PROCESS | UTILITES

[Documentation]

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At the core of the ProcessUtilities Excel add-in is a set custom functions tailored toward chemical process engineering applications. A user-interface integrated with Excel's native 'Ribbon' offers additional functionality, including setting standard conditions and customizing significant figures.

functions

ribbon interface

Process Utilities Functions

The core of the ProcessUtilities Excel add-in is a set custom functions tailored toward chemical process engineering applications. They are particularly useful in developing process models, techno-economic models, and equipment sizing calculations, but can also provide an efficient means for performing many daily calculations.

CONVERSION FUNCTIONS	
CONV	Converts a number from one unit of measure to another.
TCONV	Converts a number from one temperature scale to another.
PCONV	Converts a number from one pressure scale to another.
MCONV	Converts a quantity of a specified compound from mass to moles or standard volume, or vice versa.
VCONV	Uses the ideal gas law to convert a number units of moles or standard volume to actual volume, or vice versa.
MOLECULAR FORMULA FUNCTIONS	
MW	Returns the molecular weight corresponding to a molecular formula.
COUNTATOM	Returns the number of atoms of a specified element in a molecular formula.

ENGINEERING REFERENCE FUNCTIONS	
CONSTANT	Returns the value of the specified physical constant in the specified units.
STP	Returns the value of temperature, pressure, ideal molar volume, or ideal molar density at standard conditions, based on the units specified.
SATSTEAM	Returns temperature, pressure, specific volume, internal energy, enthalpy, or entropy for saturated steam, based any other of these properties.
SUPERSTEAM	Returns specific volume, internal energy, enthalpy, or entropy for super-heated steam, based on temperature and pressure.
Z	Returns the compressibility factor for a gas based on reduced temperature and pressure.
PIPESIZE	Returns inner diameter, outer diameter or internal area of a pipe of the specified size and schedule, in the specified units.
ROUGHNESS	Returns the absolute surface roughness of the specified material, for use in pressure drop calculations.
EQUIVALENGTH	Returns the length of pipe that would produce equivalent pressure drop to various standard pipe fittings.

DIMENSIONAL ANALYSIS FUNCTIONS	
DIMENSIONLESS	Uses dimensional analysis to construct and calculate the value of a dimensionless number based on the arguments specified.
DIMENSIONAL	Uses dimensional analysis to construct and calculate a result with the specified units.
UNITMATH	Returns the result of multiplying or dividing unit strings.
BASEUNITS	Returns the metric base units of a unit string.

PRESSURE DROP FUNCTIONS	
CVL	Liquid flow coefficient calculator. Calculates whichever value is not specified: Cv, volumetric flow rate, or pressure drop.
CVG	Gas flow coefficient calculator. Calculates whichever value is not specified: Cv, standard flow rate, or pressure drop for subcritical flow; and Cv, standard flow rate, or inlet pressure for critical flow.
HEADPRESSURE	Converts between pressure drop and head pressure.
PRESSUREDROP	Solves the Darcy-Weisbach equation to calculate head loss or pressure drop due to friction.

MORE ENGINEERING FUNCTIONS	
PPOWER	Calculates pump fluid power based on any dimensionally consistent combination of volume flow rate, mass flow rate, density, head, and pressure drop.
CPOWER	Calculates compressor power based on inlet pressure, outlet pressure, and either volume flow rate, or inlet temperature and molar flow rate. Optionally, heat capacity ratio can also be specified.
PIPEFLOW	Converts between flow rate and velocity in a pipe.
GASDENSITY	Returns the ideal mass density of the specified gas at the specified conditions.
LMTD	Returns the log mean temperature difference.
QUADRATIC	Uses the quadratic formula to find roots of quadratic equations of the form 0=a*x^2+b*x+c.

CONV function

This article describes the formula syntax and usage of the **CONV** function in Microsoft Excel.

Description

Converts a number from one measurement system to another. CONV accepts more than 150 unit distinct units, not including compound units which are also acceptable.

Syntax

```
CONV(number, from_unit, to_unit)
```

The CONV function syntax has the following arguments:

- **Number** Required. The value in from_units to convert.
- **From_unit** Required. The units for number.
- **To_unit** Required. The units for the result.

CONV accepts the following text values (in quotation marks) for from_unit and to_unit. Combinations of these units are also acceptable, ie. "ft3/s". See the 'Remarks' section for more information.

Mass	From_unit or To_unit
atomic mass unit	"u"
grain	"gr"
gram *	"g"
ounce	"oz"
pound	"lb"
slug	"slug"
short ton	"ton"
metric ton	"t"
Time	**From_unit or To_unit**
second *	"s"
minute	"min"
hour	"h"
day	"d"
week	"wk"
month	"mon"

year	"yr"
Quantity	**From_unit or To_unit**
gram mole *	"mol", "gmol"
elementary entities	"ee"
kilogram mole	"kgmol"
pound mole	"lbmol"
standard cubic foot	"scf"
standard cubic meter	"scm"
hundred standard cubic feet	"ccf"
thousand standard cubic feet	"Mcf", "mcf"
million standard cubic feet	"MMcf", "mmcf"
billion standard cubic feet	"Bcf"
standard liter	"sL"
standard cubic centimeter	"scc"

Quantity flow	From_unit or To_unit
standard liter per minute	"sLpm"
standard liter per hour	"sLph"
standard liter per day	"sLpd"
standard cubic centimeter per minute	"sccm"
standard cubic feet per minute	"scfm"
standard cubic feet per hour	"scfh"
standard cubic feet per day	"scfd"
thousand standard cubic feet per day	"Mcfd", "mcfd"
million standard cubic feet per day	"MMcfd", "mmcfd"
billion standard cubic feet per day	"Bcfd", "bcfd"

Temperature	From_unit or To_unit
kelvin	"K"
degree Celsius	"degC"
degree Rankine	"degR"
degree Fahrenheit	"degF"

Length	From_unit or To_unit
meter *	"m"
angstrom	"ang"
mil	"mil"
inch	"in"
foot	"ft"
yard	"yd"
nautical mile	"nmi"
mile	"mi"
fathom	"ftm"
Speed	**From_unit or To_unit**
mile per hour	"mph"
kilometer per hour	"kmph"
Area	**From_unit or To_unit**
acre	"acre"
hectare	"ha"

Volume	From_unit or To_unit
liter *	"L"
ounce	"floz"
quart	"qt"
gallon	"gal"
barrel	"bbl"
thousand barrels	"Mbbl"
million barrels	"MMbbl"
Volume rate	**From_unit or To_unit**
actual cubic feet per minute	"acfm"
gallons per minute	"gpm"
gallons per hour	"gph"
gallonds per day	"gpd"
Liters per minute	"Lpm"
Liters per hour	"Lph"
Liters per day	"Lpd"

Force	From_unit or To_unit
newton *	"N"
dyne	"dyn"
pound-force	"lbf"
kilogram-force	"kgf"
Energy	**From_unit or To_unit**
joule *	"J"
erg	"erg"
electron volt	"eV"
calorie	"cal"
British thermal unit	"Btu", "btu", "BTU"
kilocalorie	"kcal"
therm	"thm"
ton of refrigeration	"TR"
thousand British thermal units	"MBtu", "MBTU", "Mbtu"
million British thermal unit	"MMBtu", "MMBTU", "MMbtu"

Power	From_unit or To_unit
watt *	"W"
horse power	"hp", "Hp", "HP"
Pressure	**From_unit or To_unit**
pascal *	"Pa"
bar	"bar"
millimeter Hg	"mmHg"
cmHg	"cmHg"
torr	"torr"
foot water	"ftH2O"
inch water	"inH2O"
inch Hg	"inHg"
pound per square inch	"psi"
meter water	"mH2O"
kilogram per square centimeter	"kgcm2"
atmosphere	"atm"

Kinematic viscosity	From_unit or To_unit
stokes *	"St"
Dynamic viscosity	**From_unit or To_unit**
poise *	"P"
Angle	**From_unit or To_unit**
radian	"rad"
degree	"deg"
turn	"rev"
Electric potential	**From_unit or To_unit**
volt *	"V"
Electrical charge	**From_unit or To_unit**
coulomb *	"C"
Current	**From_unit or To_unit**
ampere *	"A"
Resistance	**From_unit or To_unit**
Ohm *	"Ohm"

Electrical capacitance	From_unit or To_unit
Farad	"F"
Electrical conductance	**From_unit or To_unit**
siemens	"S"
Magnetic flux	**From_unit or To_unit**
weber	"Wb"
Magnetic field strength	**From_unit or To_unit**
Tesla	"T"
Inductance	**From_unit or To_unit**
Henry	"H"
Luminous intensity	**From_unit or To_unit**
candle	"cd"
Luminous flux	**From_unit or To_unit**
lumen	"lm"
Illuminance	**From_unit or To_unit**
lux	"lx"

Radioactivity	From_unit or To_unit
Becquerel	"Bq"

Absorbed dose	From_unit or To_unit
gray	"Gy"

Equivalent dose	From_unit or To_unit
Sievert	"Sv"

Catalytic activity	From_unit or To_unit
katal	"kat"

Frequency	From_unit or To_unit
hertz	"Hz"

Gas permeability	From_unit or To_unit
barrer	"barrer"

The following abbreviated unit prefixes can be prepended to any metric unit, marked with an '*' above.

Prefix	Multiplier	Abbreviation
tera	1E+12	"T"
giga	1E+09	"G"
mega	1E+06	"M"
kilo	1E+03	"k"
hecto	1E+02	"h"
deci	1E-01	"d"
centi	1E-02	"c"
milli	1E-03	"m"
micro	1E-06	"u"
nano	1E-09	"n"
pico	1E-12	"p"
femto	1E-15	"f"
atto	1E-18	"a"

Remarks

- Exponents can be entered as digits after a unit, for example "m3" will be interpreted as cubic meters, and can be converted to any other combination of units that has the dimensions of volume.
- If the input data types are incorrect, the units do not exist, or the dimensions of the units do not match, CONV returns the #VALUE! error value.
- Order of operations is observed in compound units, for example "J/mol-K" is equivalent to "J-K/mol", not "J/(mol-K)".
- Unit names and prefixes are case-sensitive.
- Temperature differential conversions can be performed by the CONV function. Temperature scale conversions should use the TCONV function, for example converting a measured temperature.
- Pressure unit conversions can be performed by the CONV function, for example converting units for pressure drop. Gauge pressure conversions should use the PCONV function.
- Dashes or asterisks should be used to signify multiplication in compound units, ie. "N-m" or "N*m"
- A forward slash should be used to signify division in compound units, ie. "m/s"

Example

	A	B
1	**Formula**	**Description (Result)**
2	=CONV(1.0, "lb", "kg")	Converts 1 pound mass to kilograms (0.4536).
3	=CONV(5.0, "m3", "gal")	Converts 5 cubic meters to gallons (1321).
4	=CONV(8.314, "J/(mol-K)", "L-atm/(mol-K)")	Converts the ideal gas constant from J/(mol-K) to L-atm/(mol-K) (0.08208).
5	=CONV(3.2, "kg-m/s", "N")	Unit dimensions do not match, so an error is returned (#VALUE).
6	=CONV(140, "lb-(ft/s)2","J")	Converts 140 lb-(ft/s)2 to joules (5.900).

TCONV function

This article describes the formula syntax and usage of the **TCONV** function in Microsoft Excel.

Description

Converts a number from one temperature **scale** to another. This is distinguished from the CONV function, which can be used to convert temperature differentials, but not temperature scales.

Syntax

```
TCONV(number, from_unit, to_unit)
```

The TCONV function syntax has the following arguments:

- **Number** Required. The value in from_units to convert.
- **From_unit** Required. The units for number.
- **To_unit** Required. The units for the result.

TCONV accepts the following text values (in quotation marks) for from_unit and to_unit.

Temperature scale	From_unit or To_unit
Celsius	"degC"
Kelvin	"K"
Fahrenheit	"degF"
Rankine	"degR"

Remarks

- If the input data types are incorrect or the units do not exist, TCONV returns the #VALUE! error value.
- Unit names and prefixes are case-sensitive.

Example

	A	B
1	**Formula**	**Description (Result)**
2	=TCONV(0, "degC", "degF")	Converts 0 degC to degF (32).
3	=TCONV(298, "K", "degF")	Converts 298K to degF (76.73).
4	=CONV(0, "degC", "degF")	Converts a temperature differential of 0 degC to degF (0).

PCONV function

This article describes the formula syntax and usage of the **PCONV** function in Microsoft Excel.

Description

Converts a number from one pressure **scale** to another, and accepts gauge pressures as unit arguments. This is distinguished from the CONV function, which can be used to convert pressure differentials, but not gauge pressures.

Syntax

```
PCONV(number, from_unit, to_unit)
```

The PCONV function syntax has the following arguments:

- **Number** Required. The value in from_units to convert.
- **From_unit** Required. The units for number.
- **To_unit** Required. The units for the result.

PCONV accepts the following text values (in quotation marks) for from_unit and to_unit. Note that a 'g' or an 'a' can be entered after any of these units to signify gauge or absolute pressure, respectively.

Pressure scale	**From_unit or To_unit**
pascal *	"Pa"
bar *	"bar"
atmosphere	"atm"
inch water	"inH2O"
foot water	"ftH2O"
meter water	"mH2O"
milimeter mercury	"mmHg"
centimeter mercury	"cmHg"
inch mercury	"inHg"
torr	"torr"
kilogram per square centimeter	"kg_cm2"
pound per square inch	"psi"

Remarks

- Gauge pressures are based on the setpoint ambient pressure, which can be set through the ProcessUtilities user interface under 'Conditions'. Default is 14.7 psia.
- If the input data types are incorrect or the units do not exist, PCONV returns the #VALUE! error value.
- Unit names and prefixes are case-sensitive.

Example

	A	B
1	**Formula**	**Description (Result)**
2	=PCONV(0, "psig", "atm")	Converts 0 pounds per square inch gauge to atmospheres (1).
3	=PCONV(20, "psig", "bar(g)")	Converts 20 pounds per square inch gauge to bar gauge (1.379).

MCONV function

This article describes the formula syntax and usage of the **MCONV** function in Microsoft Excel.

Description

Converts a quantity of a specified compound from mass to moles or standard volume, or vice versa. Mass, mole or standard volume flow rates are also acceptable arguments.

$$m = MW \cdot \frac{pV}{RT}$$

Syntax

```
MCONV(fomrula, number, from_unit, to_unit)
```

The MCONV function syntax has the following arguments:

- **Formula** Required. The chemical formula of the compound.
- **Number** Required. The value in from_units to convert.
- **From_unit** Required. The units for number.
- **To_unit** Required. The units for the result.

MCONV accepts any chemical formula that meets the requirements described under the section for the **MW** function. It will likewise accept any combination of units as described under the section for the **CONV** function, as long as the dimensions of From_units/To_units can be simplified to Mass/Quantity or Quantity/Mass.

Remarks

- If the input data types are incorrect or the units do not exist, MCONV returns the #VALUE! error value.
- Unit names and prefixes are case-sensitive.

Example

	A	B
1	**Formula**	**Description (Result)**
2	=MCONV("O2", 12, "g", "sL")	Converts 12 grams of oxygen to standard liters (8.864).
3	=MCONV("H2S",15,"Mcfd","lb/d")	Converts 15 million standard cubic feet of H2S to pounds per day (1350).

VCONV function

This article describes the formula syntax and usage of the **VCONV** function in Microsoft Excel.

Description

Converts a value from actual volume to moles or standard volume, or vica versa. Mole, standard volume and actual volume flow rates are also acceptable arguements.

$$V = \frac{nRT}{p}$$

Syntax

VCONV(temperature, temperature_units, pressure, pressure_units, number, from_unit, to_unit)

The VCONV function syntax has the following arguments:

- **temperature** Required. Temperature of gas.
- **temperature_units** Required. Units for temperature.
- **pressure** Required. Pressure of gas.
- **pressure_units** Required. Units for pressure.
- **Number** Required. The value in from_units to convert.
- **From_unit** Required. The units for number.
- **To_unit** Required. The units for the result.

VCONV will accept any combination of units as described under the section for the **CONV** function, as long as the dimensions of From_units/To_units can be simplified to Volume/Quantity or Quantity/Volume.

Remarks

- If the input data types are incorrect or the units do not exist, VCONV returns the #VALUE! error value.
- Unit names and prefixes are case-sensitive.

Example

	A	B
1	**Formula**	**Description (Result)**
2	=VCONV(70, "degC", 20, "psig", 100, "ft3", "mol")	Returns the number of moles in 100 cubic feet of gas at 70degC and 20psig (237.4).
3	=VCONV(30, "degC", 8, "bar", 220,"Mcfd","m3/h")	Converts 220 million standard cubic feet per day to cubic meters per hour at 30degC and 8 bar (34.52).

MW function

This article describes the formula syntax and usage of the **MW** function in Microsoft Excel.

Description

Returns the molecular weight of the compound with the specified molecular formula. Units other than "g/mol" can be specified if desired.

Syntax

```
MW(formula, [units])
```

The MW function syntax has the following arguments:

- **Formula** Required. The molecular formula of the compound.
- **Units** Optional. The desired units for the molecular weight. Default is "g/mol".

MW accepts the following text values (in quotation marks) for formula.

Atomic no.	Name	Symbol
1	Hydrogen	H
2	Helium	He
3	Lithium	Li
4	Beryllium	Be
5	Boron	B

Atomic no.	Name	Symbol
6	Carbon	C
7	Nitrogen	N
8	Oxygen	O
9	Fluorine	F
10	Neon	Ne
11	Sodium	Na
12	Magnesium	Mg
13	Aluminium	Al
14	Silicon	Si
15	Phosphorus	P
16	Sulfur	S
17	Chlorine	Cl
18	Argon	Ar
19	Potassium	K
20	Calcium	Ca

Atomic no.	Name	Symbol
21	Scandium	Sc
22	Titanium	Ti
23	Vanadium	V
24	Chromium	Cr
25	Manganese	Mn
26	Iron	Fe
27	Cobalt	Co
28	Nickel	Ni
29	Copper	Cu
30	Zinc	Zn
31	Gallium	Ga
32	Germanium	Ge
33	Arsenic	As
34	Selenium	Se
35	Bromine	Br

Atomic no.	Name	Symbol
36	Krypton	Kr
37	Rubidium	Rb
38	Strontium	Sr
39	Yttrium	Y
40	Zirconium	Zr
41	Niobium	Nb
42	Molybdenum	Mo
43	Technetium	Tc
44	Ruthenium	Ru
45	Rhodium	Rh
46	Palladium	Pd
47	Silver	Ag
48	Cadmium	Cd
49	Indium	In
50	Tin	Sn

Atomic no.	Name	Symbol
51	Antimony	Sb
52	Tellurium	Te
53	Iodine	I
54	Xenon	Xe
55	Caesium	Cs
56	Barium	Ba
57	Lanthanum	La
58	Cerium	Ce
59	Praseodymium	Pr
60	Neodymium	Nd
61	Promethium	Pm
62	Samarium	Sm
63	Europium	Eu
64	Gadolinium	Gd
65	Terbium	Tb

Atomic no.	Name	Symbol
66	Dysprosium	Dy
67	Holmium	Ho
68	Erbium	Er
69	Thulium	Tm
70	Ytterbium	Yb
71	Lutetium	Lu
72	Hafnium	Hf
73	Tantalum	Ta
74	Tungsten	W
75	Rhenium	Re
76	Osmium	Os
77	Iridium	Ir
78	Platinum	Pt
79	Gold	Au
80	Mercury	Hg

Atomic no.	Name	Symbol
81	Thallium	Tl
82	Lead	Pb
83	Bismuth	Bi
84	Polonium	Po
85	Astatine	At
86	Radon	Rn
87	Francium	Fr
88	Radium	Ra
89	Actinium	Ac
90	Thorium	Th
91	Protactinium	Pa
92	Uranium	U
93	Neptunium	Np
94	Plutonium	Pu
95	Americium	Am

Atomic no.	Name	Symbol
96	Curium	Cm
97	Berkelium	Bk
98	Californium	Cf
99	Einsteinium	Es
100	Fermium	Fm
101	Mendelevium	Md
102	Nobelium	No
103	Lawrencium	Lr
104	Rutherfordium	Rf
105	Dubnium	Db
106	Seaborgium	Sg
107	Bohrium	Bh
108	Hassium	Hs
109	Meitnerium	Mt
110	Darmstadtium	Ds

Atomic no.	Name	Symbol
111	Roentgenium	Rg
112	Copernicium	Cn
113	Ununtrium	Uut
114	Flerovium	Fl
115	Ununpentium	Uup
116	Livermorium	Lv
117	Ununseptium	Uus
118	Ununoctium	Uuo

Organic group symbols:

Name	Symbol	Formula
Acetyl	AC	C2H3O
Benzoyl	Bz	C6H5CO
Benzyl	Bn	C6H5C2
Butyl	Bu	C4H9

Name	Symbol	Formula
Cyclopentadienyl	Cp	C5H5
Cyclohexyl	Cy	C6H11
Ethyl	Et	C2H5
Methyl	Me	CH3
Mesyl	Ms	CH3SO2
Phenyl	Ph	C6H5
Propyl	Pr	C3H7
Triflyl	Tf	F3CSO2
Trityl	Tr	Ph3C
Tosyl	Ts	CH3C6H4SO2

Remarks

- If the input data types are incorrect, do not exist, or units are of the wrong dimensions, MW will return #VALUE! error.
- Formulas and prefixes are case-sensitive.
- Hydrate and similar formulas are acceptable, see example 3 below.
- See 'Remarks' section for CONV function regarding acceptable units arguments.
- Source: IUPAC

Example

	A	B
1	**Formula**	**Description (Result)**
2	=MW("Na2SO4")	Returns the molecular weight of sodium sulfate in units of g/mol (142.0...).
3	=MW("(CH3)3N","lb/kmol")	Returns the molecular weight of trimethylamine in units of lb/kmol (130.3...).
4	=MW("Na2SO4-10H2O")	Returns the molecular weight of sodium sulfate decahydrate in units of g/mol (322.2...).

COUNTATOM function

This article describes the formula syntax and usage of the **COUNTATOM** function in Microsoft Excel.

Description

Returns the number of atoms of the specified element in a compound of the specified molecular formula.

Syntax

```
COUNTATOM(formula, symbol)
```

The COUNTATOM function syntax has the following arguments:

- **Formula** Required. The molecular formula of the compound.
- **Symbol** Required. The symbol for the element to be counted.

COUNTATOM accepts them same symbols as arguments as the MW function.

Remarks

- If the input data types are incorrect or do not exist, COUNTATOM will return #VALUE! error.
- Formulas and prefixes are case-sensitive.
- Hydrate and similar formulas are allowed - see example 3 below.

Example

	A	B
1	**Formula**	**Description (Result)**
2	=COUNTATOM("Na2SO4","Na")	Returns the number of sodium atoms in a molecule of sodium sulfate (2).
3	=COUNTATOM("(CH3)3N","H")	Returns the number of hydrogen atoms in a molecule of trimethylamine (9).
4	=COUNTATOM("Na2SO4-10H2O","O")	Returns the number of oxygen atoms in sodium sulfate decahdyrate (14).

CONSTANT function

This article describes the formula syntax and usage of the **CONSTANT** function in Microsoft Excel.

Description

Returns the value of a specified physical constant in the units specified.

Syntax

```
CONSTANT(Symbol, Units)
```

The CONSTANT function syntax has the following arguments:

- **Symbol** Required. The symbol or name of the constant.
- **Units** Required. The desired units for the constant.

CONSTANT accepts the following text values (in quotation marks) for symbol, and requires text values for units to be of the following dimensions.

NAME	SYMBOL	VALUE	UNIT DIMENSIONS
Molar gas constant	R	8.3144321	J/(mol-K)
Faraday constant	F	96,485	C/mol
Avagadro's number	Na	6.022 E23	1/mol
Acceleration due to gravity	g	9.80665	m/s2
Newtonian constant of gravitation	G	6.67384 E-11	m3/(kg-s2)
Speed of light	c	2.99776 E8	m/s
Boltzmann constant	k	1.38065 E-23	J/K
Plank constant	h	6.62607 E-34	J-s
Elementary charge	e	1.602176565 E-19	C
Electron mass	me	9.10938291 E-31	kg
Proton mass	mp	1.672621777 E-27	kg

Remarks

- If the input data types are incorrect, do not exist, or units are of the wrong dimensions, CONSTANT will return #VALUE! error.
- Unit names and prefixes are case-sensitive.
- See 'Remarks' section of CONV function regarding acceptable units arguments.

Example

	A	B
1	**Formula**	**Description (Result)**
2	=CONSTANT("R", "J/(mol-K)")	Returns the value of the ideal gas constant in units of J/(mol-K) (8.314...).
3	=CONSTANT("R","ft3-mmHg/(lbmol-degR)")	Returns the value of the ideal gas constant in units of ft3-mmHg/(lbmol-degR) (554.9...).
4	=CONSTANT("R","J/mol-K")	Unit dimensions are incorrect due to order of operations, returns an error (#VALUE!).

STP function

This article describes the formula syntax and usage of the **STP** function in Microsoft Excel.

Description

Returns the value of temperature, pressure, ideal molar volume, or ideal molar density at standard conditions, based on the units specified. Standard temperature and pressure can be set through the ProcessUtilities user interface. Default is 15 degC and 14.7 psia.

Syntax

```
STP(units)
```

The STP function syntax has the following arguments:

- **Units** Required. The desired units for the result.

Remarks

- If the input data types are incorrect or the units do not exist, STP returns the #VALUE! error value.
- Unit names and prefixes are case-sensitive.

Example

	A	B
1	**Formula**	**Description (Result)**
2	=STP("psi")	Returns the value for standard pressure in psi (14.7).
3	=STP("psig")	Returns the value for standard pressure in psi gauge (0).
4	=STP("degF")	Returns the value for standard temperature in Farenheit (59.0).
5	=STP("ft3/lbmol")	Returns the ideal molar volume of standard conditions in cubic feet per pound-mol (379).

SATSTEAM function

This article describes the formula syntax and usage of the **SATSTEAM** function in Microsoft Excel.

Description

Returns temperature, pressure, specific volume, internal energy, enthalpy, or entropy for saturated steam, based any other of these properties.

Syntax

```
SATSTEAM(input_property, input_value, input_unit, result_property, result_unit)
```

The SATSTEAM function syntax has the following arguments:

- **Input_property** Required. The property supplied as input. See below for acceptable arguments.
- **Input_value** Required. The value of Input_property.
- **Input_units** Required. The units for Input_value.
- **Result_property** Required. The property desired as a result. See below for acceptable arguments.
- **Result_units** Required. The units for the result.

SATSTEAM accepts the following case-insensitive text values (in quotation marks) for Input_property and Result_property.

Property	Symbol; Dimensions
Temperature	"T"
Pressure	"P"
Specific volume	"vf", "vg"; volume/mass
Internal energy	"uf", "ug*"; energy/mass
Enthalpy	"hf", "hfg", "hg*"; energy/mass
Entropy	"sf", "sfg", "sg"; energy/(mass*temperature)

Remarks

- Gas internal energy "ug" and gas enthalpy "hg" are acceptable as Result_property arguments but not Input_property arguments.
- If the input data types or units are incorrect, SATSTEAM returns the #VALUE! error value.
- Unit names and prefixes are case-sensitive.
- In the property names, a suffix of 'f' indicates the liquid phase, 'g' indicates the gas phase, and 'fg' indicates the difference between the liquid and gas phases.
- Source: NIST

Example

	A	B
1	**Formula**	**Description (Result)**
2	=SATSTEAM("T", 150, "degC", "P", "psig")	Returns the pressure in psig of saturated steam at a temperature of 150degC (54.4).
3	=SATSTEAM("P", 6.5, "bar", "hf", "Btu/lb")	Returns the liquid phase enthalpy in Btu/lb of saturated steam at a pressure of 6.5 bar (294).
4	=SATSTEAM("vf",1.2,"cm3/g","T","degF")	Returns the temperature in degF of saturated steam with a liquid phase specific volume 1.2 cm3/g (437).

SUPERSTEAM function

This article describes the formula syntax and usage of the **SUPERSTEAM** function in Microsoft Excel.

Description

Returns specific volume, internal energy, enthalpy, or entropy for super heated steam, based on temperature and pressure.

Syntax

```
SUPERSTEAM(temperature, temperature_unit, pressure, pressure_unit, result_property, result_unit)
```

The SUPERSTEAM function syntax has the following arguments:

- **Temperature** Required. Temperature of the superheated steam.
- **Temperature_unit** Required. Units for Temperature.
- **Pressure** Required. Pressure of the superheated steam.
- **Pressure_unit** Required. Units for Pressure.
- **Result_property** Required. Desired result property. See below for options.
- **Result_unit** Required. The units for the result.

SUPERSTEAM accepts the following case-insensitive text values (in quotation marks) for Result_property.

Property	Symbol; Dimensions
Specific volume	"v"; volume/mass
Internal energy	"u"; energy/mass
Enthalpy	"h"; energy/mass
Entropy	"s"; energy/(mass*temperature)

Remarks

- If the input data types or units are incorrect, SUPERSTEAM returns the #VALUE! error value.
- Unit names and prefixes are case-sensitive.
- Temperature/Temperature_units and Pressure/Pressure_units can be entered in either order, as long as they are before Result_property/Result_units.
- If the temperature and pressure specified does not corresponded to steam in a superheated state, or is out of the range of the database, SUPERSTEAM will return a #VALUE! error.

Example

	A	B
1	**Formula**	**Description (Result)**
2	=SUPERSTEAM(150, "degC", 1, "atm", "u", "Btu/lb")	Returns the internal energy in Btu/lb, for superheated steam at 150degC and 1 atm (1111).
3	=SUPERSTEAM(100, "psig", 350, "degF", "v", "gal/lb")	Returns the specific volume in gal/lb, of steam at 100 psig and 350degF (29.8).
4	=SUPERSTEAM(100, "psig", 250, "degF", "h", "kg/kJ")	Returns the #VALUE! error - 250 degF is below the saturation temperature for 100 psig steam.

Z function

This article describes the formula syntax and usage of the **Z** function in Microsoft Excel.

Description

Returns the compressibility factor for a gas based on reduced temperature and pressure.

Syntax

```
Z(reduced_temperature, reduced_pressure)
```

The Z function syntax has the following arguments:

- **Reduced_temperature** Required. The reduced temperature for the gas (actual temperature/critical temperature).
- **Reduced_pressure** Required. The reduced pressure for the gas (actual pressure/critical pressure).

Remarks

- Based on linear interpolation of the Nelson-Obert Generalized Compressibility Charts. Accuracy of charts is reported to be 1-2% for Z values greater than 0.6, and 4-6% for Z values 0.3-0.6. Strongly polar gases may have more error. Unit names and prefixes are case-sensitive.
- For most gases, reduced pressure is defined as actual temprature divided by critical temperature, and reduced pressure is defined as actual pressure divided by critical pressure.
- For the gases hydrogen, helium, and neon, reduced temperature is defined as Tr = T/(Tc+8), and reduced pressure is defined as Pr = P/(Pc+8).
- If the reduced temperature or reduced pressure specified are outside the range of the charts, Z will return a #VALUE! error.

Example

	A	B
1	**Formula**	**Description (Result)**
2	=Z(2.25, 1.1)	Returns the compressibility factor for gas at a reduced temperature of 2.25 and a reduced pressure of 1.1 (0.988).
3	=Z(1.025, 0.45)	Returns the compressibility factor for gas at a reduced temperature of 1.025 and a reduced pressure of 0.45 (0.844).
4	=Z(6.5, 4.3)	Returns the #VALUE! error – the reduced temperature and reduced pressure specified are out of the range of the Nelson-Obert Charts.

PIPESIZE function

This article describes the formula syntax and usage of the **PIPESIZE** function in Microsoft Excel.

Description

Returns the inner diameter, outer diameter or transverse inner area for a NPS pipe of the specified size and schedule.

Syntax

```
PIPESIZE(pipe_size, dimension, units)
```

The PIPESIZE function syntax has the following arguments:

- **pipe_size** Required. The pipe size and schedule, in quotes. ie. "1.5in Sch80"
- **dimension** Required. The dimension desired - ID, OD, A.
- **units** Required. The desired units for the result.

Remarks

- Pipe_size should be entered as a string including both NPS size and schedule. Acceptable arguments include: "1.5" Sch80", "0.5inch SCH40"
- If the input data types are incorrect or the units do not exist, PIPESIZE returns the #VALUE! error value.
- Unit names and prefixes are case-sensitive.

Example

	A	B
1	**Formula**	**Description (Result)**
2	=PIPESIZE("4in Sch 40", "ID", "in")	Returns the inner diameter of 4 inch schedule 40 pipe in inches (4.026).
3	=PIPESIZE("0.5inch SCH80", "A", "cm2")	Returns the inner area of a 0.5 inch schedule 80 pipe in square centimeters (1.510).

ROUGHNESS function

This article describes the formula syntax and usage of the **ROUGHNESS** function in Microsoft Excel.

Description

Returns the absolute surface roughness of the specified material, for use in pressure drop calculations.

Syntax

```
ROUGHNESS(material, unit)
```

The ROUGHNESS function syntax has the following arguments:

- **Material** Required. The type of material. See below for options.
- **Unit** Required. Units for the result in dimensions of length.

ROUGHNESS accepts the following case case-insensitive text values for fitting type.

Material	Notes
Drawn tubing	brass, lead, glass, steal, etc.
Plastic pipe	
Commercial steel	
Wrought iron	
Asphalted cast iron	
Galvanized iron	
Cast iron	
Wood stove	
Concrete	
Riveted steel	

Remarks

- If the input data types or units are incorrect, ROUGHNESS returns the #VALUE! error value.
- Unit names and prefixes are case-sensitive.
- Data source: Perry's 6-10, GPSA Handbook

Example

	A	B
1	**Formula**	**Description (Result)**
2	=ROUGHNESS("Drawn tubing", "in")	Returns the absolute roughness of drawn tubing in inches (5.98E-05).
3	=ROUGHNESS("Commercial steel", "ft")	Returns the absolute roughness of commercial steel pipe in ft (1.50E-04).

EQUIVALENTLENGTH function

This article describes the formula syntax and usage of the **EQUIVALENTLENGTH** function in Microsoft Excel.

Description

Returns the length of pipe that would produce an equivalent pressure drop to various standard pipe fittings.

Syntax

```
EQUIVALENTLENGTH(fitting_type, diameter, diameter_unit, unit)
```

The EQUIVALENTLENGTH function syntax has the following arguments:

- **Fitting_type** Required. Fitting type. See below for options.
- **Diameter** Required. Inner diameter of fitting pipe size.
- **Diameter_unit** Required. Units for Diameter.
- **Unit** Required. Units for the result in dimensions of length.

EQUIVALENTLENGTH accepts the following case-insensitive text values for fitting type.

Fitting type	Notes
Ball valve, small	Reduced bore, 1.5" and smaller
Ball valve, large	reduced bore, 2" and larger
Gate valve	standard bore
Gate valve, reduced bore	
Globe valve	Straight pattern
Globe valve, Y	Y pattern
Globe valve, angle	Angle pattern
Check valve, swing	
Check valve, ball	1.5" and smaller
Check valve, piston	1.5" and smaller
Plug valve	
Butterfly valve	6" and larger
Tee, straight	
Tee, branch	

Fitting type	Notes
Elbow, 90	R = 1.5D
Elbow, 45	R = 1.5D
Bend, 90, 4D	R = 4D
Bend, 45, 5D	R = 5D
Bend, 90, 4D	R = 4D
Bend, 45, 5D	R = 5D
Strainer	Pump suction Y type and bucket type
Nozzle	Suction nozzle vessel/tank

Remarks

- If the input data types or units are incorrect, EQUIVALENTLENGTH returns the #VALUE! error value.
- Unit names and prefixes are case-sensitive.
- Data source: GPSA handbook

Example

	A	B
1	**Formula**	**Description (Result)**
2	=EQUIVALENTLENGTH("Plug valve", 2, "in", "ft")	Returns the equivalent length in feet of a standard plug valve on a 2" ID line (7.5).
3	=EQUIVALENTLENGTH("Tee, straight", 4, "in", "in")	Returns the equivalent length in inches of a straight tee on a 4" ID line (80).

DIMENSIONLESS function

This article describes the formula syntax and usage of the **DIMENSIONLESS** function in Microsoft Excel.

Description

Uses dimensional analysis to construct and calculate the value of a dimensionless number based on the arguments specified. Value/unit pairs can be entered in any order, given that all numerator value/unit pairs are entered before all denominator pairs.

Syntax

```
DIMENSIONLESS(value1, units1, value2, units2, [value3], [units3]...)
```

The DIMENSIONLESS function syntax has the following arguments:

- **Value1** Required. The first value.
- **Units1** Required. The units for Value1.
- **Value2** Required. The second value.
- **Units2** Required. The units for Value2.
- **Value3** Optional. The third value.
- **Units3** Optional. The units for Value3.

Remarks

- See entry for the CONV function regarding acceptable units arguments.
- If the input data types are incorrect, the units do not exist, or a dimensionless number cannot be constructed from the arguments, DIMENSIONLESS returns the #VALUE! error value.
- Dimensionsless numbers that can be calculated include Re, Pr, Nu, Sh, Ma, Sc, Fo, La, Kn, and others.
- Dimensionless can accept up to six value/units pairs as arguments.

Example

	A	B
1	**Formula**	**Description (Result)**
2	=DIMENSIONLESS(1,"g/cm3",15,"ft/s","2.05","in",0.836,"cP")	Returns the value of Reynolds number, based on density, velocity, diameter, and viscosity (2.84E05).
3	=DIMENSIONLESS(0.93,"cP", 1.2, "Btu/(lb-degF)", 0.172,"Btu-in/(h-ft2-degF)")	Returns the value of Prandtl number, based on viscosity, heat capacity, and thermal conductivity (188)
4	=DIMENSIONLESS(1,"g/cm3",15,"ft/s",0.836,"cP","2.05","in")	Returns an error. The correct parameters are specified for Reynolds number; however, the denominator arguments for viscosity are entered before the numerator arguments for diameter(#VALUE!).

DIMENSIONAL function

This article describes the formula syntax and usage of the **DIMENSIONAL** function in Microsoft Excel.

Description

Uses dimensional analysis to construct and calculate a result with the specified units. Value/unit pairs can be entered in any order, given that all numerator value/unit pairs are entered before all denominator pairs.

Syntax

```
DIMENSIONAL(units, value1, units1, value2, units2, [value3], [units3]...)
```

The DIMENSIONAL function syntax has the following arguments:

- **Units** Required. The units for the result.
- **Value1** Required. The first value.
- **Units1** Required. The units for Value1.
- **Value2** Required. The second value.
- **Units2** Required. The units for Value2.
- **Value3** Optional. The third value.
- **Units3** Optional. The units for Value3.

Remarks

- See entry for the CONV function regarding acceptable units arguments.
- If the input data types are incorrect, the units do not exist, or a number with the specified dimensions cannot be constructed from the arguments, DIMENSIONLESS returns the #VALUE! error value.
- Dimensionless can accept up to six value/units pairs as arguments.
- Only multiplication and division operations are supported.
- Values with the units 'degC' and 'degF' are considered as temperature differentials. Units of 'K' or 'degR' should be used where absolute temperature is needed.

Example

	A	B
1	**Formula**	**Description (Result)**
2	=DIMENSIONAL("kW",142,"lb/h",4.18,"kJ/(kg-degC)",35,"degF")	Implements the equation 'Q=m*Cp*dT', to calculate the amount of energy in kilowatts required to heat 142 lb/h of water 35degF (1.45).
3	=DIMENSIONAL("d",2.5,"gal", 10,"mL/min")	Implements the equation "Residence time = V/F', to calculate the residence time in hours for a vessel with a capacity of 2.5 gallons at a flow rate of 10 mL/min (0.657).
4	=DIMENSIONAL("degF", 1.45, "kW", 4.18, "kJ/(kg-degC)", 142, "lb/h")	Implements the equation 'm=Q/(m*Cp*dT)', to calculate the temperature change in degF for a 142 lb/h water stream after the addition of 1.45kW of heat (35).

UNITMATH function

This article describes the formula syntax and usage of the **UNITMATH** function in Microsoft Excel.

Description

Returns the product of one to six unit strings, raised to the specified exponents and simplified.

Syntax

```
UNITMATH(units1, [exp1], [units2], [exp2], [units3], [exp3]...)
```

The UNITMATH function syntax has the following arguments:

- **Units1** Required. The first unit string to be considered.
- **Exp1** Optional. The exponent associated with units1.
- **Units2** Optional. The second unit string to be considered.
- **Exp2** Optional. The exponent associated with units2.
- **Units3** Optional. The third unit string to be considered.
- **Exp3** Optional. The exponent associated with units3.

UNITMATH returns the following unit symbols for each dimension.

Dimension	Unit	Symbol
Time	second	"s"
Length	meter	"m"
Mass	kilogram	"kg"
Electric current	ampere	"A"
Temperature	kelvin	"K"
Luminous intensity	candela	"cd"
Amount of substance	mole	"mol"

Remarks

- See entry for the CONV function regarding acceptable units arguments.
- If the input data types are incorrect or the units do not exist, UNITMATH returns the #VALUE! error value.
- Division of unit strings can be performed by specifying negative exponents.
- UnitMath can accept up to six string/exponent pairs as arguments.

Example

	A	B
1	**Formula**	**Description (Result)**
2	=UNITMATH("m2",1,"m/s",1)	Returns the product of square meters and meters per second (m3/s).
3	=UNITMATH("gal",1,"gal/s",-1)	Returns the quotient of gallons and gallons per second (s).
4	=UNITMATH("m2",1,"ft/s",1)	Returns the product of square meters and feet per second (ft-m2/s).
5	=UNITMATH("atm","mi")	Second argument must be exp1 (a number), returns #VALUE! error.

BASEUNITS function

This article describes the formula syntax and usage of the **BASEUNITS** function in Microsoft Excel.

Description

Returns the metric base units of a unit string.

Syntax

```
BASEUNITS(units)
```

The BASEUNITS function syntax has the following arguments:

- **Units** Required. The unit string to be simplified.

BASEUNITS returns the following unit symbols for each dimension.

Dimension	Unit	Symbol
Time	second	"s"
Length	meter	"m"
Mass	kilogram	"kg"
Electric current	ampere	"A"
Temperature	kelvin	"K"
Luminous intensity	candela	"cd"
Amount of substance	mole	"mol"

Remarks

- See entry for the CONV function regarding acceptable units arguments.
- If the input data types are incorrect or the units do not exist, BASEUNITS returns the #VALUE! error value.

Example

	A	B
1	**Formula**	**Description (Result)**
2	=BASEUNITS("L-atm/(mol-K)")	Returns base units for the molar gas constant (m2-kg/(mol-s2)).
3	=BASEUNITS("erg")	Returns base units for the erg (m2-kg/s2).

CVL function

This article describes the formula syntax and usage of the **CVL** function in Microsoft Excel.

Description

Liquid flow coefficient calculator. Calculates whichever value is not specified of Cv, flow rate, and pressure drop, according to the equation:

$$\dot{V} = Constant \cdot C_v \sqrt{\frac{\Delta p}{SG}}$$

Syntax

To calculate Cv:

CVL(volume_rate, volume_rate_units, spec_gravity, pressure_drop, pressure_drop_units)

To calculate pressure drop:

CVL(units, volume_rate, volume_rate_units, spec_gravity, Cv)

To calculate volume flow rate:

CVL(units, spec_gravity pressure_drop, pressure_drop_units, Cv)

The CVL function syntax has the following arguments:

- **Units** Units for result.
- **Volume_rate** The volume flow rate of the fluid.
- **Volume_rate_unit** The units for Volume_rate.
- **Spec_gravity** The specific gravity of the fluid, relative to water.
- **Pressure_drop** The pressure drop.
- **Pressure_drop_unit** The units for Pressure_drop.
- **Cv** The flow coefficient.

Remarks

- Value/unit argument pairs can be entered in any order, with the following exception: if both Cv and SG are specified as arguments, SG must be specified first.
- Flow coefficient and specific gravity are considered dimensionless for the purposes of this function.
- If the input data types are incorrect, or the equation specified has no real roots, CVL returns the #VALUE! error value.
- See documentation for the CONV function regarding acceptable unit arguments.

Example

	A	B
1	**Formula**	**Description (Result)**
2	=CVL(34, "gpm", 12, "psi", 0.86)	Returns the Cv of a valve or fitting that would result in a 12 psi pressure drop at a flow rate of 34gpm and specific gravity of 0.86 (9.10).
3	=CVL("kPa", 0.95, 2.8, "gpm", 0.5)	Returns the pressure drop in kilopascals for 2.8 gpm of a 0.95 specific gravity fluid passing through a valve or fitting with a Cv of 0.5 (205).

CVG function

This article describes the formula syntax and usage of the **CVG** function in Microsoft Excel.

Description

Gas flow coefficient calculator. Calculates whichever value is not specified: Cv, standard flow rate, or pressure drop for subcritical flow; and Cv, flow rate, or inlet pressure for critical flow.

$$\dot{n} = Constant \cdot C_v \cdot p_1 \left(1 - \frac{2\Delta p}{3p_1}\right) \sqrt{\frac{\Delta p}{p_1 \cdot SG \cdot T_1}} \quad , \; p_2 > 0.53 \; p_1$$

$$\dot{n} = Constant \cdot C_v \cdot p_1 \sqrt{\frac{1}{SG \cdot T_1}} \quad , \; p_2 < 0.53 \; p_1$$

Syntax

To calculate standard volume or molar flow rate for subcritical or critical flow:

CVG(unit, P_in, P_in_unit, P_out, P_out_unit, SG, T, T_unit, Cv)

To calculate standard volume or molar flow rate for critical flow:

CVG(unit, P_in, P_in_unit, SG, T, T_unit, Cv)

To calculate Cv for subcritical or critical flow:

CVG(Q, Q_unit, P_in, P_in_unit, P_out, P_out_unit, SG, T, T_unit)

To calculate Cv for critical flow:

CVG(Q, Q_unit, P_in, P_in_unit, SG, T, T_unit)

To calculate pressure drop for subcritical flow:

```
CVG(unit, Q, Q_unit, P_in, P_in_unit, SG, T, T_unit, Cv)
```

To calculate inlet pressure for critical flow:

```
CVG(unit, Q, Q_unit, SG, T, T_unit, Cv)
```

The CVG function syntax has the following arguments:

- **Units** Units for result.
- **Q** The molar or standard volume flow rate of the gas.
- **Q_unit** The units for Q.
- **P_in** The inlet pressure.
- **P_in_unit** The units for P_in.
- **P_out** The outlet pressure.
- **P_out_unit** The units for P_out.
- **SG** The specific gravity of the fluid, relative to water.
- **T** The inlet pressure.
- **T-unit** The units for T.
- **Cv** The flow coefficient.

Remarks

- Flow is assumed to be critical if the down stream pressure is less than one half of the upstream pressure.
- Value/unit argument pairs can be entered in any order, with the following exception: if both Cv and SG are specified as arguments, SG must be specified first.
- Flow coefficient and specific gravity are considered dimensionless for the purposes of this function.
- If the input data types are incorrect, or the equation specified has no real roots, CVG returns the #VALUE! error value.
- See documentation for the CONV function regarding acceptable unit arguments.

Example

	A	B
1	**Formula**	**Description (Result)**
2	=CVG(120, "scfm", 80, "psig", 60, "psig", 55, "degF", 1)	Returns the flow coefficient for a valve or fitting where the gas flow rate is 120 scfm, upstream pressure is 80 psig, downstream pressure is 60 psig, upstream temperature is 55 degF, and specific gravity is 1 (3.21).
3	=CVG("psi", 125, "Mcfd", 220, "psig", 0.86, 95, "degF", 5)	Returns pressure drop in psi for a fitting with a Cv of 5, when 125 Mcfd of gas with an upstream pressure of 220 psig, upstream temperature of 95 degF, and specific gravity of 0.86 (1.200).

HEADPRESSURE function

This article describes the formula syntax and usage of the **HEADPRESSURE** function in Microsoft Excel.

Description

Converts between pressure drop and head pressure, according the equation:

$$\Delta p = \rho \cdot g \cdot h_f$$

Syntax

To calculate head:

```
HEADPRESSURE(unit, density, density_unit, pressure, pressure_unit)
```

To calculate pressure:

```
HEADPRESSURE(unit, density, density_unit, head, head_unit)
```

The HEADPRESSURE function syntax has the following arguments:

- **Unit** Required. Units for result.
- **Density** Required. Density of fluid.
- **Density_unit** Required. Units for density.
- **Pressure** The value for fluid pressure.
- **Pressure_unit** Units for Pressure.
- **Head** The head pressure.
- **Head_unit** Units for Head.

Remarks

- If the input data types or units are incorrect, HEADPRESSURE returns the #VALUE! error value.
- Unit names and prefixes are case-sensitive.
- Gauge pressures are not acceptable arguments.
- Pressure and density value/unit pairs can be entered in either order.

Example

	A	B
1	**Formula**	**Description (Result)**
2	=HEADPRESSURE("ft", "50", "psi", 1, "g/cm3")	Converts 50 psi to feet of head for a fluid with a density of 1 g/cm3 (115).
3	=HEADPRESSURE("bar", 6, "lb/gal", 12, "m")	Converts 12 meters of head to pressure in bar for a substance with a density of 6 lb/gal (0.846).

PRESSUREDROP function

This article describes the formula syntax and usage of the **PRESSUREDROP** function in Microsoft Excel.

Description

Implements the Darcy-Weisbach equation to calculate head loss or pressure drop due to friction.

$$h_f = f_d \cdot \frac{L}{D} \cdot \frac{u^2}{2g}$$

$$f = \frac{64}{Re} \text{ , } laminar \ \ flow$$

$$\frac{1}{\sqrt{f}} = -2log_{10}\left(\frac{\varepsilon}{3.7D_h} + \frac{2.51}{Re\sqrt{f}} \right) \text{ , } turbulent \ \ flow$$

Syntax

PRESSUREDROP(unit, D, D_unit, L, L_unit, R, R_unit, Q, Q_unit, visc, visc_unit, dens, dens_unit)

The PRESSUREDROP function syntax has the following arguments:

- **Unit** Units for result.
- **D** The diameter of the pipe.
- **D_unit** The units for D.
- **L** The length of the pipe.
- **L_unit** The units for L.
- **R** The absolute roughness of the pipe material, see ROUGHNESS function.
- **R_unit** The units for R.
- **Q** The volume flow rate, mass flow rate, or velocity of the fluid.
- **Q_unit** The units for Q.
- **Visc** The kinematic or dynamic viscosity of the fluid.
- **Visc_unit** The units for Visc.
- **Dens** The density of the fluid.
- **Dens_unit** The unit for Dens.

Remarks

- Value/unit argument pairs can be entered in any order.
- If the input data types or units are incorrect, PRESSUREDROP returns the #VALUE! error value.
- Unit names and prefixes are case-sensitive.

Example

	A	B
1	**Formula**	**Description (Result)**
2	=PRESSUREDROP("psi", 2, "in", 80, "ft", 12, "lb/s", 0.00015, "ft", 1.1, "cP", 700, "kg/m3")	Returns the frictional pressure drop in psi for 80 ft of pipe with an inner diameter of 2 inches and a surface roughness of 0.0015 ft, that is transporting 12 lb/s of a fluid with a viscosity of 1.1 cP and a dnesity fo 0.7 kg/m3 (15.0).
3	=PRESSUREDROP("ft", PIPESIZE("4in Sch40", "ID", "in"), "in", 1.2, "mi", ROUGHNESS("commercial steel", "in"), "in", 1450, "gpm", 1.2, "cP", 940, "kg/m3")	Returns the frictional head loss in feet for 1.2 miles of 4" Sch40 steel pipe, that is transporting 1450 gpm of a fluid with a viscosity of 1.2 cP and a density of 940 kg/m3 (1.10).

PPOWER function

This article describes the formula syntax and usage of the **PPOWER** function in Microsoft Excel.

Description

Calculates pump fluid power based on any dimensionally consistent combination of volume flow rate, mass flow rate, density, differential head, and differential pressure.

$$P = \dot{V} \cdot \rho \cdot g \cdot h = \dot{V} \cdot \Delta p = \dot{m} \cdot g \cdot h$$

Syntax

```
PPOWER(unit, volume_rate, volume_rate_unit, density, density_unit, head, head_unit)
```

```
PPOWER(unit, volume_rate, volume_rate_unit, pressure, pressure_unit)
```

```
PPOWER(unit, mass_rate, mass_rate_unit, head, head_unit)
```

The PPOWER function syntax has the following arguments:

- **Unit** Units for result.
- **Volume_rate** The volume flow rate of the fluid.
- **Volume_rate_unit** The units for Volume_rate.
- **Mass_rate** The mass flow rate of the fluid.
- **Mass_rate_unit** The units for Mass_rate.
- **Density** The fluid density.
- **Density_unit** The unit for Density.
- **Head** The differential head.
- **Head_unit** The units for Head.
- **Pressure** The differential pressure.
- **Pressure_unit** The units for Pressure.

Remarks

- Value/unit argument pairs can be entered in any order.
- If the input data types or units are incorrect, PPOWER returns the #VALUE! error value.
- Unit names and prefixes are case-sensitive.

Example

	A	B
1	**Formula**	**Description (Result)**
2	=PPOWER("hp", 50, "gpm", 1, "g/cm3", 85, "ft")	Returns the fluid power in horsepower required to pump 50 gallons per minute of a fluid with a density of 1.0 g/cm3, against 85 ft of differential head (1.07).
3	=PPOWER("J/min", 20, "L/s", 45, "psi")	Returns the power in joules per minute required to pump 20 L/s of a fluid against a 45 psi pressure differential (3.72E05).
4	=PPOWER("W", 1100, "lb/d", 120, "m")	Returns the power in watts to pump 1100 lb/d of a fluid against 120 m of head (6.80).

CPOWER function

This article describes the formula syntax and usage of the **CPOWER** function in Microsoft Excel.

Description

Calculates compressor power based on inlet pressure, outlet pressure, and either volume flow rate, or inlet temperature and molar flow rate. Optionally, heat capacity ratio can also be specified.

$$P = \frac{\gamma \dot{V} p_1}{\gamma - 1}\left[\left(\frac{p_2}{p_1}\right)^{\left(\frac{\gamma}{\gamma-1}\right)} - 1\right] = \frac{\gamma R T_1}{\gamma - 1}\left[\left(\frac{p_2}{p_1}\right)^{\left(\frac{\gamma}{\gamma-1}\right)} - 1\right]$$

Syntax

```
CPOWER(unit, P_in, P_in_units, P_out, P_out_units, V_rate, V_rate_units, [K])
```

```
CPOWER(unit, P_in, P_in_units, P_out, P_out_units, T, T_units, N_rate, N_rate_units, [K])
```

The CPOWER function syntax has the following arguments:

- **Unit** The Units for result.
- **P_in** The compressor suction pressure.
- **P_in_unit** The units for P_in.
- **P_out** The compressor discharge pressure.
- **P_out_unit** The units for P_out.
- **V_rate** The volume flow rate of the fluid.
- **V_rate_unit** The units for V_rate.
- **T** The suction temperature.
- **T_unit** The units for T.
- **N_rate** The molar or standrad volume flow rate of the fluid.
- **N_rate_unit** The units for N_rate.
- **K** Optional. The ratio of specific heats for the gas, Cp/Cv. Default is 1.4.

Remarks

- Default ratio of heat capacities is 1.4.
- Value/unit argument pairs can be entered in any order.
- If the input data types or units are incorrect, CPOWER returns the #VALUE! error value.
- Unit names and prefixes are case-sensitive.

Example

	A	B
1	**Formula**	**Description (Result)**
2	=CPOWER("hp", 2000, "psig", 100, "psig", 85, "ft3/min")	Returns the horsepower required to compress 85 ft3/min of a gas from 100 psig to 2000 psig, assuming a specific heat ratio of 1.4 (189).
3	=CPOWER("kW", 1, "bar", 9, "bar", 60, "degF", 50, "sLpm", 1.59)	Returns the power in kilowatts required to compress 50 standard liters per minute of a gas with a specific heat ratio of 1.59, from a suction pressure of 1 bar and suction temperature of 60F, to a pressure of 9 bar (0.287).

PIPEFLOW function

This article describes the formula syntax and usage of the **PIPEFLOW** function in Microsoft Excel.

Description

Converts between flow rate and velocity in a pipe.

$$\dot{V} = \frac{\pi d^2}{r} \cdot v$$

Syntax

To convert volume rate to velocity:

```
PIPEFLOW(unit, diameter, diameter_unit, velocity, velocity_unit)
```

To convert velocity to volume rate :

```
PIPEFLOW(unit, diameter, diameter_unit, volume_rate, volume_rate_unit
```

The PIPEFLOW function syntax has the following arguments:

- **Unit** Required. Units for result.
- **Diameter** Required. The diameter of the pipe.
- **Diameter_unit** Units for Diameter.
- **Velocity** The velocity of the fluid in the pipe.
- **Velocity_unit** Units for Velocity
- **Volume_rate** The volume flow rate of the fluid in the pipe.
- **Volume_rate_unit** Units for Voume_rate

Remarks

- If the input data types or units are incorrect, PIPEFLOW returns the #VALUE! error value.
- Unit names and prefixes are case-sensitive.
- Diameter, velocity, and volume flow value/unit pairs can be entered in either order.

Example

	A	B
1	**Formula**	**Description (Result)**
2	=PIPEFLOW("ft/s", 2, "in", 45, "gpm")	Returns the velocity in ft/s of 45 gpm through a 2 inch ID pipe (4.59).
3	=PIPEFLOW("m3/d", 12, "ft/s", 0.5, "in")	Returns the volume flow rate in m3/d of a fluid flowing at 12 ft/s through a 1/2 inch ID pipe (40.0).

GASDENSITY function

This article describes the formula syntax and usage of the **GASDENSITY** function in Microsoft Excel.

Description

Returns the ideal mass density of the specified gas at the specified conditions.

$$\rho = MW \cdot \frac{n}{V} = MW \cdot \frac{p}{RT}$$

Syntax

```
GASDENSITY(unit, temperature, temperature_unit, pressure, pressure_unit)
```

The GASDENSITY function syntax has the following arguments:

- **Unit** Required. Units for result.
- **Formula** Required. The molecular formula of the gas.
- **Temperature** Required. The temperature of the gas.
- **Temperature_unit** Required. Units for Temperature.
- **Pressure** Required. The pressure of the gas.
- **Pressure_unit** Required. Units for Pressure.

Remarks

- If the input data types or units are incorrect, GASDENSITY returns the #VALUE! error value.
- Unit names and prefixes are case-sensitive.
- Temperature and pressure value/unit pairs can be entered in either order.

Example

	A	B
1	**Formula**	**Description (Result)**
2	=GASDENSITY("lb/ft3", "CH4", 80, "degF", 220, "psig")	Returns the ideal density in lb/ft3 of methane at 80F and 220 psig (0.650).
3	=GASDENSITY("g/cm3", "Ar", 420, "K", 10, "bar")	Returns the ideal density in g/cm3 of argon at 420K and 10 bar (0.0114).

LMTD function

This article describes the formula syntax and usage of the **LMTD** function in Microsoft Excel.

Description

Returns the log mean temperature difference, useful in heat transfer calculations.

$$LMTD = \frac{\Delta T_A - \Delta T_B}{\ln \frac{\Delta T_A}{\Delta T_B}}$$

Syntax

```
LMTD(Temperature_A1, Temperature_A2, Temperature_B1, Temperature_B2)
```

The LMTD function syntax has the following arguments:

- **Temperature_A1** Required. The temperature of Stream 1, on Side A.
- **Temperature_A2** Required. The temperature of Stream 2, on Side A.
- **Temperature_B1** Required. The temperature of Stream 1, on Side B.
- **Temperature_B2** Required. The temperature of Stream 2, on Side B.

Remarks

- Temperature units are assumed to be consistent.
- If the input data types incorrect, LMTD returns the #VALUE! error value.

Example

	A	B
1	**Formula**	**Description (Result)**
2	=LMTD(100, 40, 90, 39)	Returns the LMTD for counter-current heat exchange with an inlet hot-side temperature of 100, an outlet hot-side temperature of 40, an inlet cold side temperature of 39, and an outlet cold-side temperature of 90 (3.91).
3	=LMTD(40, 100, 110, 150)	Returns the LMTD for co-current heat exchange with an inlet cold-side temperature of 40, an outlet cold-side temperature of 100, an inlet hot-side temperature of 110, and an outlet hot-side temperature of 150 (59.4).

QUADRATIC function

This article describes the formula syntax and usage of the **QUADRATIC** function in Microsoft Excel.

Description

Uses the quadratic formula to find roots of quadratic equations of the form:

$$0 = a \cdot x^2 + b \cdot x + c$$

Syntax

```
QUADRATIC(a, b, c, root_index)
```

The QUADRATIC function syntax has the following arguments:

- **A** Required. The coefficient of the x^2 term.
- **B** Required. The coefficient of the x^1 term.
- **C** Required. The coefficient of the x^0 term.
- **Root_index** Optional. Indicates which of up to two roots to return.

QUADRATIC accepts the following case-insensitive text values (in quotation marks) for Root_index.

Root_index	Description
r1	Returns the root that corresponds to (-b + sqrt(b2-4ac))/2a.
r2	Returns the root that corresponds to (-b - sqrt(b2-4ac))/2a.
pos	If one positive and one negative root exist, returns the positive root, otherwise returns the #VALUE! error.
neg	If one positive and one negative root exist, returns the negative root, otherwise returns the #VALUE! error.

Remarks

- If the input data types are incorrect, or the equation specified has no real roots, QUADRATIC returns the #VALUE! error value.

Example

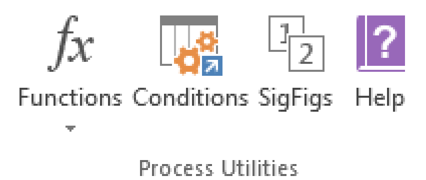
	A	B
1	**Formula**	**Description (Result)**
2	=QUADRATIC(1, -5, -6, "pos")	Returns the positive root for the equation '0 = x^2 - 5x - 6'. (6).
3	=QUADRATIC(2, -5, -6, "r1")	Returns 'r1' root (as defined above) for the equation '0 = 2x^2 - 5x - 6' (3.39).

Ribbon Interface

This article describes the function of the Process Utilities **Ribbon menu** in Microsoft Excel.

Description

The Ribbon menu gives the user access to Process Utilities' Function menu, Conditions menu, and SigFigs menu. It can be found under the ADD-INS heading.



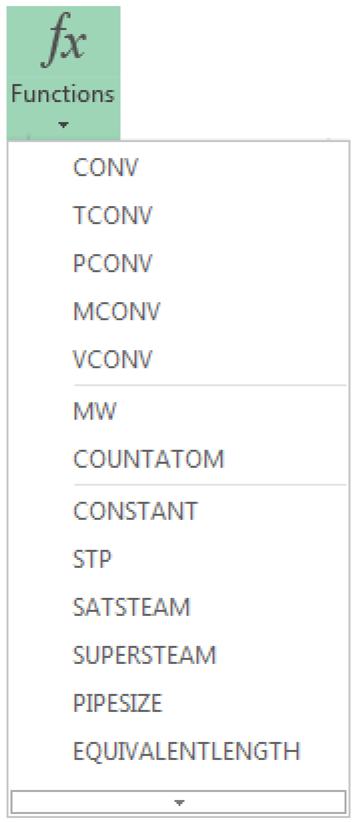
SUBMENUS	
Functions	Allows user to insert ProcessUtilities functions using Excel's built-in Function Wizard
Conditions	Allows user to specify values for standard pressure, standard temperature, and ambient pressure.
SigFigs	Allows user to specify and apply rules for how values are displayed in the spreadsheet.
Help	Opens this help file in compiled HTML format.

Functions Menu

This article describes the function of the **Functions** menu in Microsoft Excel.

Description

The Functions menu allows the user to insert ProcessUtilities functions using Excel's built-in Function Wizard.

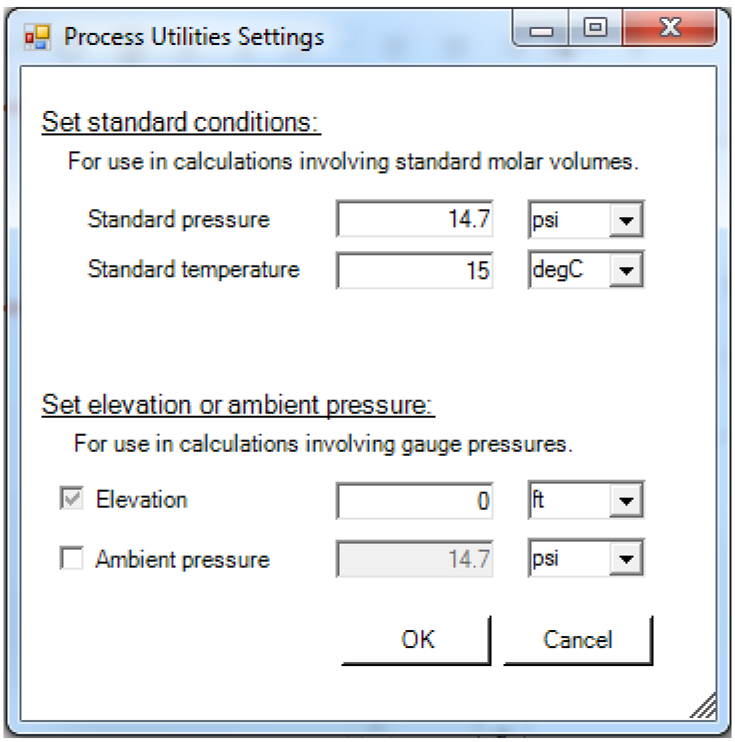


Conditions Menu

This article describes the function of the **Conditions** menu in Microsoft Excel.

Description

The Conditions menu allows the user to specify setpoints for Standard pressure, Standard temperature, Elevation, and Ambient Pressure. These are values that are used in other ProcessUtilities functions.



'Set standard conditions' sub-menu

This submenu allows the user to specify values and units for Standard pressure and Standard Temperature. These values are used by functions including CONV, to convert between standard volume units (sL, scf, Mcf, etc.) and molar units (mol, kmol, lbmol, etc.).

'Set elevation or ambient pressure' sub-menu

This submenu allows the user to specify values and units Elevation and Ambient Pressure. These values are used by functions including PCONV, to convert between gauge pressure (psig, barg, etc.) and absolute pressure (psi, bar, mmHg, etc.).

Either Elevation or Ambient pressure may be specified, but not both. The value that is not specified is calculated using the equation below; where Po is pressure at sea level, L is temperature lapse rate, h is elevation, To is temperature at sea level, g is Earth-surface gravitational acceleration, M is the molar mass of dry air, and R is the Universal Gas Constant.

$$p = p_0 \cdot \left(1 - \frac{L \cdot h}{T_0}\right)^{\frac{g \cdot M}{R \cdot L}}$$

Remarks

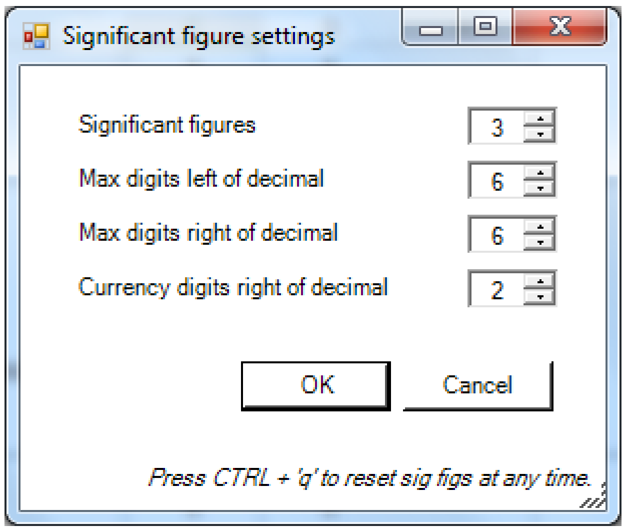
- Setpoints specified in the Conditions menu are stored by Excel as named ranges, and will be saved along with the worksheet.

SigFigs Menu

This article describes the function of the **SigFigs** menu in Microsoft Excel.

Description

The SigFigs menu allows the user to specify rules for how numbers are displayed in a spreadsheet. These rules can be applied to the spreadsheet at any time by pressing 'CNTRL + q'.



Remarks

- Setpoints specified in the SigFigs menu are stored by Excel as named ranges, and will be saved along with the worksheet.