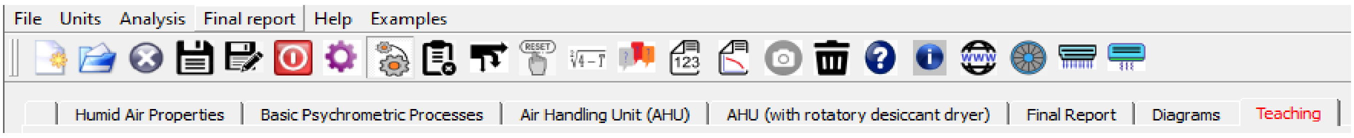
ThermoPsychro

THERMOPSYCHRO | Technical & Educational Software

THERMOPsychro is a software for the design of air conditioning systems, altering the properties of air (primarily humidity and temperature) to favorable conditions, typically with the aim of distributing the conditioned air to an occupied space is to improve comfort. Perform a complete thermodynamic study, including the second principle. It is supported by the psychometric diagram and allows a final report of the results.



INDEX

Characteristics

- **Solid technology**
- **Precision**
- **Easy handling**
- **Intuitive interface**
- **Input variability**
- **Application in several industrial systems**

Software capabilities

- Educational software
- Many current devices
- Energy and exergetic analysis
- Humid air properties
- Psychrometric diagrams
- Efficient use of resources
- Design of ACU
- Final report

Applications

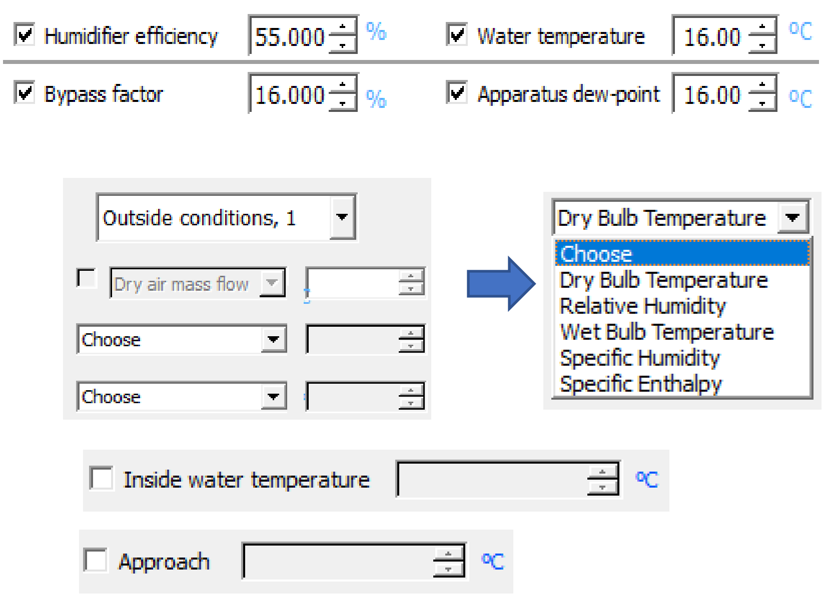
It is noteworthy the pedagogical use of these tools that improve the learning experience by facilitating students a greater mastery of psychrometric aspects, facilitating otherwise tedious and repetitive calculations, motivating them to focus more on design aspects and analysis of the meaning of the different parameters for technological application purposes with the objective of the study or analysis, as well as the improvement of this type of systems .

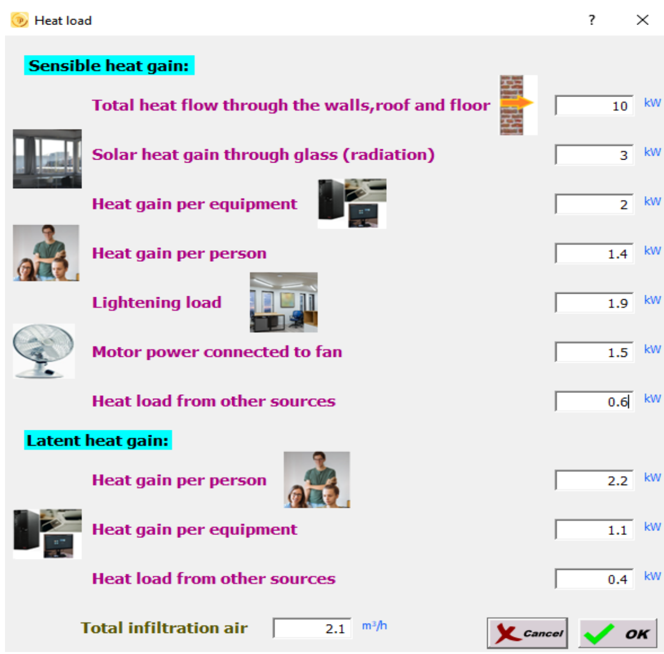
Characteristics

Software algorithms are based on up-to-date bibliography and the latest mathematical models, which in conjunction result in a **well-defined** and **solid technology**. The software has been set up with an **intuitive interface** that allows **easy handling**.

Input data

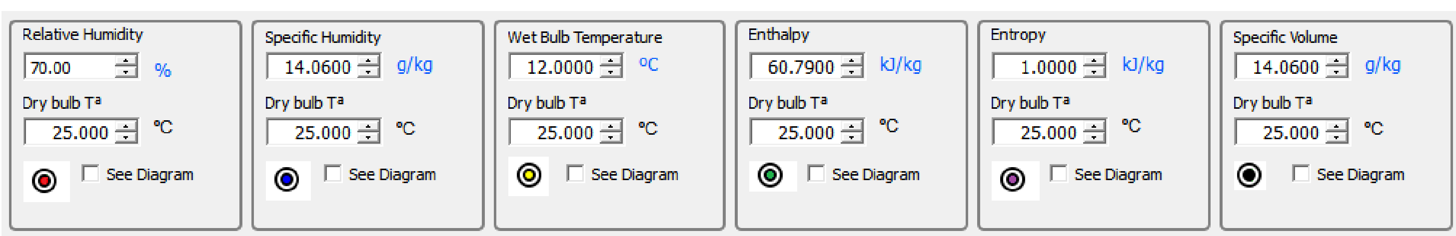
The software allows different combinations of input data, including the sensible and latent heats of each process, as well as the thermodynamic state of a specific point. Allows to work in design mode, introducing the gain and loss of thermal loads.



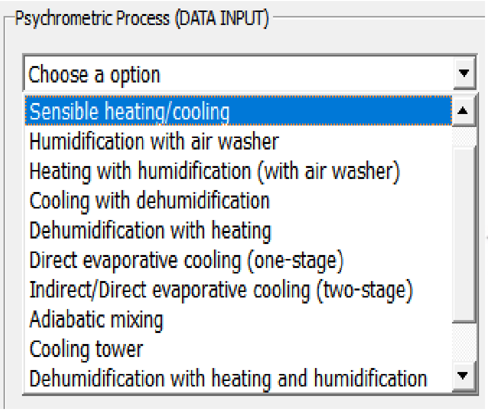


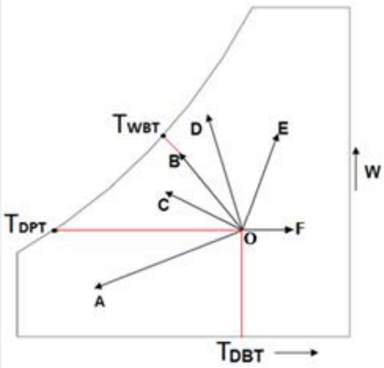
Psychrometry diagram

A psychrometric chart presents physical and thermal properties of moist air in a graphical form. It allows different combinations of input variables, as well as working at locations above sea level.



Software capabilities





A → Cooling and dehumidification: $T_{apt} < T_{DPT}$

Humidification with air-washer:

B → Evaporative cooling: $T_w = T_{WBT}$ (adiabatic, pure water recirculation)

C → Cooling: $T_{DPT} < T_w < T_{WBT}$ (water cooled externally)

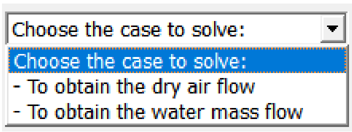
D → Cooling: $T_{WBT} < T_w < T_{DBT}$ (water heated externally)

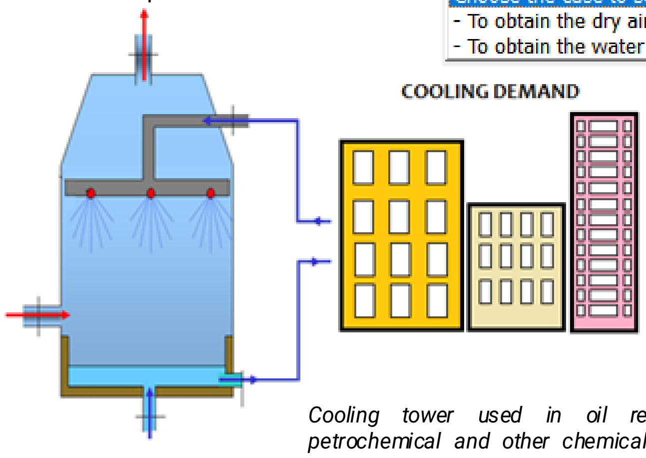
E → Heating: $T_w > T_{DBT}$ (water heated externally or vapor)

F → Sensible heating: $T_F > T_{DBT}$

Cooling tower

Various possibilities of calculation.

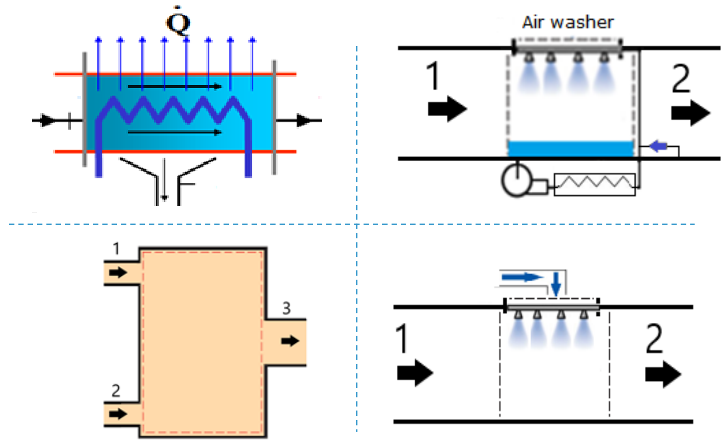




Cooling tower used in oil refineries, petrochemical and other chemical plants, thermal power stations, nuclear power stations and HVAC systems for cooling buildings.

Basic psychrometric processes

Psychrometry is the study related to the thermodynamic properties of humid air (mixture of dry air with water vapor), such as temperature, humidity, enthalpy and specific volume.

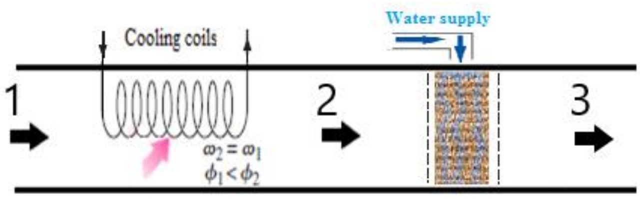


Psycrometric process

Evaporative cooling

The principle underlying evaporative cooling is the fact that water must have heat applied to it to change from a liquid to a vapor. When evaporation occurs, this heat is taken from the water that remains in the liquid state, resulting in a cooler liquid.

Evaporative cooling systems use the same principle as perspiration to provide cooling for machinery and buildings.



Indirect/Direct evaporative cooling (two-stage)

Numerical results

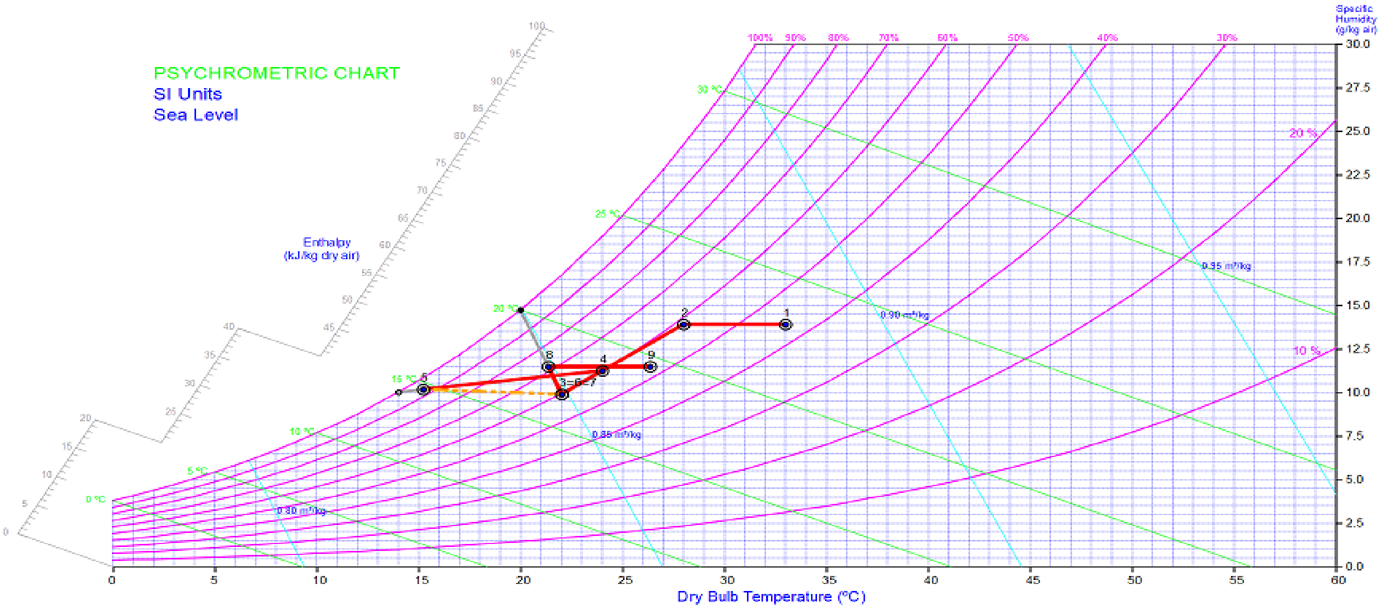
Psychrometry is therefore useful in the design and analysis of food storage and processing systems, design of refrigeration equipment, study of food drying, studies of air conditioning and air conditioning, cooling towers, and in all industrial processes that require strong control of the water vapor content in the air.

Variable	State 1	State 2	State 3	State 4	State 5	State 6	State 7	State 8	State 9	Units
Pressure	101325	101325	101325	101325	101325	101325	101325	101325	101325	Pa
Dry bulb temperature	33	27	22	25.75	17.56	22	22	18.6959	24.7327	ºC
Relative humidity	44	62.0946	60	62.1424	92.8142	60	60	79.6988	55.1011	%
Humidity at saturation	32.5187	22.6968	16.6698	21.0287	12.5742	16.6698	16.6698	13.5249	19.7543	g/kg air
Specific humidity	13.9012	13.9012	9.89577	12.9026	11.6537	9.89577	9.89577	10.7318	10.7318	g/kg air
Degree of saturation	0.427483	0.612473	0.593636	0.613571	0.926795	0.593636	0.593636	0.793485	0.543264	
Dew temperature	19.123	19.123	13.8835	17.9583	16.3816	13.8835	13.8835	15.1173	15.1173	ºC
Wet bulb temperature	23.2416	21.5418	16.872	20.4539	16.7993	16.872	16.872	16.4188	18.48	ºC
Density	1.12805	1.15078	1.17765	1.15742	1.19247	1.17773	1.17765	1.18945	1.16536	kg/m3
Specific volume	0.886486	0.868973	0.849151	0.863989	0.838598	0.849092	0.849151	0.840727	0.858107	m3/kg
Saturation pressure	5034.59	3567.49	2644.89	3313.87	2007.94	2644.89	2644.89	2156.52	3119.22	Pa
Vapor pressure	2215.22	2215.22	1586.93	2059.32	1863.65	1586.93	1586.93	1718.73	1718.73	Pa
Enthalpy	68.8045	62.6081	47.2725	58.7742	47.1724	47.2725	47.2725	46.0046	52.201	kJ/kg
Entropy	0.243136	0.222712	0.170229	0.209675	0.170163	0.170229	0.170229	0.166074	0.187071	kJ/kg K
Air pressure	99109.8	99109.8	99738.1	99265.7	99461.3	99738.1	99738.1	99606.3	99606.3	Pa
Total exergy	2.57086	2.03942	1.06412	1.77251	1.06918	1.06412	1.06412	0.990046	1.36216	kJ/kg
Thermal exergy	1.46557	0.934131	0.574294	0.836136	0.330331	0.574294	0.574294	0.3863	0.758415	kJ/kg
Mechanical exergy	0	0	0	0	0	0	0	0	0	kJ/kg

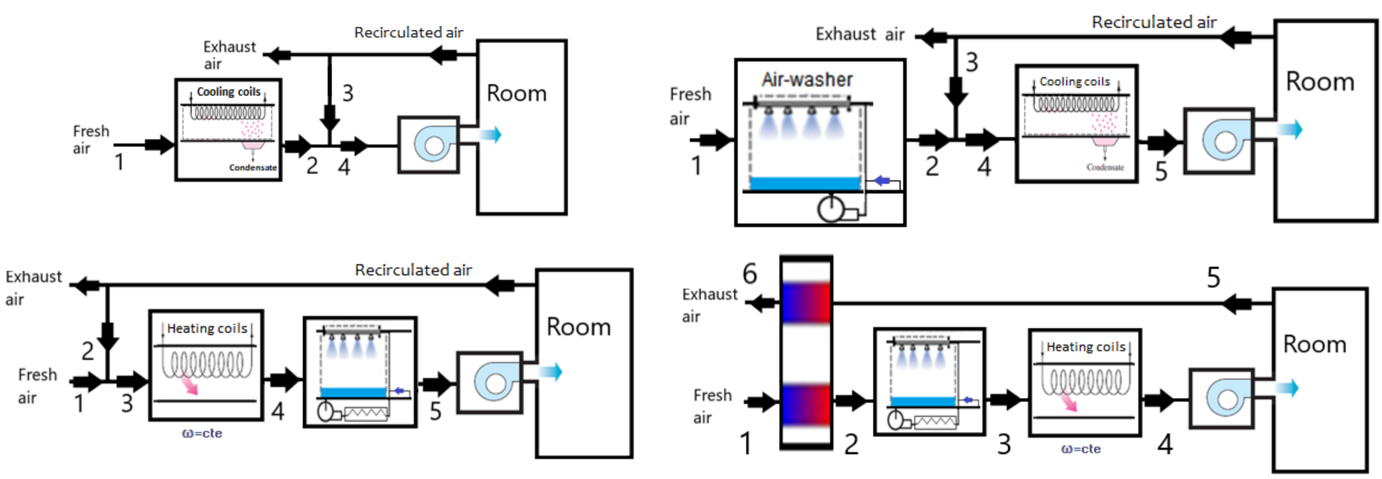
Some numerical results

Air Conditioning Units

Air conditioning is a process of treating the air in such a way that its temperature, humidity, cleanliness and distribution are controlled, so that it meets the requirements of the conditioned space (temperature control, humidity control, filtering, air cleaning and purification, and air circulation and movement). All these properties can be visualized and related in the Psychrometric Diagram.

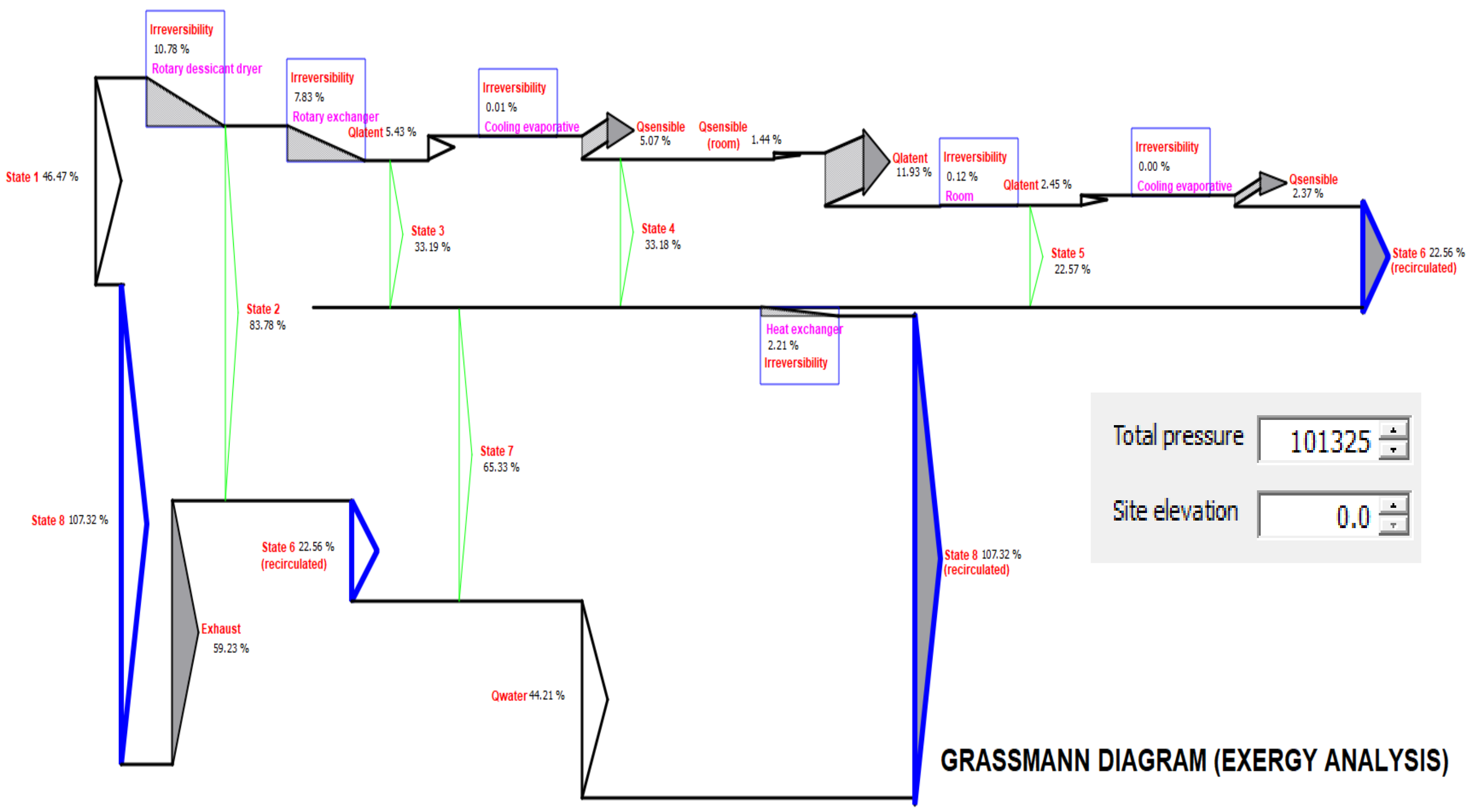


Graph of the Psychrometric Diagram



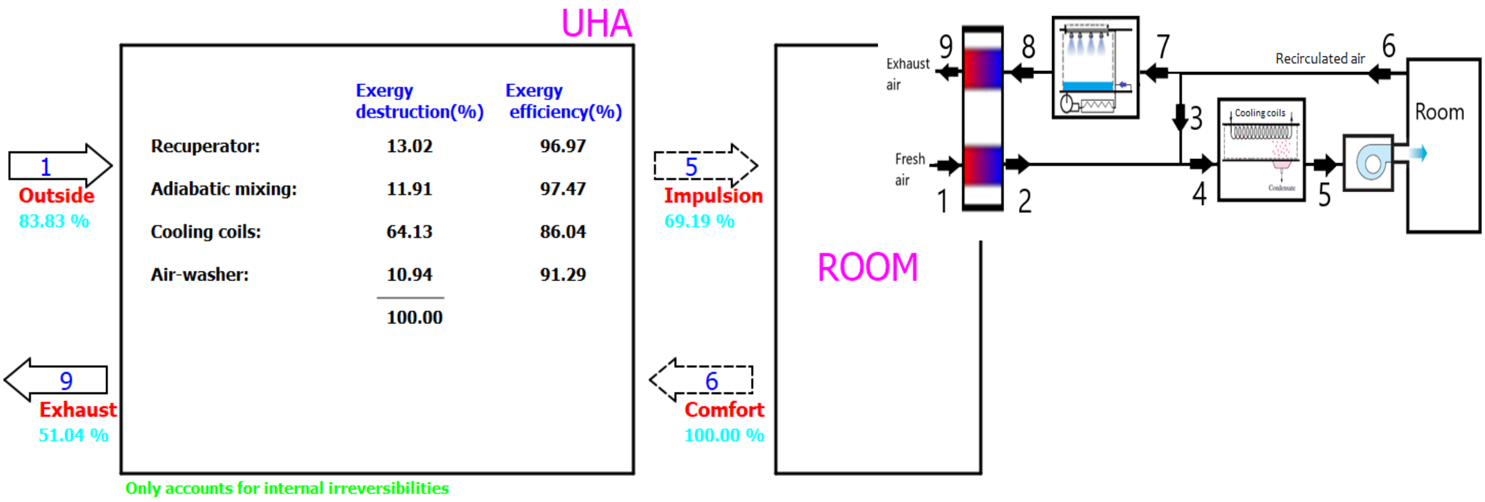
Applications: Industry applications

In our professional life we will have to condition houses, buildings and industries and even control materials manufacturing processes, to improve the quality of the finished product. To condition the air in a space, it is required to have basic knowledge of the properties of air and humidity, perform calculations for heating or cooling and even handle specific instruments.



Summary of results (exergy analysis of UHA)

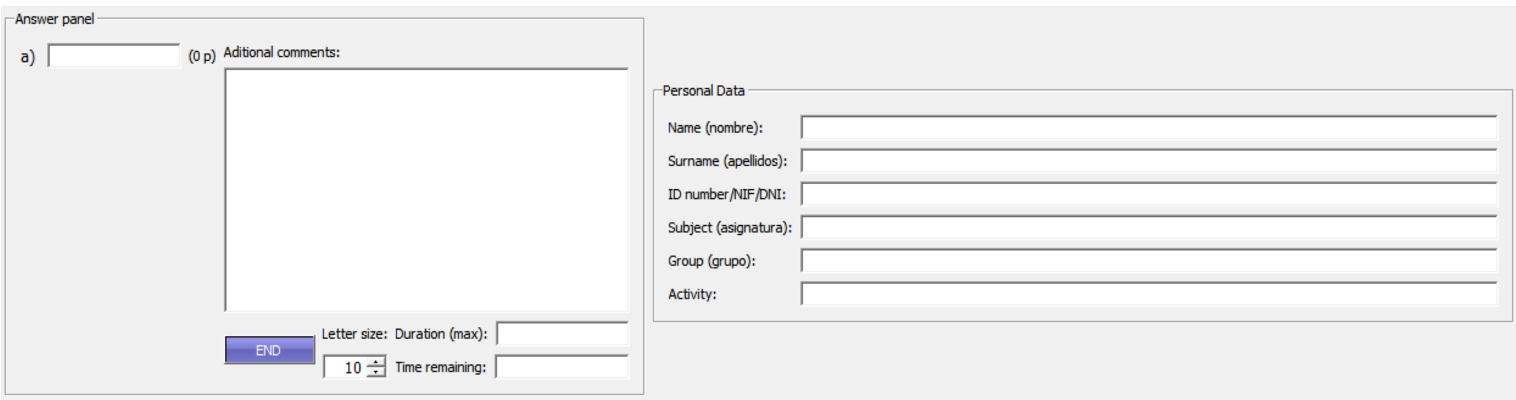
Traditional methods of human thermal comfort are based on the first law of thermodynamics. These methods use an energy balance to study UHA with the mass and heat transfer between the room and its environment. By contrast, the second law of thermodynamics introduces the concept of exergy. It enables the determination of exergy consumption in the different elements of the installation dependent on the design parameters and environmental factors.

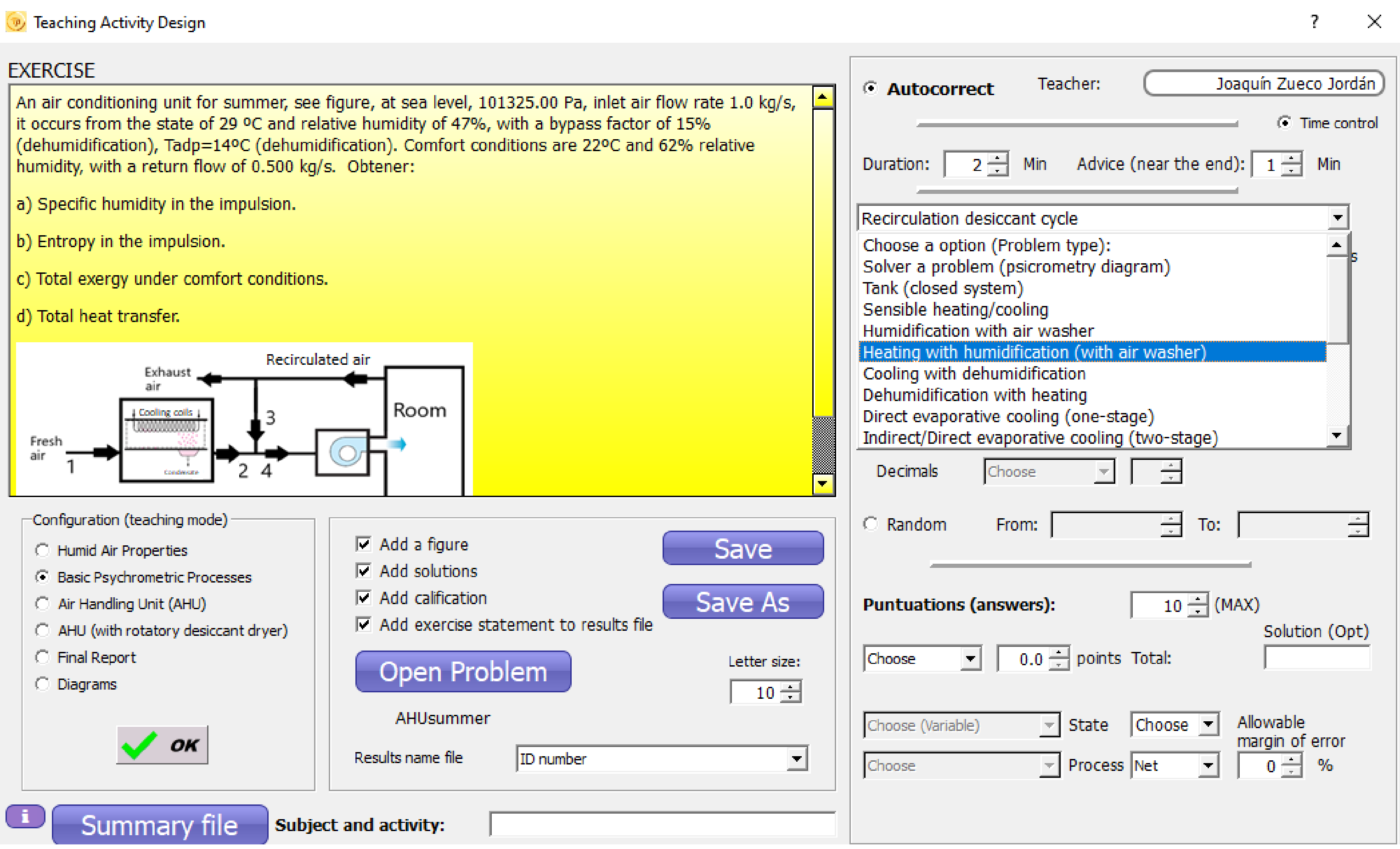


Exergy analysis for Summer Air Conditioning Unit (with heat recovery and humidifier in extraction stream)

Teaching activity

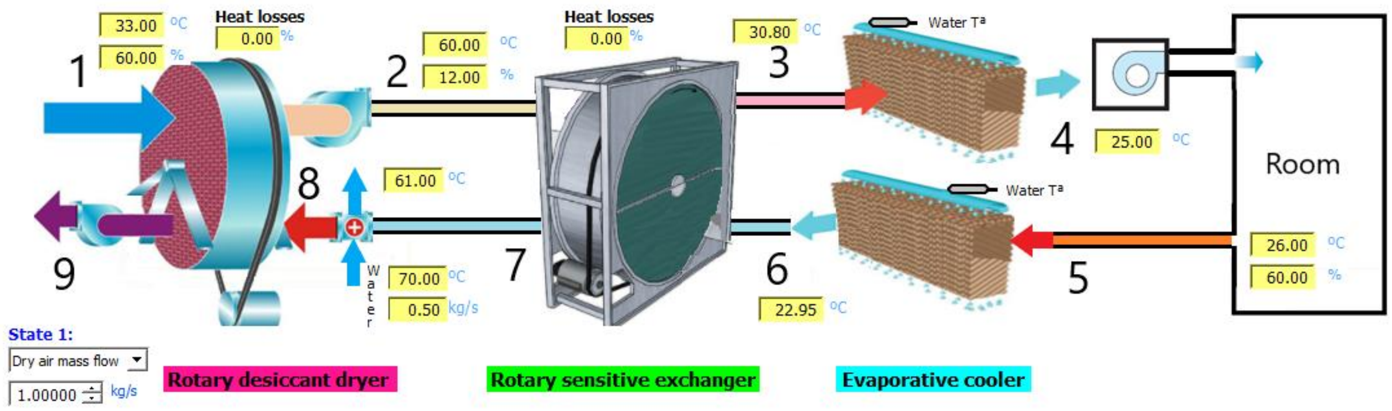
The teacher can design a teaching activity that the student will solve using the software and the score obtained by the student, results and student responses are generated immediately in a pdf file no-editable. You can decide the random variables and the interval of the random variables, so that each student has a different exercise.



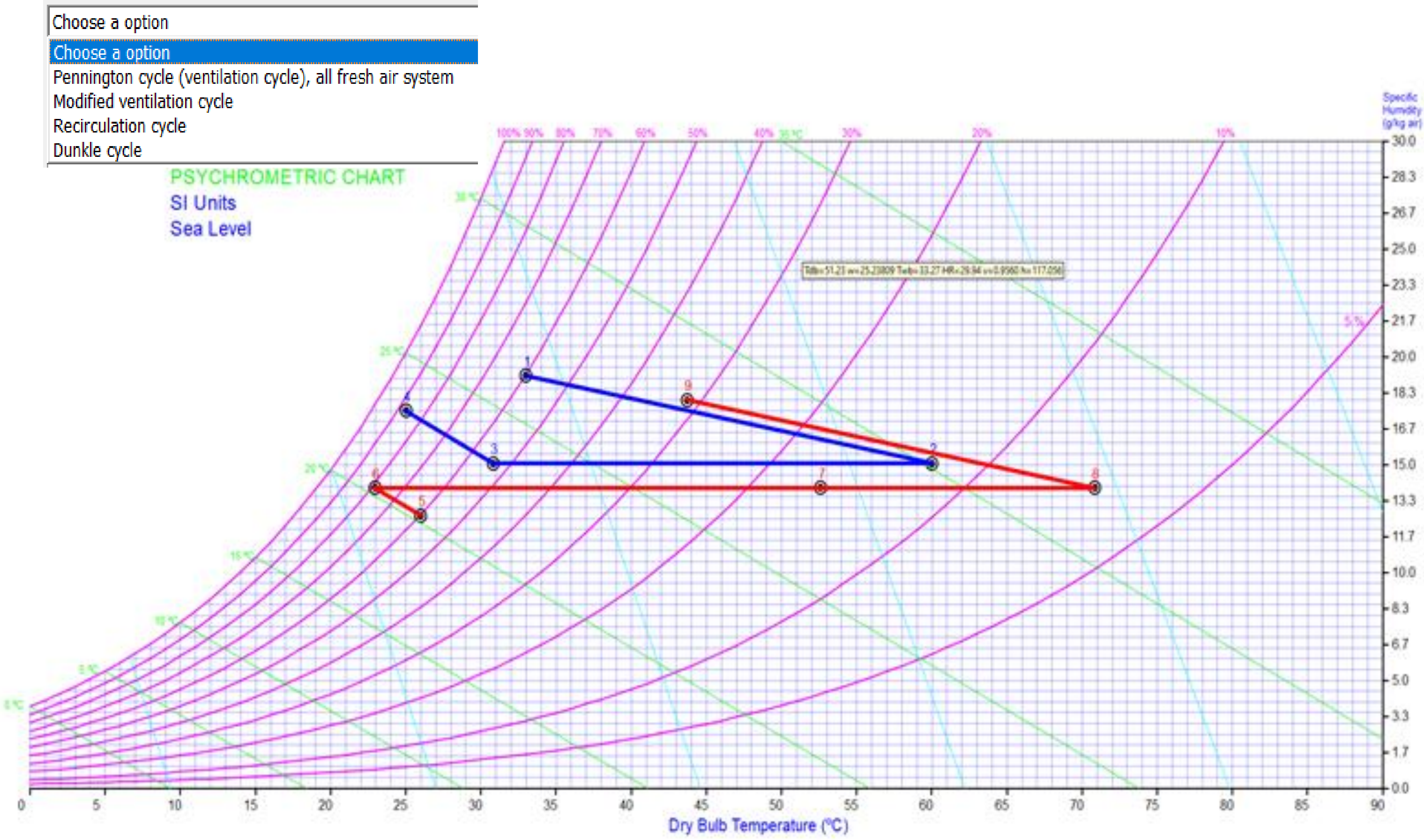


Desiccant process (Air Conditioning Unit)

Desiccant cooling systems have been considered as an efficient method of controlling moisture content in supply air. They do not use any ozone-depleting coolants and consume less energy as compared with the vapor compression systems. Desiccant systems include rotating desiccant wheel, solid packed tower, liquid spray tower, falling film and multiple vertical bed.



ACU with rotatory dessicant dryer



Graph of the Psychrometric Diagram

THERMOPsychro Software: PROPERTIES OF HUMID AIR -AIR CONDITIONING PROCESSES

Outdoor air handling equipment: Summer air conditioning unit (with heat recovery and humidifier in extraction stream).

DATA INPUT:

Dry air mass flow (state 1):	1.5000 kg/s
Dry air mass flow (state 3):	0.5000 kg/s
Dry bulb temperature (state 1):	33.0000 ºC
Relative humidity (state 1):	44.0000 %
Dry bulb temperature (state 2):	27.0000 ºC
Dry bulb temperature (state 3):	22.0000 ºC
Relative humidity (state 3):	60.0000 %
Dry bulb temperature (state 8):	22.5526 ºC
Humidifier efficiency:	55.000 %
Water temperature:	23.000 ºC
Bypass factor:	6.000 %
Apparatus dew-point:	12.000 ºC

Results	1-2	2-3-4	4-5	7-8	8-9	Room	Net	Units
Delta-w	0		-3.88669	4.36073	0	0.879858	1.3539	g/kg
Delta-RH	18.0946		35.6307	23.0079	-24.8659	-37.7731	14.0942	%
Delta-Tdb	-6.00001		-12.925	0.552576	5.99692	9.17499	-3.20053	ºC
Delta-Twb	-1.69986		-7.83218	3.59302	1.76974	4.25021	0.0809302	ºC
Delta-v	-0.0175128		-0.0425138	0.00747049	0.0173364	0.0276165	-0.00760321	m3/kg
Delta-h	-6.19643		-23.1232	11.646	6.19643	11.6214	0.1442	kJ/kg
Delta-s	-0.0204245		-0.0795371	0.040173	0.0207279	0.0400913	0.0010306	kJ/kg ºC
Sensible heat	-9.29464		-26.4473	0.849472		18.773	-16.1195	KW
Latent heat			-19.799	16.6196		4.46987	1.29047	kW
Total heat	-9.29464		-46.2463	17.4691		23.2429	-14.8289	kW
Energy efficiency		100	100	100	62.6787			%
Generated entropy		0.00016647	0.00435005	0.000163275	0.000457284	0.00263182	0.0077689	kW/ºC
Irreversibility		0.0461372	1.20562	0.0452517	0.126736	0.729409	2.15315	kW
Exergy efficiency		98.7145	65.97	98.3339	98.0577			%
Water mass flow			0.00777337					kg/s
Water temperature				23				ºC
Humidifier efficiency				55				%
Bypass factor			6					%
Apparatus dew-point			12					ºC
Recuperator efficiency	57.4305							%
Recirculated air								
Coil sensible HF (CSHF)			0.571879	0.0486272				
Room sensible HF (RSHF)						0.807689		