

Engineering Software

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Product Line

Engineering Software has developed a new Windows based product line that quickly, easily and reliably calculates thermodynamic and transport properties of gaseous, liquid and solid species, contains coefficients for the calculation of physical properties -- the user has the capability to use the coefficients to carry out independent engineering calculations involving physical properties of various species, steam approximations for both saturated and superheated areas, analyzes power cycles, power cycle components/processes and compressible flow.

Benefits

The **Engineering Software** product line should prove to be a good tool for those who are involved at various levels with design, operation and management of energy conversion systems. It should provide the user with the opportunity to more quickly, easily and effectively do his/her work, explore more options, save time and give more confidence in carrying out engineering calculations.

Physical Properties

Physical Properties: Temperature - Pressure

Physical Properties - Input

Species

Tmin [K] Tmax [K]

Temperature [K]

Pressure [atm]

Physical Properties - Results

Species

	SI Units	US Customary Units
Temperature	<input type="text" value="298.00"/> [K]	<input type="text" value="76.73"/> [F]
Pressure	<input type="text" value="1.00"/> [atm]	<input type="text" value="14.70"/> [psia]
Density	<input type="text" value=""/> [kg/m ³]	<input type="text" value=""/> [lbm/ft ³]
Specific Enthalpy	<input type="text" value="-0.141"/> [kJ/kg]	<input type="text" value="-0.061"/> [Btu/lbm]
Internal Specific Energy	<input type="text" value="-91.969"/> [kJ/kg]	<input type="text" value="-39.540"/> [Btu/lbm]
Gibbs Free Specific Energy	<input type="text" value="-312.847"/> [kJ/kg]	<input type="text" value="-134.500"/> [Btu/lbm]
Specific Entropy	<input type="text" value="1.049"/> [kJ/kg*K]	<input type="text" value="0.251"/> [Btu/lbm*R]
Molecular Weight	<input type="text" value="26.982"/> [kg/kmol]	<input type="text" value="26.982"/> [lbm/lbmol]
Gas Constant	<input type="text" value="0.308"/> [kJ/kg*K]	<input type="text" value="0.074"/> [Btu/lbm*R]
Specific Heat (Cp)	<input type="text" value="0.900"/> [kJ/kg*K]	<input type="text" value="0.215"/> [Btu/lbm*R]
Kappa	<input type="text" value=""/> [1]	<input type="text" value=""/> [1]

Physical properties of available species are provided for assigned two state values such as: temperature and pressure, enthalpy and pressure and entropy and pressure. Physical properties are given in both U.S. Customary and International Units.

Steam Approximations

Steam Approximations: Superheated Area

Steam Approximations - Input (Superheated Area)

Temperature [F]

Pressure [psia]

Steam Approximations - Results (Superheated Area)

	SI Units	US Customary Units
Temperature	<input type="text" value="93.33"/> [C]	<input type="text" value="200.00"/> [F]
Pressure	<input type="text" value="0.68"/> [atm]	<input type="text" value="10.00"/> [psia]
Specific Volume	<input type="text" value="2.425"/> [m ³ /kg]	<input type="text" value="38.850"/> [ft ³ /lbm]
Internal Specific Energy	<input type="text" value="2,499.8"/> [kJ/kg]	<input type="text" value="1,074.7"/> [Btu/lbm]
Specific Enthalpy	<input type="text" value="2,667.0"/> [kJ/kg]	<input type="text" value="1,146.6"/> [Btu/lbm]
Specific Entropy	<input type="text" value="7.5055"/> [kJ/kg*K]	<input type="text" value="1.7927"/> [Btu/lbm*R]

Provides steam approximations, steam table calculations are available for both saturated and superheated areas.

Power Cycle Analysis

Power Cycles: Brayton: Power (Ideal)

Brayton Cycle - Power (Ideal)

Working Fluid

Compressor Inlet Temperature [K] Compressor Inlet Pressure [atm]

Turbine Inlet Temperature [K] Turbine Inlet Pressure [atm]

Working Fluid Mass Flow Rate [kg/s] Fuel HHV [Btu/lbm]

Power Output [kW] Cycle Efficiency [%]

Fuel Mass Flow Rate [kg/s] Heat Rate [Btu/kWhr]

Provides analysis of a few power cycles (Carnot, Brayton, Rankine, Otto, Diesel, Magnetohydrodynamics and Fuel Cell).

Power Cycle Components/Processes

Power Cycle Components: Combustion: Coal/Oil

Reactants

Fuel - Coal/Oil			Oxidant		
Composition			Composition		
	MW	Weight		MW	Weight
C	12	<input type="text" value="0.780"/>	N	28	<input type="text" value="0.786"/>
H	2	<input type="text" value="0.050"/>	O	32	<input type="text" value="0.233"/>
S	32	<input type="text" value="0.030"/>	Total	<input type="text" value="1.00"/>	<input type="text" value="1.00"/>
N	28	<input type="text" value="0.040"/>	Stoichiometric Oxidant to Fuel Ratio [] <input type="text" value="10.477"/>		
O	32	<input type="text" value="0.080"/>	<input type="button" value="Normalize"/> <input type="button" value="Normalize"/>		
W	18	<input type="text" value="0.020"/>	Fuel Temperature [K] <input type="text" value="298.0"/>		
Total	<input type="text" value="1.000"/>		Fuel Specific Enthalpy [kJ/kg] <input type="text" value="-317.8"/>		
HHV [Btu/lbm]	<input type="text" value="14,162"/>		Oxidant Temperature [K] <input type="text" value="298.0"/>		
<input type="button" value="Normalize"/>			Oxidant Specific Enthalpy [kJ/kg] <input type="text" value="-0.2"/>		
Stoichiometry [] (1 or > 1) <input type="text" value="1.000"/>			Reactants Specific Enthalpy [kJ/kg] <input type="text" value="-27.8"/>		
			Products Specific Enthalpy [kJ/kg] <input type="text" value="-27.8"/>		
			Combustion Efficiency [] <input type="text" value="1.000"/>		

Combustion Products

Oxidant to Fuel Ratio [] <input type="text" value="10.477"/>					
	MW	Weight	Mole	Specific Enthalpy [kJ/kg]	
CO2	44	<input type="text" value="0.250"/>	<input type="text" value="0.171"/>	<input type="text" value="-6,179.0"/>	
H2O	18	<input type="text" value="0.041"/>	<input type="text" value="0.068"/>	<input type="text" value="-7,952.0"/>	
SO2	64	<input type="text" value="0.005"/>	<input type="text" value="0.002"/>	<input type="text" value="-2,756.6"/>	
N2	28	<input type="text" value="0.703"/>	<input type="text" value="0.756"/>	<input type="text" value="2,647.6"/>	
O2	32	<input type="text" value="0.000"/>	<input type="text" value="0.000"/>	<input type="text" value="0.0"/>	
Total	<input type="text" value="30.1"/>	<input type="text" value="1.000"/>	<input type="text" value="1.000"/>	<input type="text" value="-27.9"/>	
Flame Temperature [K] <input type="text" value="2,495"/>					

Record: 1 of 1 No Filter Search

Provides analysis of power cycle components/processes (compression, combustion, expansion, heat transfer and mixing).

Compressible Flow

Compressible Flow: Thrust (Real)

Thrust (Real)

Working Fluid	<input type="text" value="Air"/>		
Stagnation Temperature [K]	<input type="text" value="1,500.0"/>	Stagnation Pressure [atm]	<input type="text" value="10.00"/>
Velocity [m/s]	<input type="text" value="500.0"/>	Ambient Pressure [atm]	<input type="text" value="1.00"/>
Working Fluid Mass Flow Rate [kg/s]	<input type="text" value="1.0"/>	Thrust Efficiency [1]	<input type="text" value="1.000"/>
Ideal Static Temperature [K]	<input type="text" value="1,375.5"/>	Static Pressure [atm]	<input type="text" value="7.38"/>
Ideal Mach Number [1]	<input type="text" value="0.67"/>	Thrust [N]	<input type="text" value="1,181.9"/>
Static Temperature [K]	<input type="text" value="1,375.5"/>	Velocity [m/s]	<input type="text" value="500.0"/>
Mach Number [1]	<input type="text" value="0.67"/>		

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Provides analysis of compressible flow (velocity of sound, Mach number, stagnation and static properties, nozzle, diffuser, normal shock and thrust).

Claim Sheet

Engineering Software product line allows quick and reliable calculation of thermodynamic and transport properties of gaseous, liquid and solid species, contains coefficients for the calculation of physical properties, steam approximations for both saturated and superheated areas, provides analyses of power cycles, power cycle components/processes and compressible flow.

The aforementioned engineering calculations are valid under the following assumptions:

Thermodynamic and Transport Properties

Single species consideration

Ideal gas approach is used ($pV=RT$)

Specific heat is not constant

Coefficients describing thermodynamic and transport properties were obtained from the NASA Glenn Research Center at Lewis Field in Cleveland, OH -- such coefficients conform with the standard reference temperature of 298.15 K (77 F) and the JANAF Tables

Power Cycles

Single species consideration -- fuel mass flow rate ignored and its impact on the properties of the working fluid

Basic equations hold (continuity, momentum and energy equations)

Specific heat is constant

Power Cycle Components/Processes

Single species consideration

Basic equations hold (continuity, momentum and energy equations)

Specific heat is constant

Compressible Flow

Single species consideration

Basic equations hold (continuity, momentum and energy equations)

Specific heat is constant

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