

@GAS - THERMODYNAMIC PROPERTIES OF FLUE GAS

@Gas is a member of Techware's family of software packages bringing accurate thermodynamic properties of fluids to many popular **Windows**[®] programs. **@Gas** provides thermodynamic and transport properties of gas mixtures, which include most of the constituents found in flue gas and moist air. The **@Gas** package includes: DeskTop Gas, an interactive gas properties calculator; a dynamic link library (DLL) of gas property functions; and various add-ins which link the functions to **Windows**[®] applications. The add-ins allow you to use the functions as if they were built-in to **Microsoft Excel**[®], **Lotus 1-2-3 for Windows**[®], and **MathSoft Mathcad**[®]. Programmers can call the functions in the dynamic link library directly from many **Windows**[®] programming languages such as **Microsoft Visual BASIC**[®], **Microsoft Visual C++ for Windows**[®] and **Microsoft Access**.

@Gas will greatly simplify all types of calculations involving moist air and flue gas. The functions are extremely useful in calculating the performance of waste heat boilers, fossil fuel fired steam generators, heat exchangers, air compressors and gas turbines. You can conveniently design equipment right on your favorite spreadsheet and your results will be more accurate because you won't have to interpolate data from tables or read data from charts. You won't have to make perfect gas assumptions either.

Summary of @Gas Features

- Seamlessly extends your spreadsheet program's set of built-in functions
- Equations based on virial equation of state using second and third order mixing coefficients. No perfect gas assumptions
- Excellent accuracy is fully documented.
- All routines are robust, flexible and fast
- Supports most useful combinations of input parameters
- Uses English, SI and Metric units
- Properties on wet or dry basis
- Composition on mass or volume basis
- Includes easy to follow examples
- Allows pressures up to approximately 50 atmospheres (725 psia)
- Temperatures from 180 °K (-135.67 °F) to 2000 °K (3140.33 °F)
- Calculates specific volume, enthalpy, entropy, specific heat, dynamic viscosity and thermal conductivity
- Calculates humidity ratio, molecular weight, amount of condensation and dew point temperature
- Attractive quantity discounts available
- Free phone support

@Gas gives you fast, accurate functions that return specific volume, enthalpy, entropy, specific heat, viscosity or thermal conductivity for a mixture of gases. The current **@Gas** library includes the following gases; nitrogen (N₂), oxygen (O₂), argon (Ar), carbon dioxide (CO₂), and water vapor (H₂O). These gases account for 99.997% of the volumetric composition of standard air and also account for better than 99.9% of most combustion gases. **@Gas** also includes functions that calculate humidity ratio, molecular weight, dew point temperature and reverse functions that calculate the temperature when specific volume, enthalpy or entropy is known. The thermodynamic properties are calculated for mixtures of all five gases using an accurate third order virial equation of state. The general form of the equation of state and the derived thermodynamic properties can be found in many publications dealing with gas properties. The specific form of the equations, the data correlation and the computational methodology have been developed by Techware. The functions have been tested against published data and show excellent agreement. Information documenting the theoretical basis and accuracy is included with the package.

@Gas can be used to calculate the thermodynamic properties of moist air by entering the functions with the composition of standard air. In some cases, when dealing with psychrometric properties of air such as relative humidity, wet bulb temperature or degree of saturation, it may be more convenient to use Techware's **@Air** product which includes functions to handle these parameters.

No programming is required to use the **@Gas** functions with Excel, 1-2-3 or Mathcad. Just follow a few simple steps to load the ready-made add-ins. The **@Gas** functions can be used in formulas just like any of the other built-in functions.

The **@Gas** package also includes DeskTop Gas, a handy, interactive gas property calculator which runs in its own window. The calculator has many advanced features and includes very flexible unit selection and an intuitive, standard Windows user interface.

Programmers should note that all of the gas property functions are contained in a Windows Dynamic Link Library (DLL). Any Windows application which allows users to call functions in a DLL should be able to access the **@Gas** functions. The 32-bit DLL's included with the package work with Windows 95, 98, 2000, NT and XP. Function protocols and .LIB files are included to support programming activities. The 64-bit DLL works with Windows 7. Function protocols and .LIB files are included to support programming activities.

@Gas

for Windows

THERMODYNAMIC PROPERTIES
OF MOIST GASES AND AIR FOR
WINDOWS APPLICATIONS

Technical Specifications

Applications Supported	Microsoft Excel Versions XP, 2003, 2007 and 2010 (32-bit and 64-bit). Lotus 1-2-3 97 and Millennium Mathcad Plus 6, 7 and 8 Visual Basic (32 bit and 64-bit) Visual C++ (32 bit and 64-bit)
Measurement Units	English, English Gauge, SI Common, SI Formal , SI kPa and Metric and Metric Formal Units
Valid Range	Pressure: Up to 50 bar (725 psia) Temperature: 180 °K to 2000 °K -135.7 °F to 3140.3 °F
Typical calling syntax	Excel: Excel: =GasPTXH(P, T, N2, O2, Ar,CO2, H2O, units) 1-2-3: @GasPTXH(P, T, N2, O2, Ar,CO2, H2O, units)

<u>Function</u>	<u>Inputs</u>	<u>Output</u>
GasPTXV()	Press, Temp, Composition	Specific Volume
GasPVXT()	Press, Spec Vol,Comp	Temperature
GasTVXP()	Temp, Spec Vol, Comp	Pressure
GasXW()	Composition	Humidity Ratio
GasPTXW()	Press, Temp, Composition	Sat Humidity Ratio
GasPXD()	Press, Composition	Dew Point Temp
GasPTXH()	Press, Temp, Composition	Specific Enthalpy
GasPTXHS()	Press, Temp, Composition	Sat Specific Enthalpy
GasPHXT()	Press, Enthalpy, Comp	Temperature
GasPTXS()	Press, Temp, Composition	Specific Entropy
GasPTXSS()	Press, Temp, Composition	Sat. Specific Entropy
GasPSXT()	Press, Entropy, Comp	Temperature
GasPTXC()	Press, Temp, Composition	Specific Heat
GasPTXM()	Press, Temp, Composition	Dynamic Viscosity
GasPTXK()	Press, Temp, Composition	Conductivity
GasPTXL()	Press, Temp, Composition	Water condensed
GasXMW()	Composition	Molecular Weight
GasWX()	Comp, Humidity Ratio	Water Mole Fraction
GasVapPT()	Water Vapor Pressure	Sat Temp
GasVapTP()	Water Temp	Sat Press of Water
GasCondPTH()	Water Press, Temp	Specific Enthalpy of Comp Liquid Water
GasCondPTS()	Water Press, Temp	Specific Entropy of Comp Liquid Water
GasVer()	None	Version/serial no.

Composition is entered as mole fractions of N2, O2, Ar, CO2 on a dry basis with H2O entered as a humidity ratio by default. Gas composition can also be entered on a wet basis with H2O entered as a mole fraction by adding "C" to the unit set. Composition can also be entered as a mass fraction instead of a mole fraction by adding "M" to the unit set.

Specific Volume, Enthalpy, Entropy and Specific Heat are expressed per dry mass of the mixture. They can be expressed on a wet basis by adding "W" to the unit set.

The reference points for Enthalpy and Entropy are either 0° F or 0° C depending upon the unit set selected. They can be set to absolute zero by adding "A" to the unit set.

Computer Requirements

Operating System: Windows NT, 2000, XP, Vista and Windows 7
Disk Space Used: up to 3.0 MB