

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

Specie	CO2(G)	
	SI Units	US Customary Units
Temperature	298.00 [K]	76.73 [F]
Pressure	1.00 [atm]	14.70 [psia]
Density	1.7998 [kg/m ³]	0.1124 [lbm/ft ³]
Enthalpy	-8,940.040 [kJ/kg]	-3,843.525 [Btu/lbm]
Internal Energy	-8,996.330 [kJ/kg]	-3,870.310 [Btu/lbm]
Gibbs Free Energy	-10,386.700 [kJ/kg]	-4,468.460 [Btu/lbm]
Entropy	4.855 [kJ/kg ^o K]	1.160 [Btu/lbm ^o R]
Molecular Weight	44.010 [kg/kmol]	44.010 [lbm/lbmol]
Gas Constant	0.189 [kJ/kg ^o K]	0.045 [Btu/lbm ^o R]
Specific Heat (Cp)	0.844 [kJ/kg ^o K]	0.202 [Btu/lbm ^o R]
Kappa	1.288 [1]	1.288 [1]
	<input type="button" value="Exit"/>	

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 (Saturated Area)

	SI Units		
	Liquid	Vapor	Steam Quality <input type="text" value="1.00"/>
Temperature	<input type="text" value="25.00"/> [C]	<input type="text" value="25.00"/> [C]	<input type="text" value="25.00"/> [C]
Pressure	<input type="text" value="0.03158"/> [atm]	<input type="text" value="0.03158"/> [atm]	<input type="text" value="0.03158"/> [atm]
Specific Volume	<input type="text" value="0.001003"/> [m ³ /kg]	<input type="text" value="43.905"/> [m ³ /kg]	<input type="text" value="43.905"/> [m ³ /kg]
Internal Energy	<input type="text" value="104.86"/> [kJ/kg]	<input type="text" value="2,409.8"/> [kJ/kg]	<input type="text" value="2,409.8"/> [kJ/kg]
Enthalpy	<input type="text" value="104.88"/> [kJ/kg]	<input type="text" value="2,547.2"/> [kJ/kg]	<input type="text" value="2,547.2"/> [kJ/kg]
Entropy	<input type="text" value="0.3672"/> [kJ/kg·K]	<input type="text" value="8.5584"/> [kJ/kg·K]	<input type="text" value="8.5584"/> [kJ/kg·K]

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

Power Cycle Analysis

Brayton Cycle - Power

Working Fluid	<input type="text" value="Air"/>		
Compressor Inlet Temperature [K]	<input type="text" value="298.0"/>	Compressor Inlet Pressure [atm]	<input type="text" value="1.0"/>
Turbine Inlet Temperature [K]	<input type="text" value="1,500.0"/>	Turbine Inlet Pressure [atm]	<input type="text" value="15.0"/>
Working Fluid Mass Flow Rate [kg/s]	<input type="text" value="1.0"/>	Fuel HHV [Btu/lbm]	<input type="text" value="24,000.00"/>
Power Output [kW]	<input type="text" value="462"/>	Cycle Efficiency [%]	<input type="text" value="53.87"/>
Fuel Mass Flow Rate [kg/s]	<input type="text" value="0.015"/>	Heat Rate [Btu/kWhr]	<input type="text" value="6,334"/>
<input type="button" value="Calculate"/>			
<input type="button" value="Exit"/>			

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

Power Cycle Components/Processes

Reactants

Fuel - Coal/Oil			Oxidant			
Composition			Composition			
	MW	Weight		MW	Weight	Mole
C	12	0.780	H	28	0.766	0.789
H	2	0.050	O	32	0.233	0.210
S	32	0.030	Total	1.00	1.00	
W	18	0.020	<input type="button" value="Normalize"/> <input type="button" value="Normalize"/>			
Total		1.000	Fuel Temperature [K] <input style="width: 50px;" type="text" value="298.0"/>			
HHV [Btu/lbm]		14,162	Fuel Enthalpy [kJ/kg] <input style="width: 50px;" type="text" value="-317.5"/>			
<input type="button" value="Normalize"/>			Oxidant Temperature [K] <input style="width: 50px;" type="text" value="298.0"/>			
Stoichiometry [] (1 or > 1) <input style="width: 50px;" type="text" value="1.000"/>			Oxidant Enthalpy [kJ/kg] <input style="width: 50px;" type="text" value="-0.2"/>			
			<input type="button" value="Exit"/>			

Stoichiometric
Oxidant to Fuel
Ratio []

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

Compressible Flow

Nozzle

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"/>	Specific Heat [J/kg·K]	<input type="text" value="1,004.0"/>
Gas Constant [J/kg·K]	<input type="text" value="286.7"/>	Kappa [γ]	<input type="text" value="1.40"/>
Static Temperature [K]	<input type="text" value="1,375.5"/>	Static Pressure [atm]	<input type="text" value="7.38"/>
Mach Number [M]	<input type="text" value="0.67"/>		
<input type="button" value="Calculate"/>			
<input type="button" value="Exit"/>			

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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