

$$-0.5 < A_f < 2.0$$

In case of questions or comments contact:

Support@taftan.com

For more information, please visit:

<http://taftan.com/>