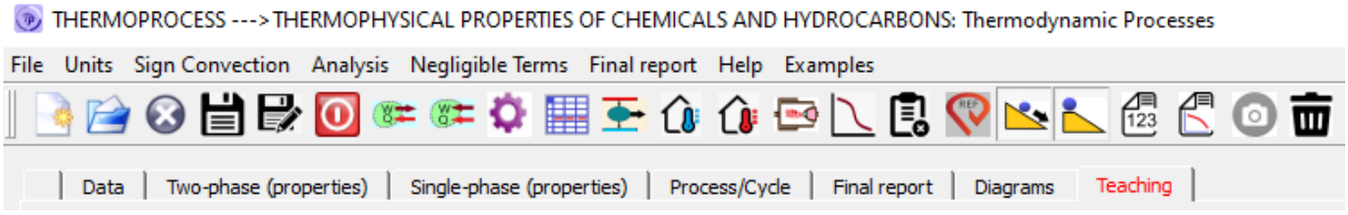
THERMOPROCESS | Technical & Educational Software

It is a software for solving problems applied in **Applied Thermodynamics**. The software is supported by up to 13 thermodynamic diagrams, from the most common to the less common ones, to facilitate the student's problem solving. Being able to define the problem with from numerical data of the different thermodynamic states or define these states interacting directly on the thermodynamic diagram.



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Characteristics

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

Software capabilities

- Educational software
- Thermodymanic properties
- Thermophysical properties
- Energy and exergetic balance
- Open and closed systems
- Thermodynamic diagrams
- Properties in gas mixtures
- Equations of state of substances
- Final report

Applications

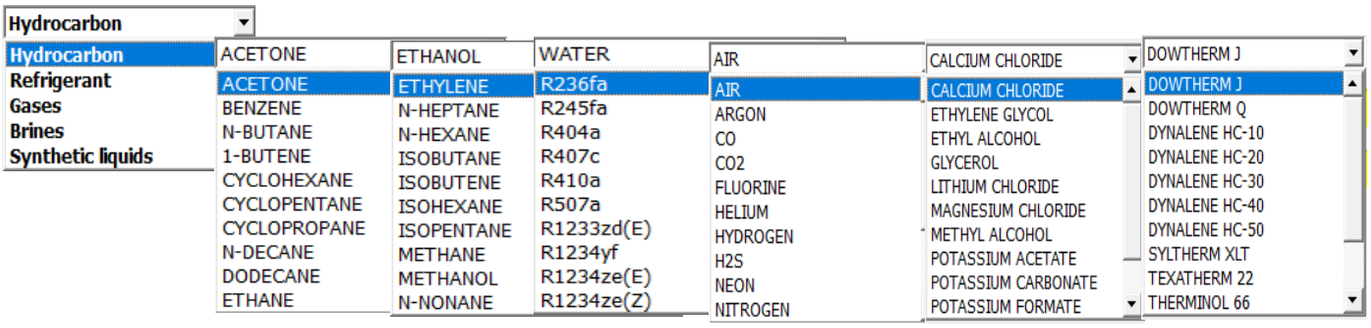
It is noteworthy the pedagogical use of these tools that improve the learning experience by facilitating students a greater mastery of thermodynamic aspects, facilitating otherwise tedious and repetitive calculations, motivating them to focus more on design aspects and analysis of the meaning of the different parameters for technological application purposes.

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

It also consists of a database of many substances, hydrocarbons, gases, refrigerants, synthetic liquids and brines, to obtain their thermodynamic and thermophysical properties.



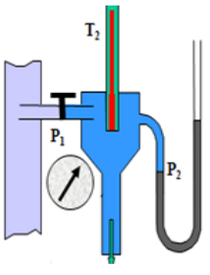
Substances

Substance properties database

The thermodynamic and thermophysical properties for the subcooled liquid, two-phase mixture and vapor states can be obtained for a large number of substances, including refrigerants and synthetic liquids used in heat transfer applications.

Thermodynamic Properties	Saturated liquid	Saturated vapor	Units
Temperature	58.0749	58.0749	°C
Pressure	108445	108445	Pa
Density	746.576	2.41803	kg/m3
Specific volume	0.00133945	0.41356	m3/kg
Internal energy	4.32427	458.833	kJ/kg
Enthalpy	4.46952	503.681	kJ/kg
Entropy	0.013506	1.52067	kJ/kg K
Exergy	3.62417	53.4736	kJ/kg
Gibbs function	-0.00399235	-0.00399235	kJ/kg
Compressibility factor	0.00306352	0.945874	
Surface tension	0.0186121	0.0186121	N/m

Thermodynamic properties



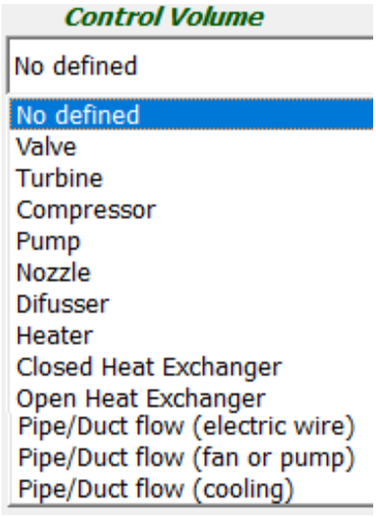
Thermal Transport Properties	Saturated liquid	Saturated vapor	Units
Thermal conductivity	0.160276	0.0157956	W/mK
Dynamic viscosity	0.000342022	8.25809e-06	kg/m s
Kinematic viscosity	4.58121e-07	3.41521e-06	m2/s
Isobaric specific heat	2.2356	1.57953	kJ/kgK
Isochoric specific heat	1.36416	1.60931	kJ/kgK
Thermal difussivity	9.60286e-08	4.13567e-06	m2/s
Prandtl number	4.77067	0.825794	

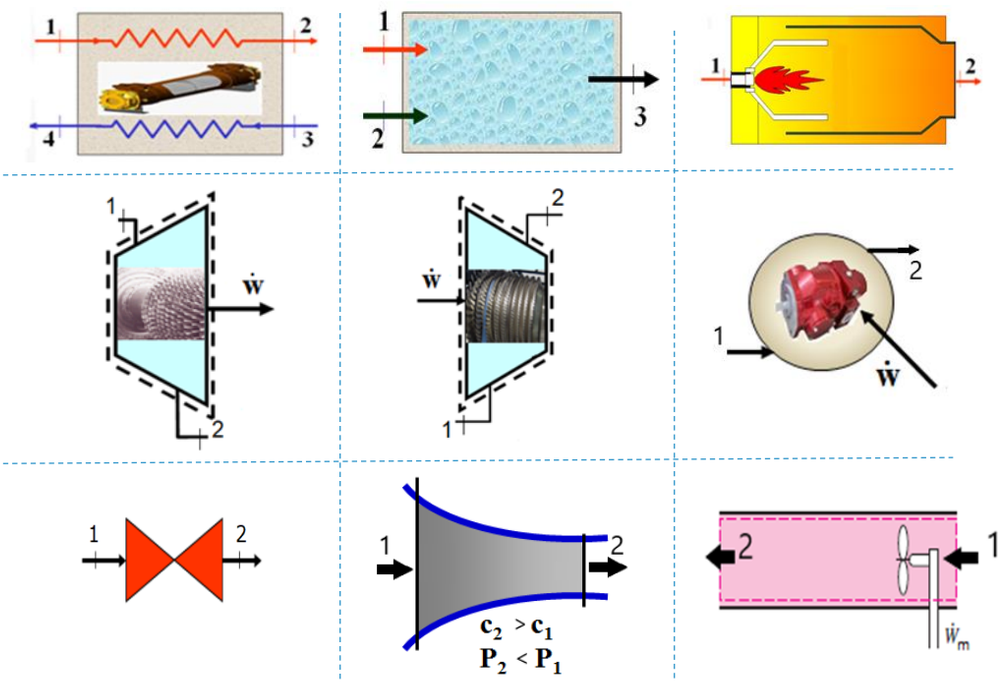
Thermophysical properties

Software capabilities

Open systems

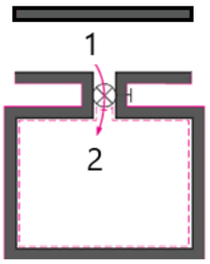
The open system is one in which the energy and mass interactions take place at the system boundary.





Unsteady flow processes (transient flow processes)

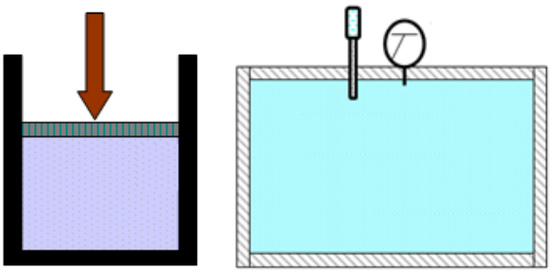
There exist a number of systems such as filling up of a bottle or emptying of a vessel etc, in which properties change continuously as the process proceeds. Such systems can not be analyzed with the steady state assumptions.



Charging of a rigid tank

Close systems

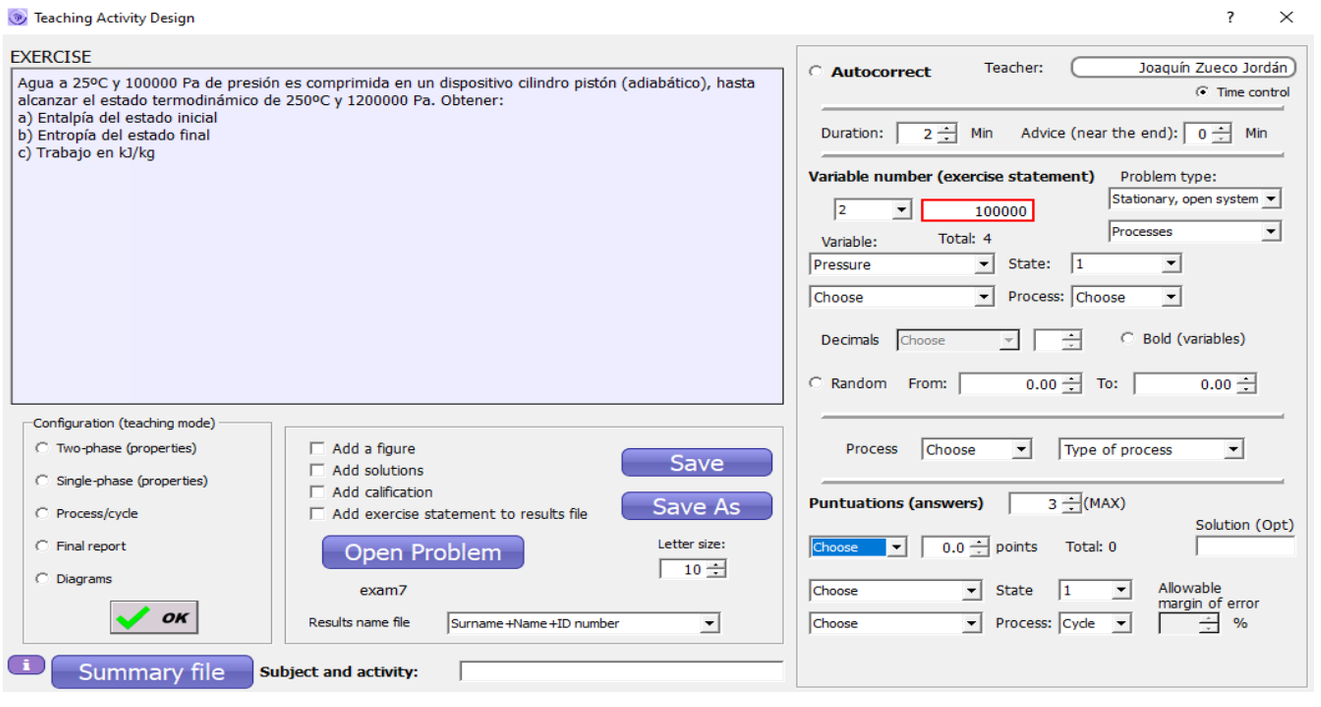
Closed system is the system having only energy interactions at its boundary. The mass interactions in such system are absent.



Piston-cylinder and deposit devices

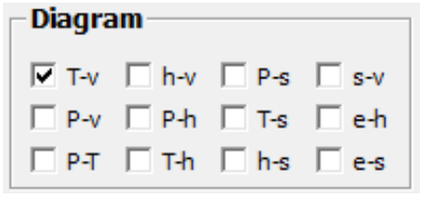
Teaching activity

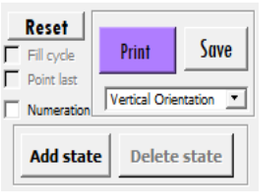
The teacher can design a teaching activity that the student will solve using the software and the score obtained by the student, results and student responses are generated immediately in a pdf file no-editable.

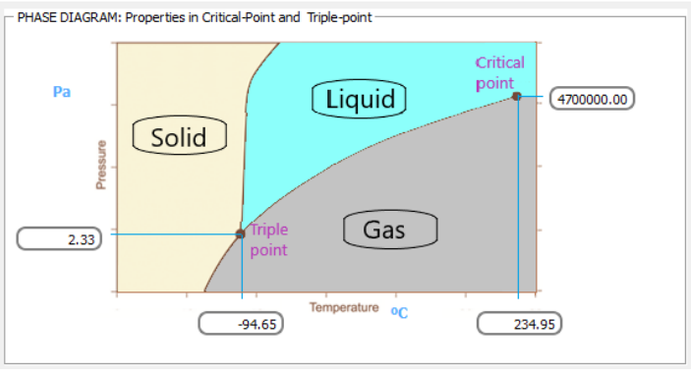


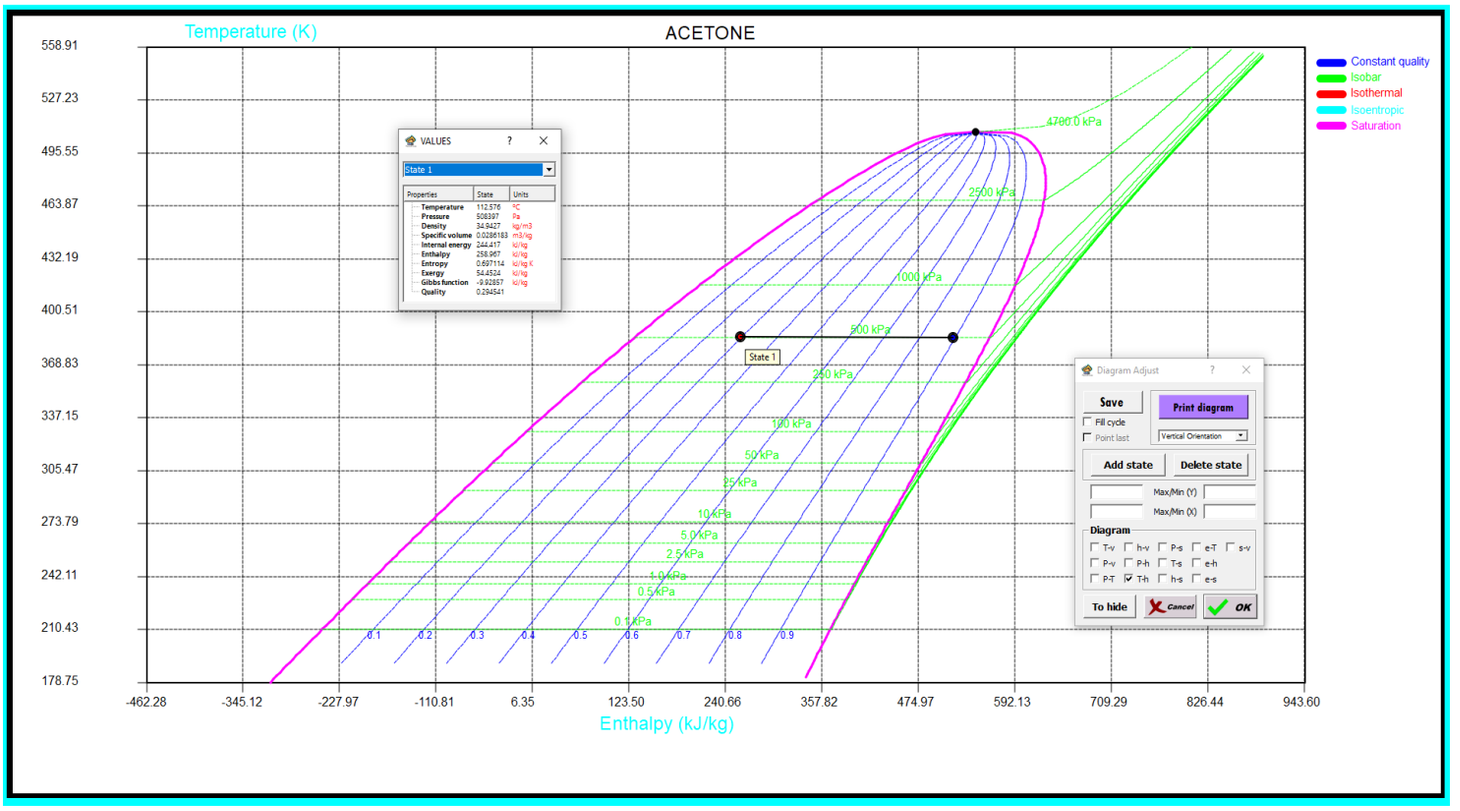
Thermodynamic diagrams

Analysis of main variables involved in the processes' study. Graphical display of results and calculation of the results of each problem studied.

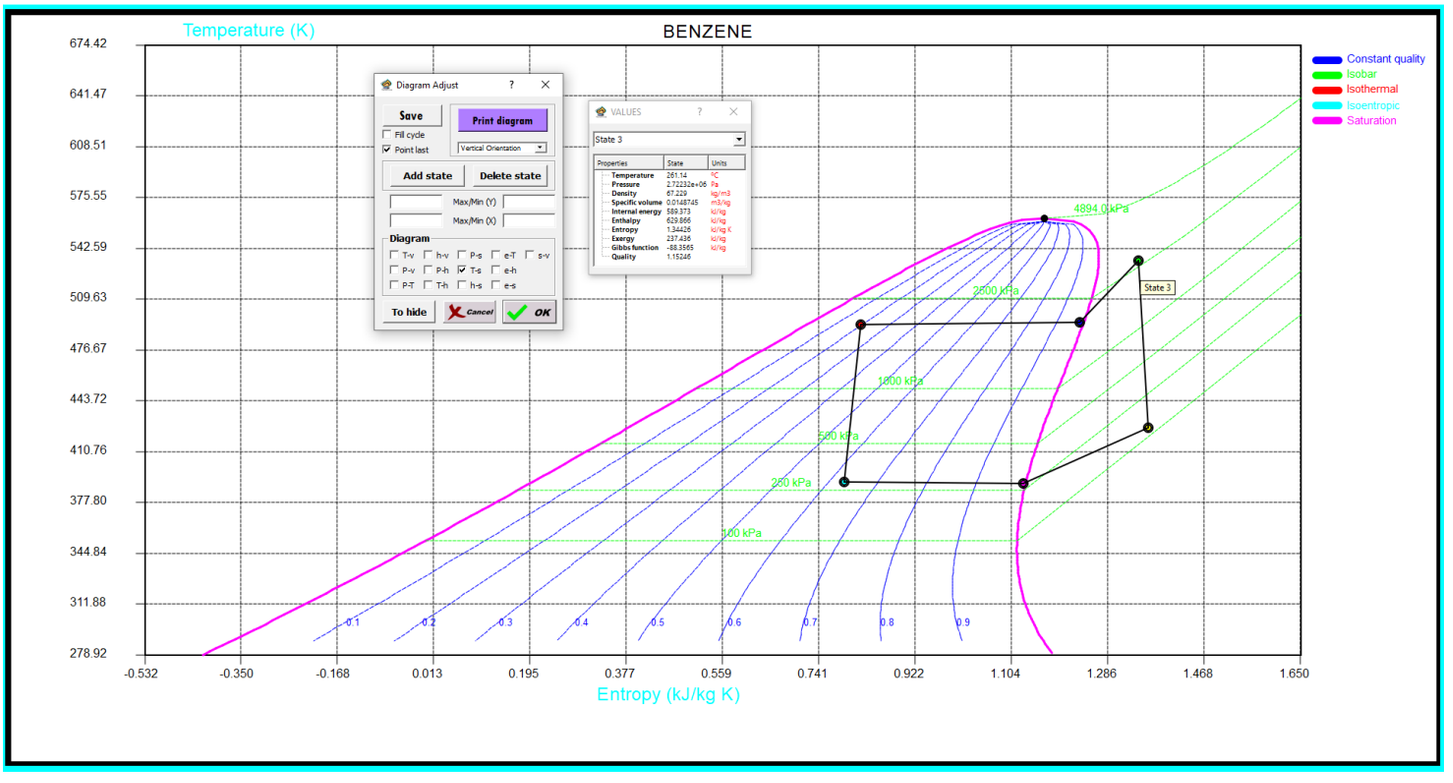








Graphic representations of a thermodynamic process



Graphic representations of a thermodynamic cycle

Applications

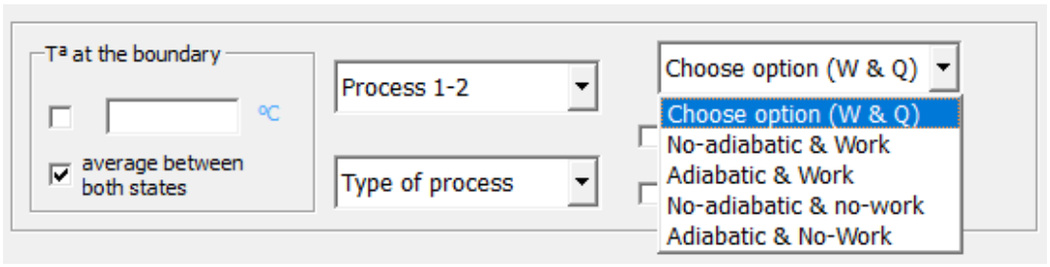
In summary, ***ThermoProcess*** provides a complete solution of thermodynamic problems, for close and open systems, analysing the effect of the main variables that participate in the process, through the possibility of graphical analysis to up thirteen diagrams (T-v, p-v, p-T, h-v, p-h, T-h,T-s, p-s, h-s, s-v, e-h, e-T and e-s).

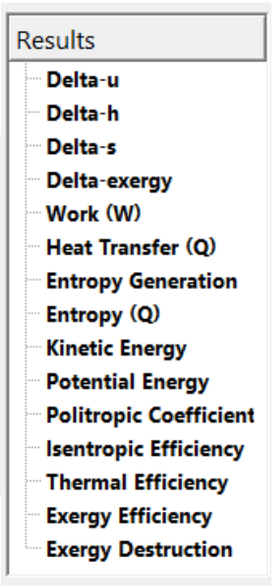
Whole range of software capabilities facilitates an improvement in thermodynamic process design, an exhaustive study of main variables effects, and the possibility to reduce irreversibilities. A final report (set up by the user) can be submitted, containing graphs and predictions.

It was developed as an interactive and illustrative tool for the simulation of thermodynamic processes. This simulator serves didactic purposes as both students and teachers can simulate these processes in a friendly, intuitive environment for those who have a basic training in the matter, with graphic and numerical answers to the problems that arise.

Numerical results

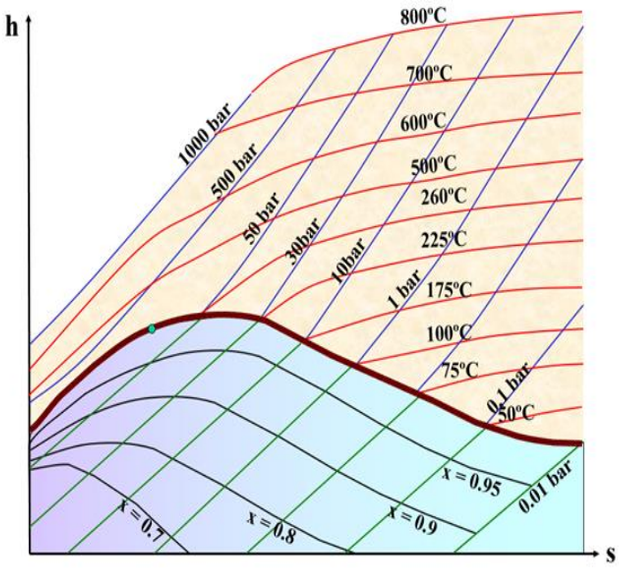
The software supplies the thermodynamic properties of each state (including exergy), as well as the exchanges of heat, work, entropy generation, exergy destruction, etc., in each process. The thermal and exergetic efficiencies are also obtained. Finally, the isentropic performance and the polytropic coefficient of each process can be obtained or initially defined by the user.





Thermodynamic Properties	State 1	State 2	State 3	State 4	State 5	State 6	Units
Temperature	220.125	221.59	261.14	153.232	116.612	117.588	ºC
Pressure	1.96191e+06	2.00489e+06	2.72232e+06	123591	276361	283031	Pa
Density	197.613	53.3702	67.229	2.78387	7.19492	11.5295	kg/m3
Specific volume	0.0050604	0.018737	0.0148745	0.359212	0.138987	0.0867337	m3/kg
Internal energy	346.36	523.431	589.373	453.489	396.937	279.623	kJ/kg
Enthalpy	356.288	560.997	629.866	497.885	435.348	304.171	kJ/kg
Entropy	0.820119	1.23346	1.34426	1.3613	1.12551	0.78745	kJ/kg K
Exergy	120.129	201.599	237.436	100.372	108.136	77.7523	kJ/kg
Gibbs function	-48.2567	-49.247	-88.3565	-82.5499	-3.33302	-3.51576	kJ/kg
Quality	0.193558	0.985941	1.15246	1.0363	0.994545	0.631349	

Some numerical results



ThermoLab
Technical Software Suite

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