TOPIS TO BE COVERED....

- Thermodynamics system and Application
- Work, Heat, Temperature
- Zeroth Law of thermodynamics
- 1st law of thermodynamics
- 2nd law of thermodynamics
- 3rd law of thermodynamics
- Internal energy, Enthalpy and entropy,
- Formation of steam at constant pressure
- Thermodynamic properties of steam
- Steam table
- Dryness fraction
- Throttling calorimeter.

What is thermodynamics?

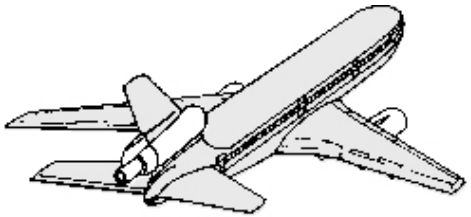
- The study of thermodynamics is concerned with ways energy is stored within a body and how energy transformations, which involve heat and work, may take place.

- Approaches to studying thermodynamics
  - Macroscopic (Classical thermodynamics)
    - study large number of particles (molecules) that make up the substance in question
    - does not require knowledge of the behavior of individual molecules
  - Microscopic (Statistical thermodynamics)
    - concerned within behavior of individual particles (molecules)
    - study average behavior of large groups of individual particles

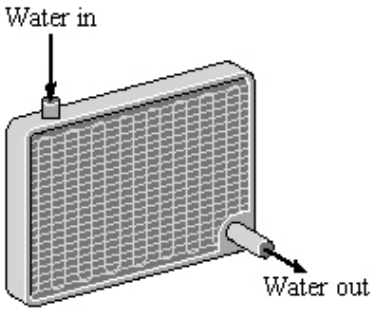
Applications of Thermodynamics

The human body

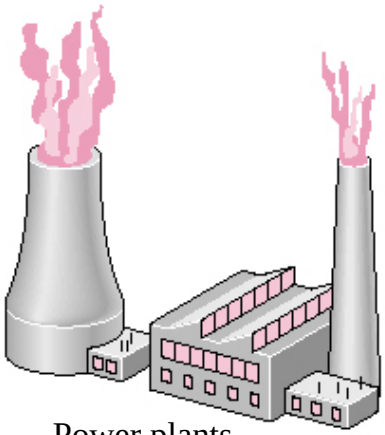
Air-conditioning systems



Airplanes



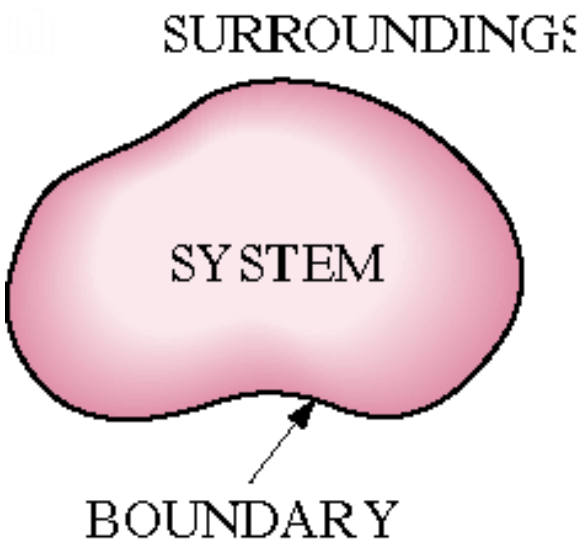
Car radiators



Power plants

Refrigeration systems

Thermodynamic Systems

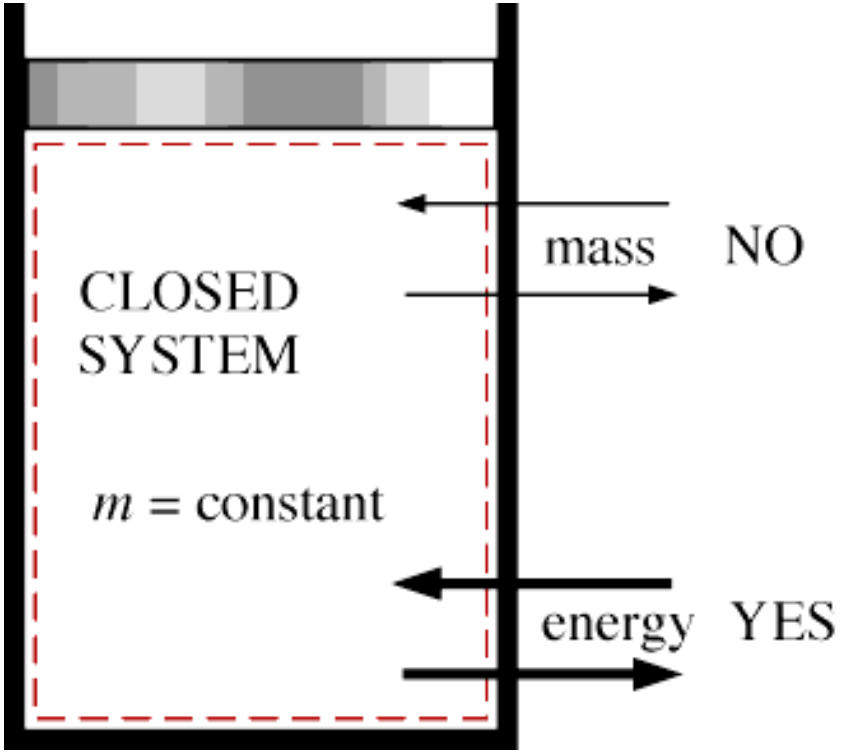


- Thermodynamic System
  - quantity of matter or a region of space chosen for study
- Boundary
  - real or imaginary layer that separates the system from its surroundings
- Surroundings
  - physical space outside the system boundary
- Types of Systems
  - Closed
  - Open

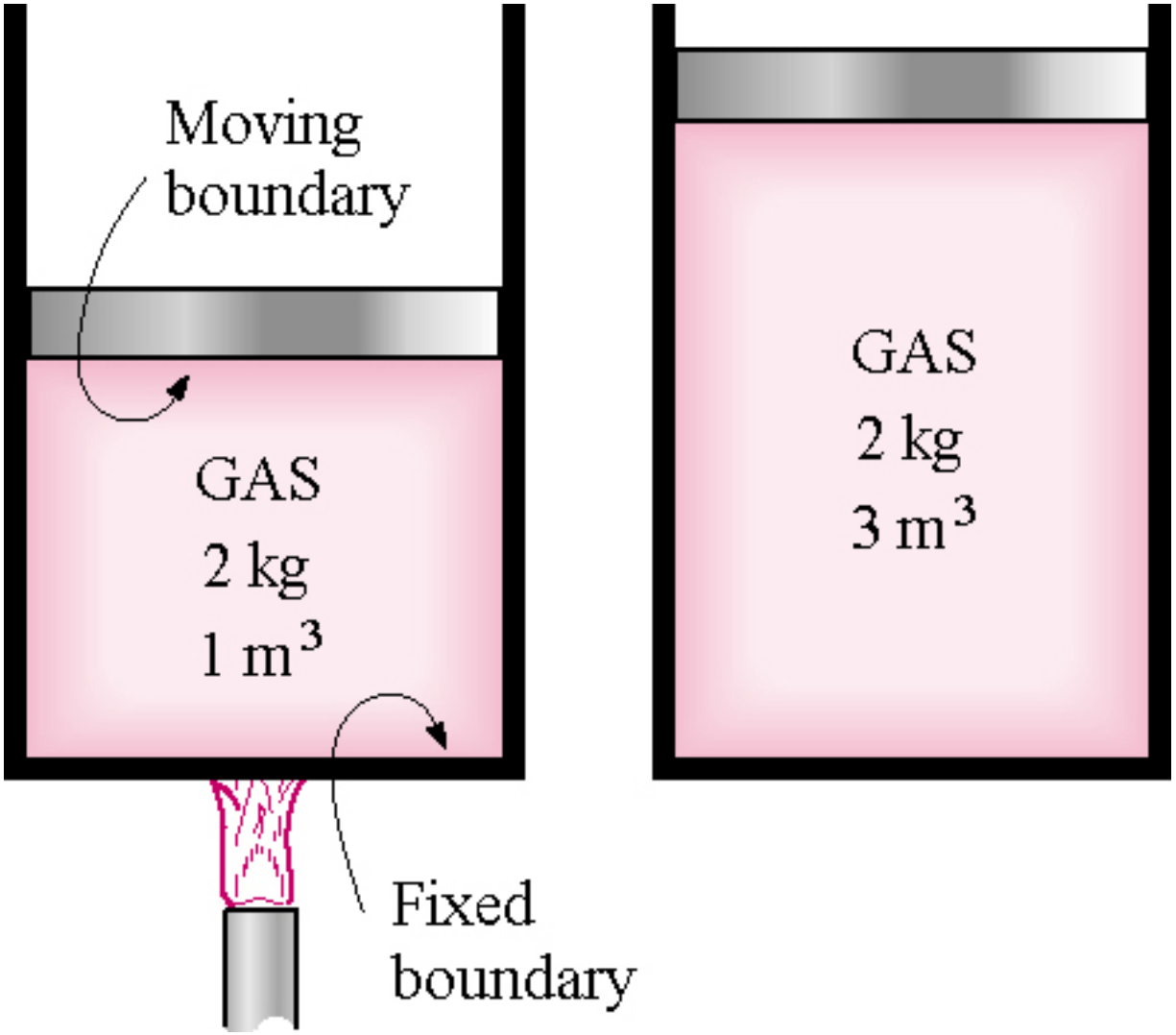
Closed Systems (fixed masses)

Energy, not mass, crosses closed-system boundaries

- (Fig. 1-13)

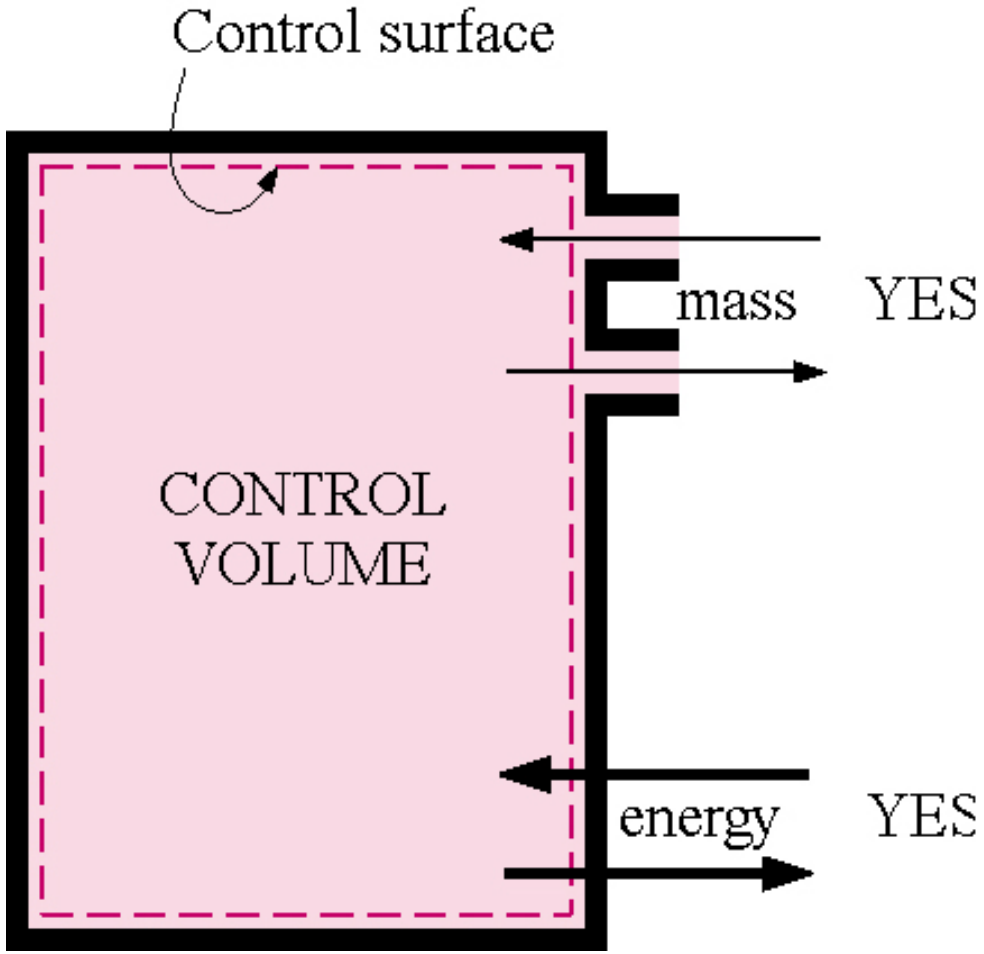


Closed System with Moving Boundry



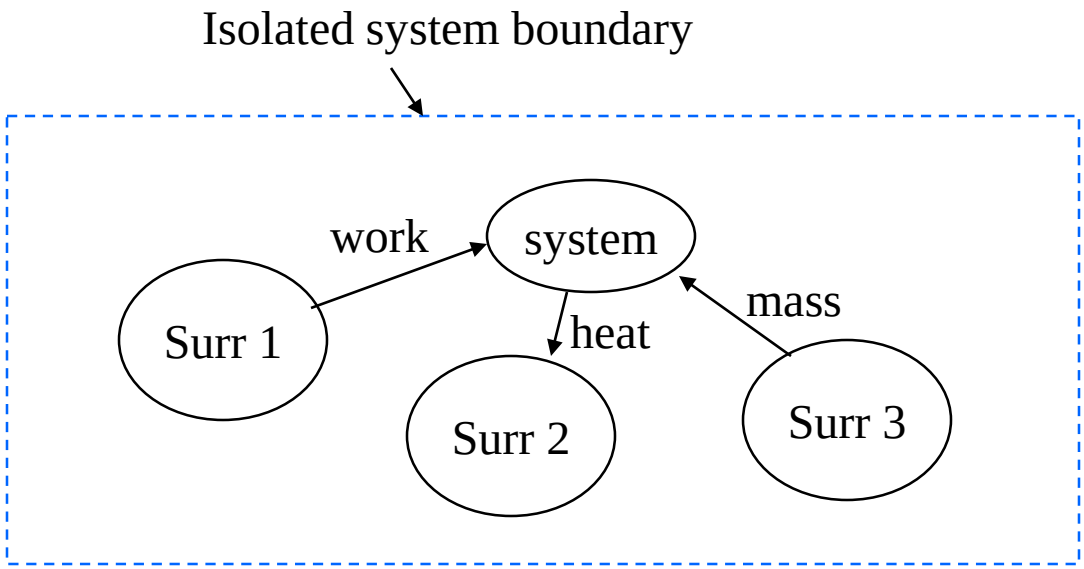
Open Systems (Control Volumes)

Mass and Energy Cross Control Volume Boundaries



Isolated System

- Closed system where no heat or work (energy) may cross the system boundary
  - typically a collection of the a main system (or several systems) and its surroundings is considered an isolated system



Thermodynamic properties

The properties define the thermodynamic **state** of a system.

a. **Intensive property**: does not depend on the mass (m) or does not change with subdivision of the system, denoted by lowercase letters, e.g., z.

b. **Extensive property**: does depend on the mass (m) or does change with subdivision of the system, denoted by uppercase letters, e.g., Z.

Exception to the convention: T for temperature and m for mass

WORK, HEAT & TEMPERATURE

Work:

- It is the transfer of energy
- Change in the system in the direction of application of force is said to be work done

Heat:

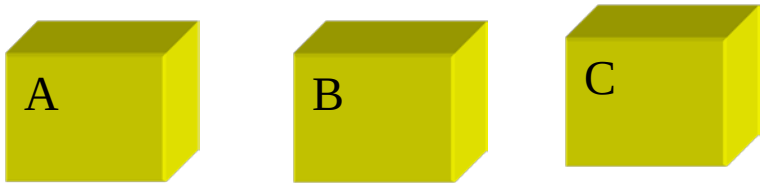
- It is a form of energy present in a body due to its temperature
- The quality of being hot is HEAT

Temperature:

- Property or thermal state of a system that differentiates between a hotter body and a colder body.

Thermodynamics basics

Zeroth Law



If A and B and B and C are in thermal equilibrium, then A and C are in thermal equilibrium. [ie. At same T]

1st Law of Thermodynamics

- 1st law is the extension of "Law of conservation of energy."
- It states that TTHE total sum of all energy in an isolated system is constant.

First Law of Thermodynamics

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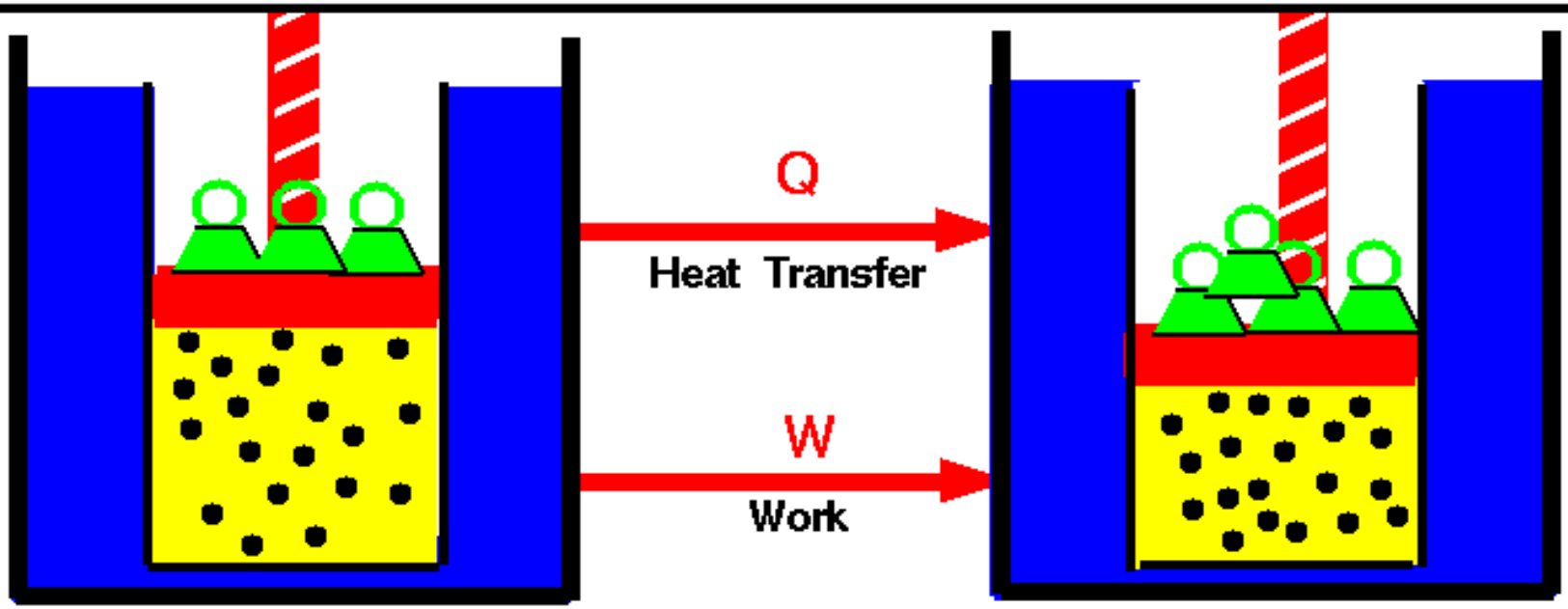


E = Internal Energy

$E_2 - E_1 = Q - W$

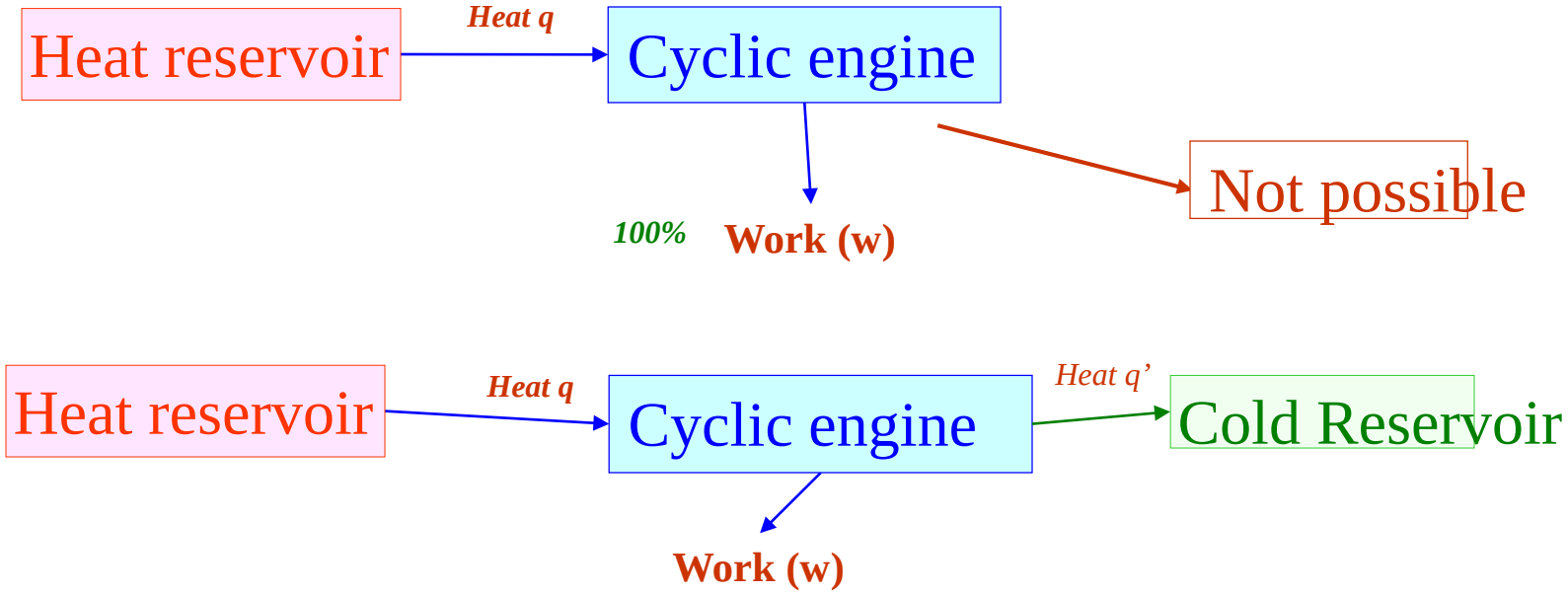
Any thermodynamic system in an equilibrium state possesses a state variable called the internal energy (E). Between any two equilibrium states, the change in internal energy is equal to the difference of the heat transfer into the system and work done by the system.

Heat Engine

- A device which transforms heat into work is called a heat engine
- This happens in a cyclic process
- Heat engines require a hot reservoir to supply energy (Q_H) and a cold reservoir to take in the excess energy (Q_C)
  - Q_H is defined as positive, Q_C is negative

Second Law of Thermodynamics

- It is impossible to build a cyclic machine that converts heat into work with 100% efficiency → Kelvin's statement of the second law.
- Another way of viewing the same:
  it is impossible to construct a cyclic machine* that completely (with 100% efficiency) converts heat, which is energy of *random molecular motion*, to mechanical work, which is *ordered motion*.
- The unavailable work is due to the role of Entropy in the process.



Another statement of the second law → the Clausius statement

- Heat does not ‘flow*’ from a colder body to a hotter body, without an concomitant change outside of the two bodies→ Clausius’s statement of the second law.[(a)]
- This automatically implies that the spontaneous direction of the ‘flow of heat*’ is from a hotter body to a colder body.[(b)]
- The Kelvin’s and Clausius’s statements of the second law are equivalent. I.e. if we violate Kelvin’s statement, then we will automatically violate the Clausius’s statement of the second law (and vice-versa).

The Third Law of Thermodynamics

- For substances in internal equilibrium, undergoing an isothermal process, the entropy change goes to zero as T (in K) goes to zero.

$$\lim_{T \to 0} \Delta S = 0$$

- The law is valid for pure substances and mixtures.
- Close to Zero Kelvin, the molecular motions have to be treated using quantum mechanics → still it is found that quantum ideal gases obey the third law.

INTERNAL ENERGY

•The energy in a system arising from the relative positions and interactions of its parts.

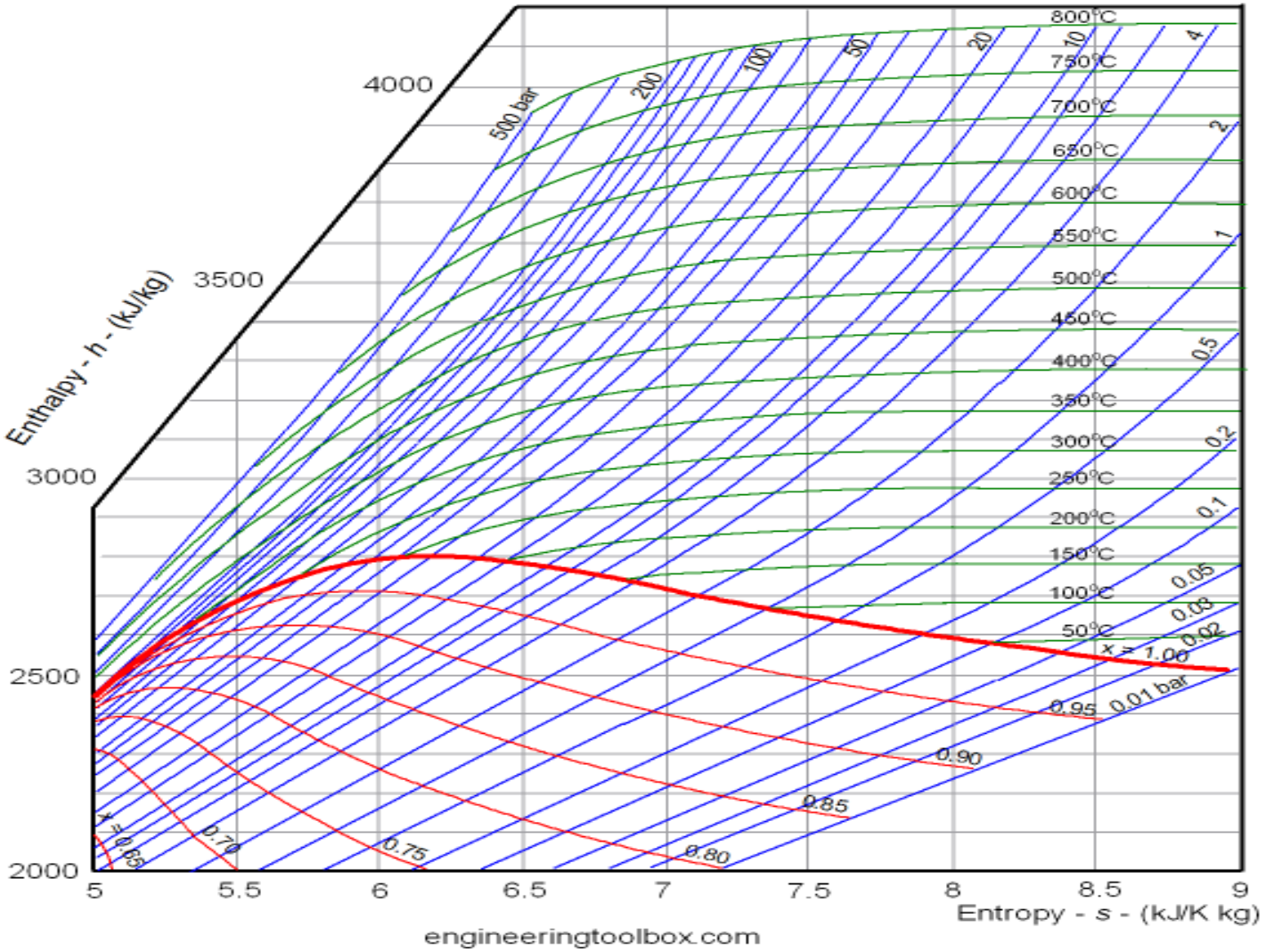
ENTHALPY

•A thermodynamic quantity equivalent to the total heat content of a system. It is equal to the internal energy of the system plus the product of pressure and volume.

ENTROPY

•A thermodynamic quantity representing the unavailability of a system's thermal energy for conversion into mechanical work, often interpreted as the degree of disorder or randomness in the system.

THERMODYNAMIC PROPERTIES OF STEAM



DRYNESS FRACTION

The steam dryness fraction is used to quantify the amount of water within steam.

Dry steam - all water molecules are in the gaseous state
Wet steam - a portion of the water molecules have lost their energy - latent heat - and condensed to tiny water droplets

To produce *100%* dry steam in an boiler and keep the steam dry throughout the piping system is in general not possible.

THROTTLING CALORIMETER