Thermophysical Data

Introduction

The ThermophysicalData package calculates the properties of pure fluids, mixtures, solutions and humid air. The package is based on the open source CoolProp library.

> with(ThermophysicalData) :

For example, this is the temperature of carbon dioxide at a user-defined pressure and enthalpy.

> Property(temperature, pressure = 6 bar, massspecificenthalpy = $5 \cdot 10^5 \mathrm{J}\,\mathrm{kg}^{-1}$, "carbondioxide")

$$296.9109661\ \mathrm{K}$$

This is the density of a 30%-70% molar mixture of helium and nitrogen at a user-defined temperature and pressure.

> Property(density, temperature = 293 K, pressure = 1 atm, "helium[0.3]&nitrogen[0.7]")

$$0.8652903239\ \frac{\mathrm{kg}}{\mathrm{m}^3}$$

This is the wet-bulb temperature of humid air at a user-defined dry-bulb temperature, pressure, and relative humidity.

> Property(Twb, HumidAir, Tdb = 293 K, P = 1 atm, R = 0.50)

$$286.8032717\ \mathrm{K}$$

With the data provided by this package, you can

- model heat flows across thermodynamic cycles,
- calculate efficiency of solar heating systems,
- simulate models of heat exchangers with lumped parameters,
- optimize the performance of turbines,
- generate customized psychrometric charts and pressure-enthalpy diagrams,
- and more

The package is units-aware, and can be used with Maple's numerical solvers, optimizers and differential equation solving routines.

State-Dependent Properties

State-dependent properties for pure fluids and refrigerants require two states to calculate the value of a property. Valid combinations of states and properties are given in ThermophysicalData,Property, and a list of fluids are given in ThermophysicalData/fluids.

This example yields the specific heat capacity in J^{-1} kg^{-1} K^{-1} of ammonia at temperature 234 K and pressure 101325 Pa.

> Property(C, T = 234, P = 101325, "ammonia")

$$4417.98833355119950$$

If no unit is specified, the input is assumed to have SI units, and the output is given in SI units.

You can also associate units with the states. By default, results are given in the current unit system.

> Property(C, T = 234K, P = 10psi, "ammonia")

$$2230.589948 \; \frac{\mathrm{J}}{\mathrm{kg}\ \mathrm{K}}$$

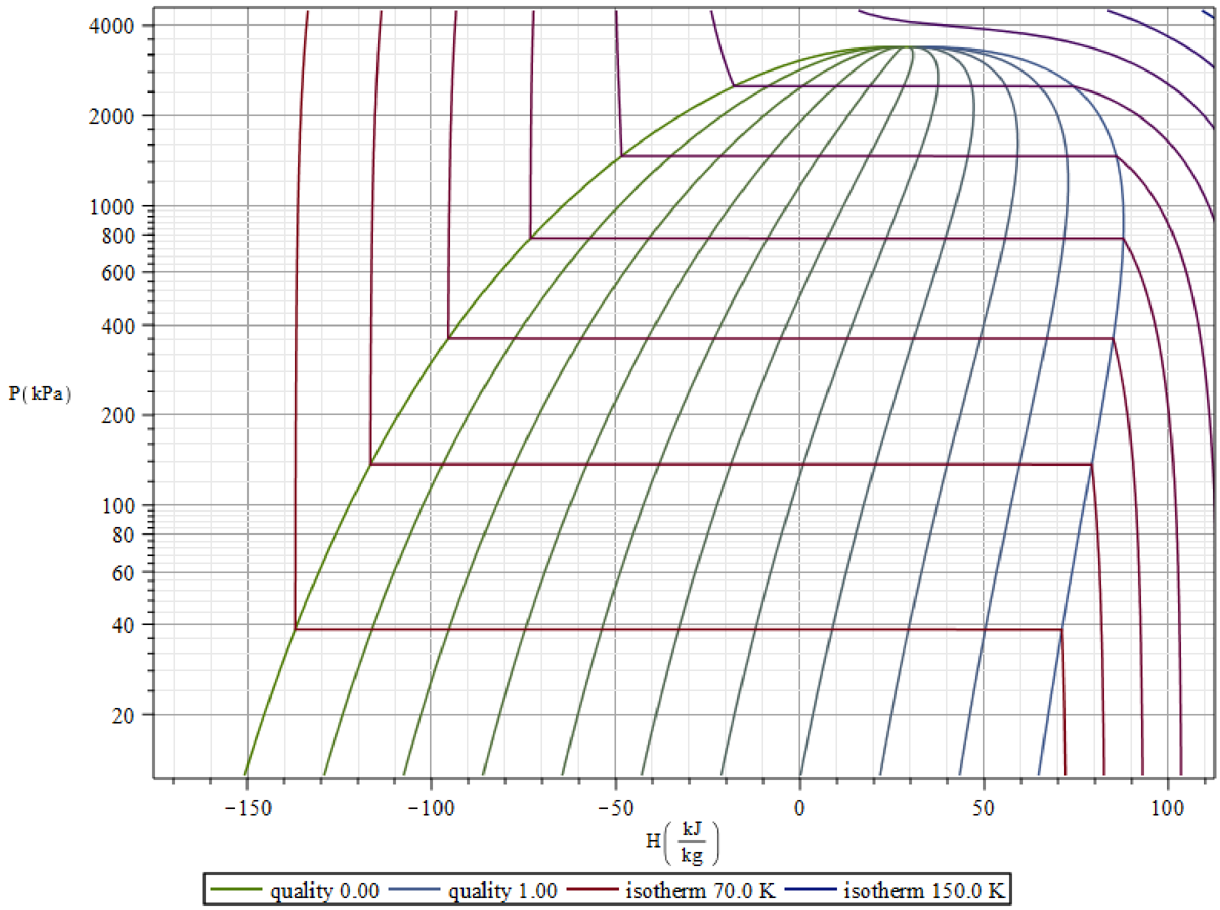
You can rescale the result to arbitrary (but dimensionally consistent) units. Just right-click on the result and then select **Units Formatting...**.

> Property(C, T = 234K, P = 10psi, "ammonia")

$$0.5331237925 \; \frac{\mathrm{Btu}}{\mathrm{lb}\ {}^{\circ}\mathrm{F}}$$

You can also generate PHT charts. Chart properties (for example, the location of the isotherms, pressure ranges, and enthalpy ranges) can be customized.

> PHTChart("nitrogen")



Thermodynamic cycles can be visualized by placing plot objects on these charts. For example, see the Refrigeration Cycle application.

State-Independent Properties

State-independent values only require two arguments - a fluid and a property. This command, for example, finds the critical temperature of water.

> Property("Tcrit", "water")

647.096000000000004

This is the 100-year Global Warming Potential for the refrigerant R134a.

> Property("global_warming_potential_100", "R134a")

1430.

ThemophysicalData,Property has a list of state-independent properties.

Humid Air

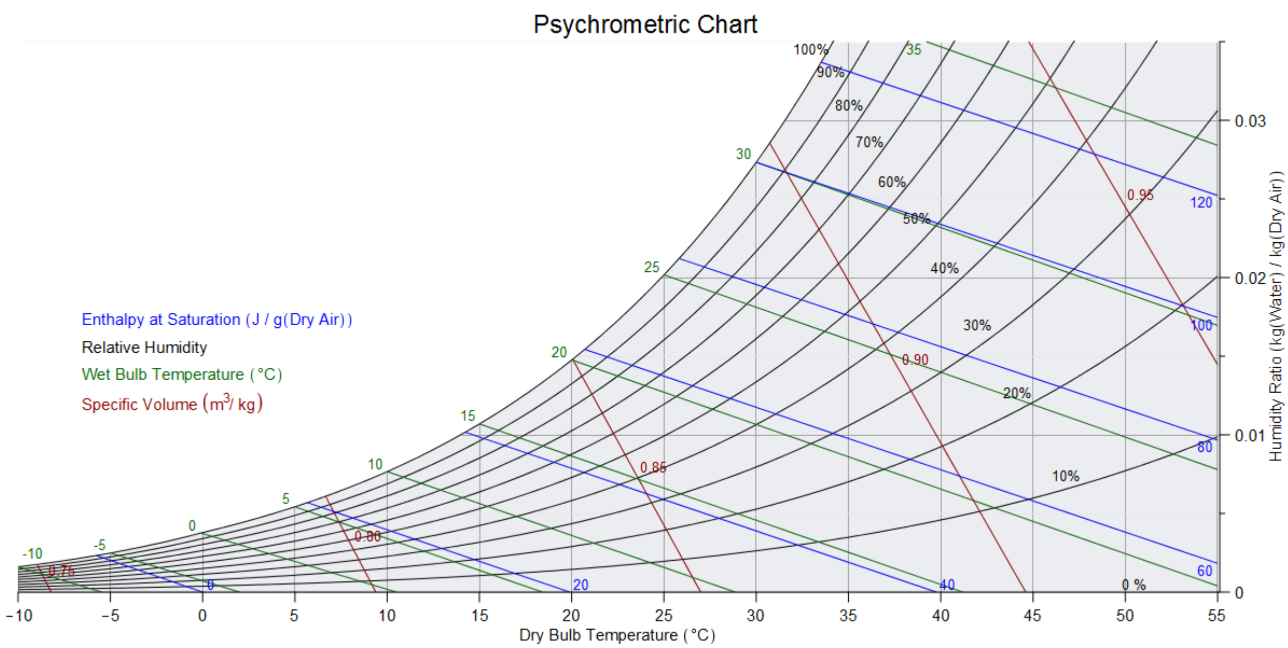
You can calculate the properties of humid air. Here we calculate the specific enthalpy of humid air at a user-defined dry-bulb temperature, pressure and relative humidity.

> $\mathrm{Property}(\mathrm{Hha}, \mathrm{HumidAir}, \mathrm{Tdb} = 293\,\mathrm{K}, \mathrm{pressure} = 101325\,\mathrm{Pa}, \mathrm{R} = 0.45)$

$$36209.64301\ \frac{\mathrm{J}}{\mathrm{kg}}$$

You can generate a psychrometric chart, and use it to visualize heating/cooling by overlaying plot objects on it. For example, see the Human Comfort Zone application.

> $\mathrm{PsychrometricChart}(\mathit{pressure} = 101325\,\mathrm{Pa})$



▼ Applications

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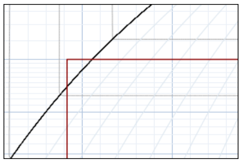

Heat Flows Across a Refrigeration Cycle

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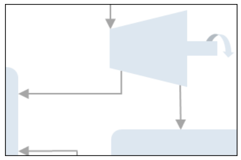

Maximize the Efficiency of a Rankine Cycle

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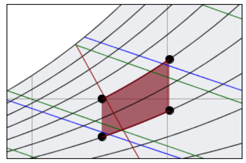

Condition Air into the Human Comfort Zone

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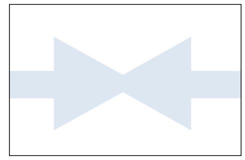

Flow of R22 Through an Expansion Valve

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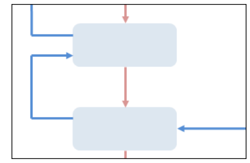

Organic Rankine Cycle

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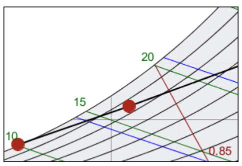

Mixing Humid Air

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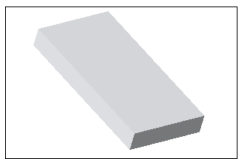

Heat Transfer Coefficient Across a Flat Plate

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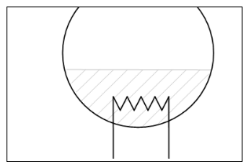

Energy Required to Vaporize Ethanol

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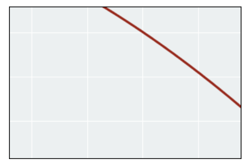

Particle Falling Through Air

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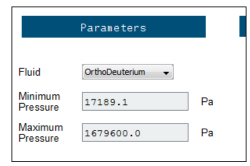

Saturation Temperature of Fluids

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