T H E R M O P T I M ®

Example

Air conditioning unit

JAVA VERSIONS 1.3 AND ABOVE

CONTENTS

Example: Air conditioning of a building

One seeks to maintain the internal ambience of a building at a temperature of 24 °C (297.15 K) and a relative humidity equal to 50%. External climatic conditions are the following: temperature to equal 30 °C (303.15 K), and relative humidity of 80%.

It is necessary to remove external and internal thermal loads of 162.6 kW, as well as a quantity of water equal to 60 kg/h, that is 0.01667 kg/s.

Knowing that, for sanitary and comfort reasons, the supply temperature must not be less than 14 °C (287.15 K), and that the recycled air proportion must not exceed 70 %, the purpose of the exercise is to determine:

- the supply conditions
- a way of processing of the outdoor air / recycled air mix.

Solution of the problem

Begin by creating a new project, titled "air conditioning". As for the time being there are no components for the moist processes, you cannot use the diagram editor.

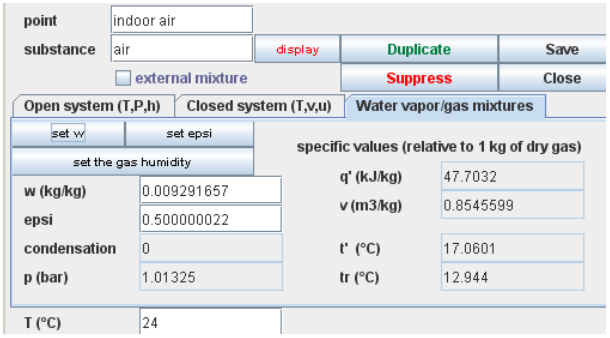
In this exercise, all points will be of the same dry gas, air, and constant pressure, 1 atm.

1 Supply conditions

Begin by creating two points titled "indoor air" and "outdoor air", and setting their respective temperature and relative humidity, as well as a third point, titled "supply", with a temperature of 14 °C.

To do this, double-click in the header of the points table, enter the names of the point and the substance. For the latter, you can either select from the list of the substances in the data base, which appears when you double-click in the name field, or enter it directly. In the latter case, it is necessary for you to type the Enter key after the name, so that Thermoptim knows that the input is complete.

For the first point, for example, you obtain this result.

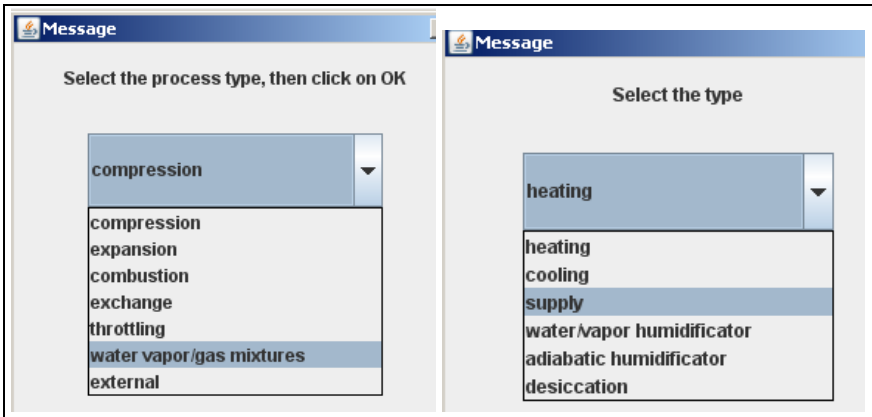


Point « indoor air»

Then, create a supply water vapor / gas mixture process, connecting points "indoor air" and "supply".

To do this, double-click in the header of the process table and select "water vapor/gas mixtures" in the list of processes available, which gives you access to a second list. Select "supply".

Once the process appears, double-click in the field under "inlet point" and select "indoor air" in the list of existing points.

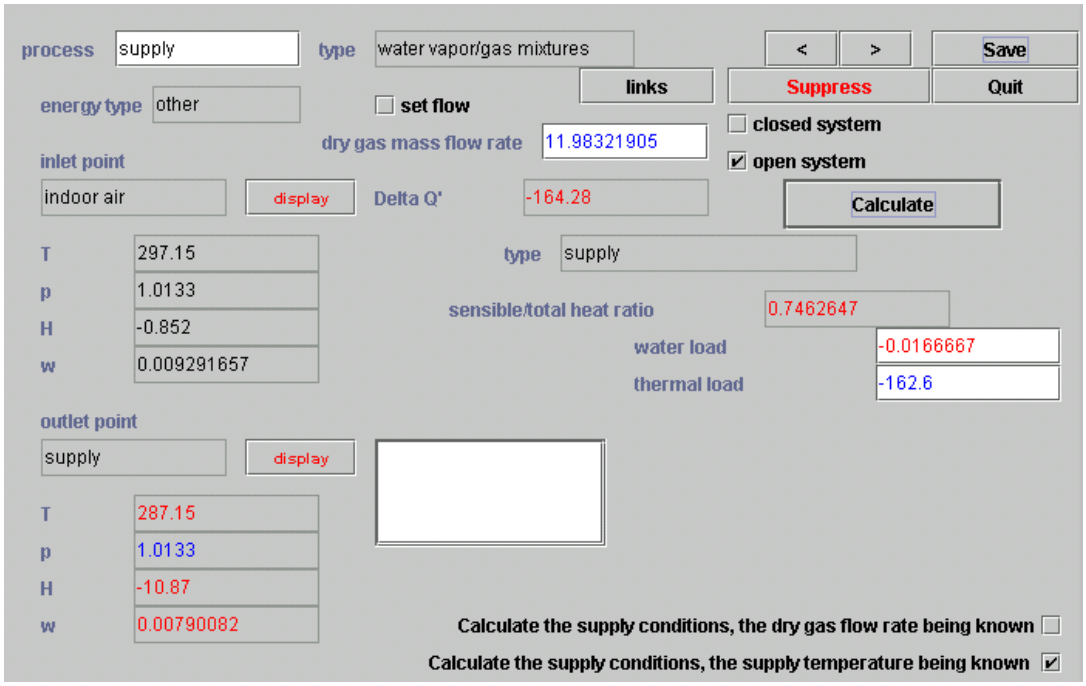


Process selection

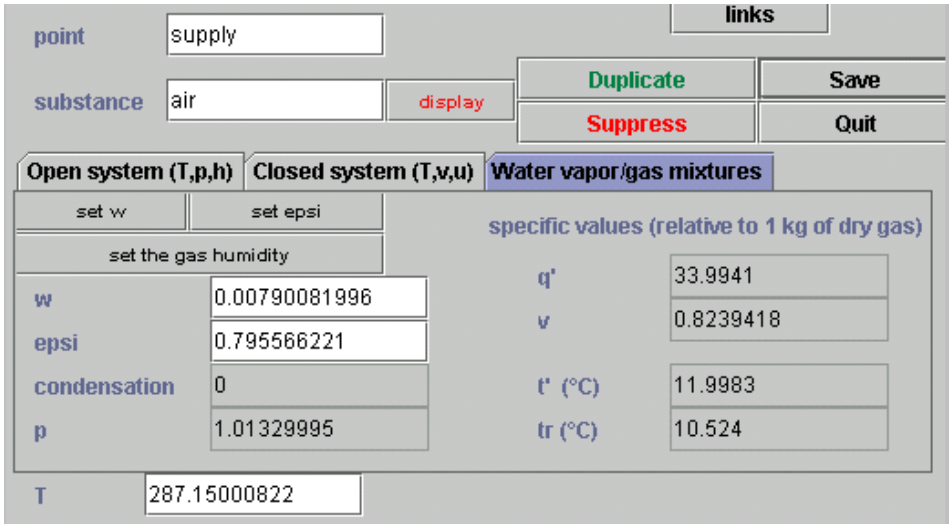
Repeat for the downstream point, and select "supply" as a point.

Enter the values of the thermal and water loads in the appropriate framework, with a negative sign because they are to be removed:

Finally calculate the process:



The process is calculated. The supply flow rate is determined, as well as the point "supply":



2 Properties of the mix

The first step of the air processing consists of calculating the properties of the mix (outdoor air / recycled air).

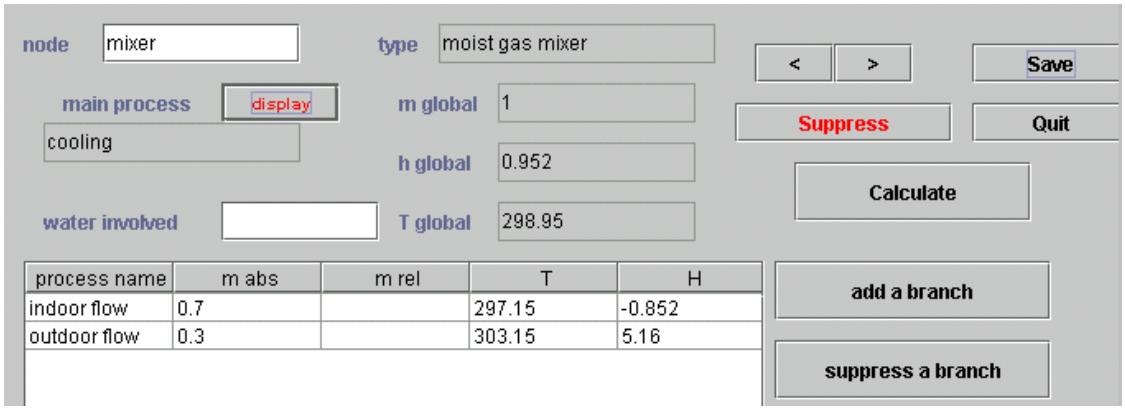
The problem consists now in determining how to process mixed air to obtain the supply conditions (287.15 K or 14 °C, w = 0.0079 kg/kg).

A solution is to cool the mixed air until its specific humidity is equal to that of the supply air, then to reheat it to obtain the desired temperature.

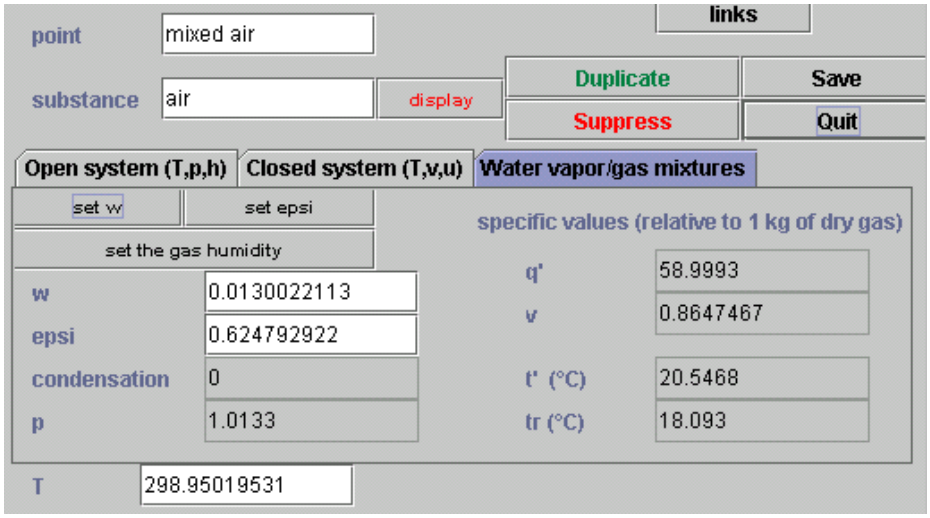
Create two new points, called "mixed air" and "cooled air", and connect them by a moist gas process of the cooling type named "cooling" ("mixed air" at the inlet and "cooled air" at the outlet).

Now, to be able to calculate the mixed air properties, it is necessaray to create two "exchange" processes representing the flows of outdoor air and recycled air, named "indoor flow" and "outdoor flow", and to set their respective mass flow rates (0.7 and 0.3). Each of these processes is connected at a single point at both the inlet and the outlet.

Create then a moist gas mixer whose branches are "indoor flow" and "outdoor flow", and whose main vein is "cooling". This mixer will automatically calculate the properties of the mix.



The mix properties are the following:

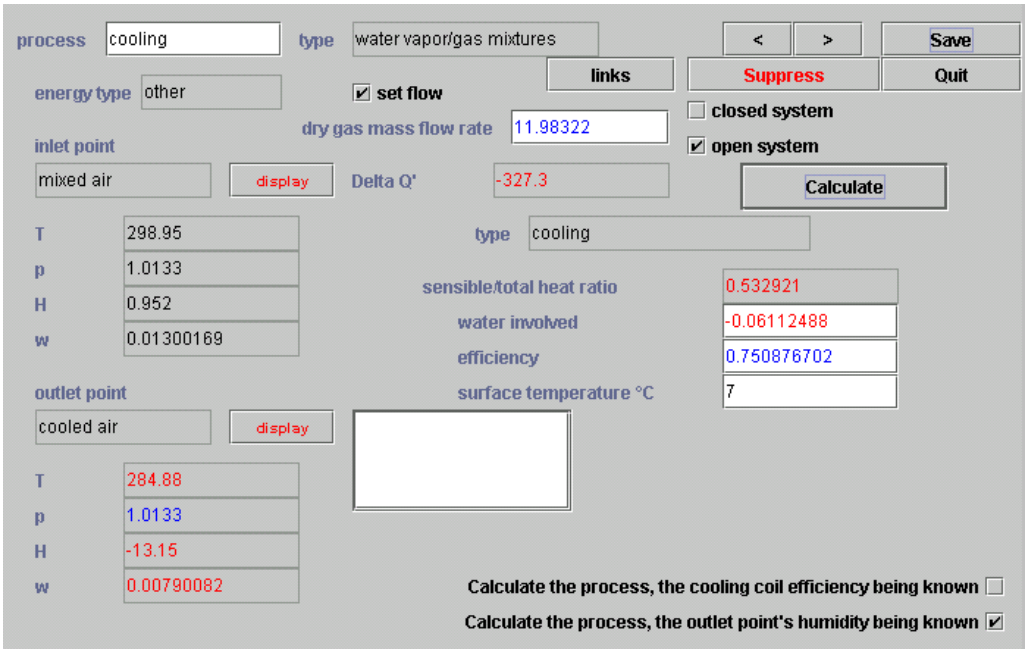


3 Air conditioning

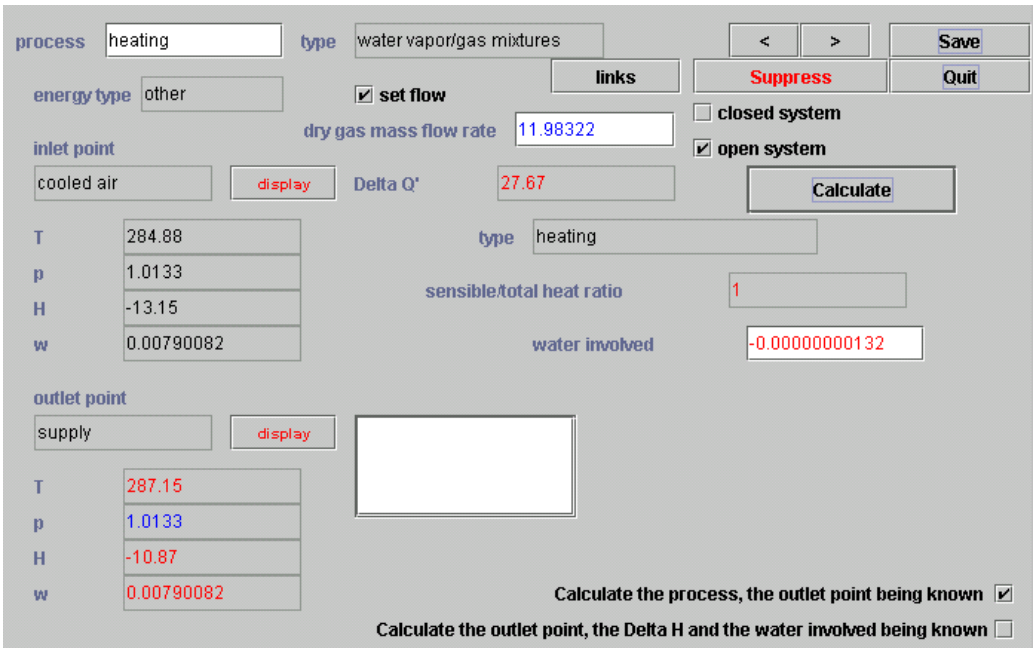
To calculate the cooling process, choose a realistic cooling coil surface temperature (for example 7 °C), check the "Calculate the process, the outlet point's humidity being known" calculation mode, and set the outlet point ("cooled air") humidity) to that of the supply conditions (w = 0.0079 kg/kg).

Then click on the "Calculate" button, so that THERMOPTIM researches the required coil efficiency.

You obtain the following results: the temperature of the cooled air is equal to 284.93 K or 11.78 °C, and the cooling coil efficiency is 75%.



To determine the required Delta H, one must connect the points "cooled air" and "supply" by a heating water vapor / gas mixture process of the same flow-rate as the "supply" process.

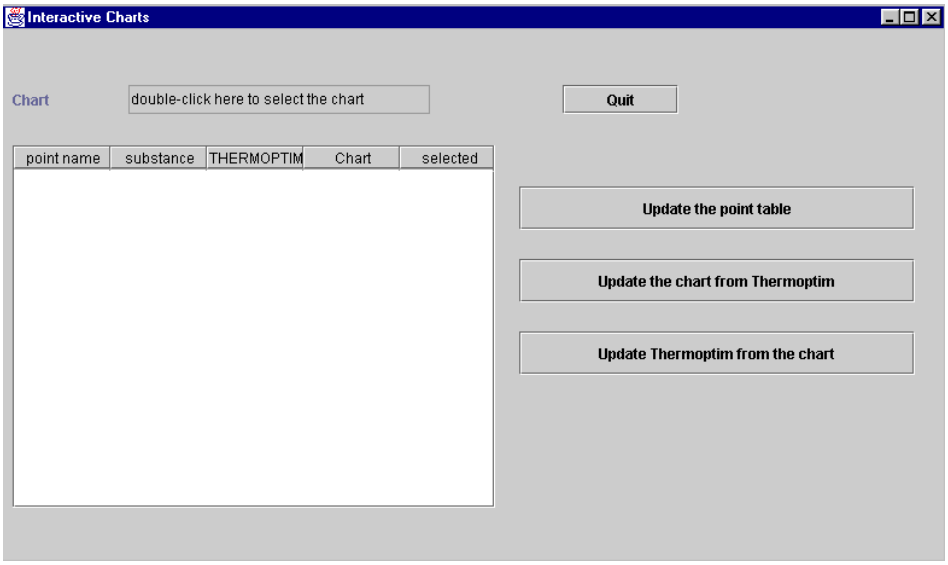


Save the project after having named if (for instance "aircond.prj").

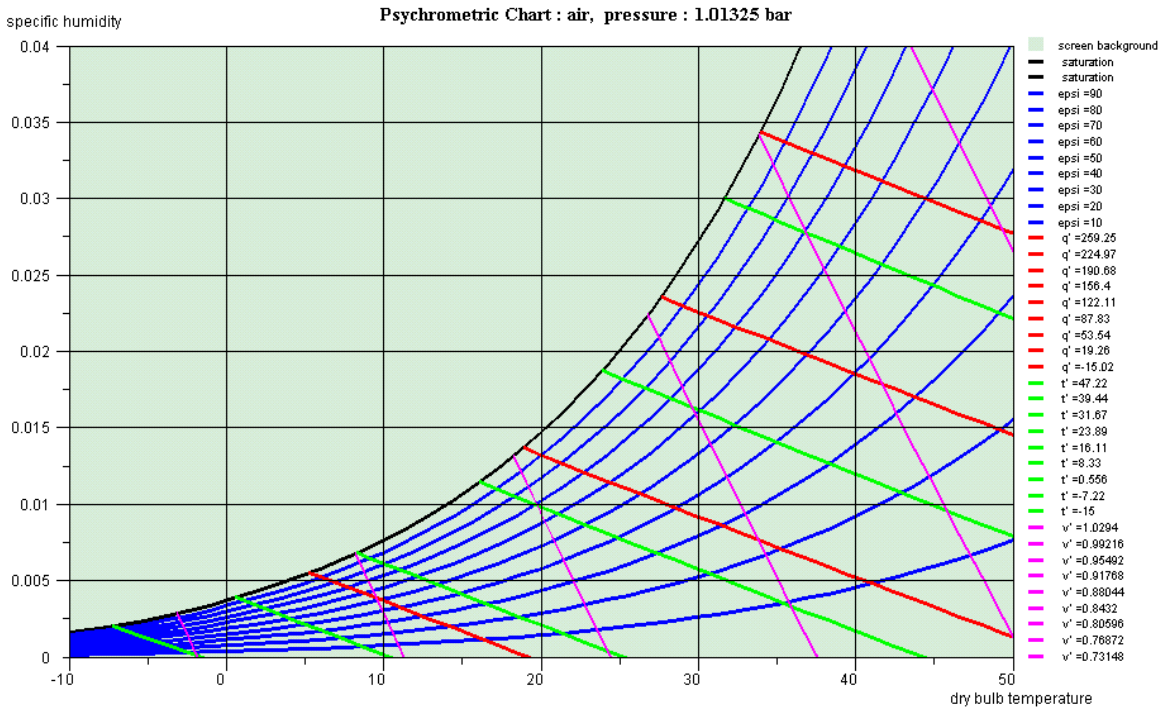
4 Plotting the cycle

If you have access to the Interactive charts, the cycle can be plotted in the following way: i n the main frame,

select item Interactive Charts of menu Special.



Then double-click in the field facing the label "Chart" and select "Psychrometric". If the substance selected is not airselect it by clicking "load a gas from the data base" after selecting the item "parameters" in menu "Chart" ; similarly change the pressure if necessary. The interactive chart frame is shown:



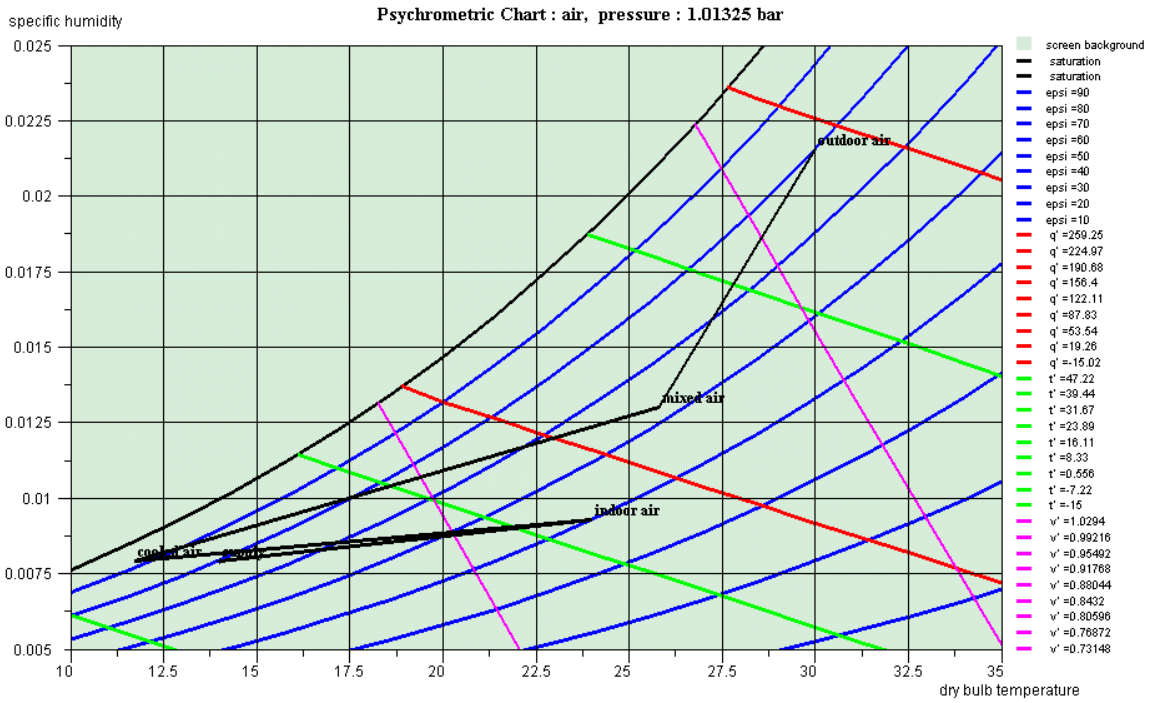
Then go back to the "Interactive Chart" frame, and click on "Update the point table". All the project points are displayed in the table:

point name	substance	THERMOPTIM	Chart	selected
outdoor air	air	X		X
mixed air	air	X		X
cooled air	air	X		X
indoor air	air	X		X
supply	air	X		X

The two first column show the names and the substance of the points. When a point is part of the Thermoptim project, a "X" appears in the third column, and when it is pszrt of the Chart cycle points, a "X" appears in the fourth one. Here, there are only Thermoptim project points.

The last table column titled "selected" shows the point status: if a "X" appears, the point is selected for being taken into account in the transfers between Thermoptim and the charts, otherwise not. To change a point status, double-click on the corresponding line. Here we want to plot all points, so we keep them all selected.

Now, click on "Update the chart from Thermoptim" to have the points transferred to the chart, and select "Connected Points" in menu Cycle. If necessary, change the axis layout in menu "Chart". You get the following result:



The problem is that the points are not in the right order: it is necessary to edit the cycle points to get a nice plot. Open the cycle point editor by selecting "Edit a cycle" in menu "Cycle". You get the following frame:

point name	dry bulb temperat...	specific humidity	relative humidity	specific enthalpy	wet bulb temperat...	specific volume
outdoor air	30	0.0215545	0.8	85.1836	27.0894	0.888703
mixed air	25.8002	0.0130017	0.624769	58.998	20.5463	0.864746
cooled air	11.72849	0.00790082	0.923109	31.6851	11.0427	0.817464
indoor air	24	0.00929166	0.5	47.7032	17.0601	0.85456
supply	14.00001	0.00790082	0.795566	33.9941	11.9983	0.823942

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By clicking on the little arrows located at the right of the screen, you can move up or down the different lines. This way you can move point "supply" above point "indoor air":

point name	dry bulb temperat...	specific humidity	relative humidity	specific enthalpy	wet bulb temperat...	specific volume
outdoor air	30	0.0215545	0.8	85.1836	27.0894	0.888703
mixed air	25.8002	0.0130017	0.624769	58.998	20.5463	0.864746
cooled air	11.72849	0.00790082	0.923109	31.6851	11.0427	0.817464
supply	14.00001	0.00790082	0.795566	33.9941	11.9983	0.823942
indoor air	24	0.00929166	0.5	47.7032	17.0601	0.85456

When you are done with your modifications, they can be transferred on the chart by clicking on the button "Validate". Automatically, the editor table points are then repositionned on the screen.