Bring ideas to life
VIA University College

DES M1
Refrigeration fundamentals

Lecture 1

Purpose and function

Refrigeration principles

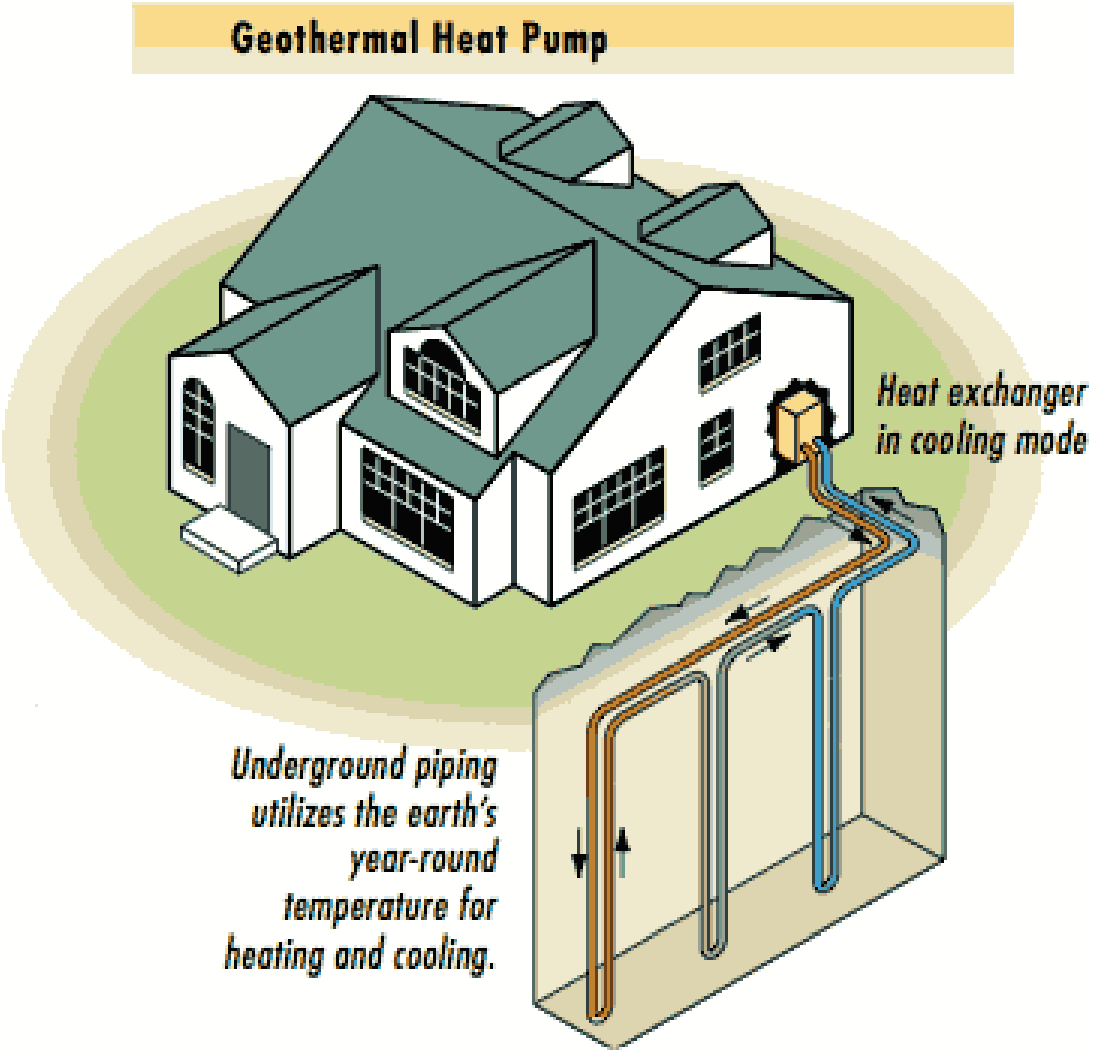
Use of pressure and boiling point in a refrigeration system

Energy balance for a refrigeration system

Refrigeration example

Refrigeration

Heat pump


Geothermal Heat Pump
Heat exchanger in cooling mode
Underground piping utilizes the earth's year-round temperature for heating and cooling.

Single stage refrigeration circuit Cold store example

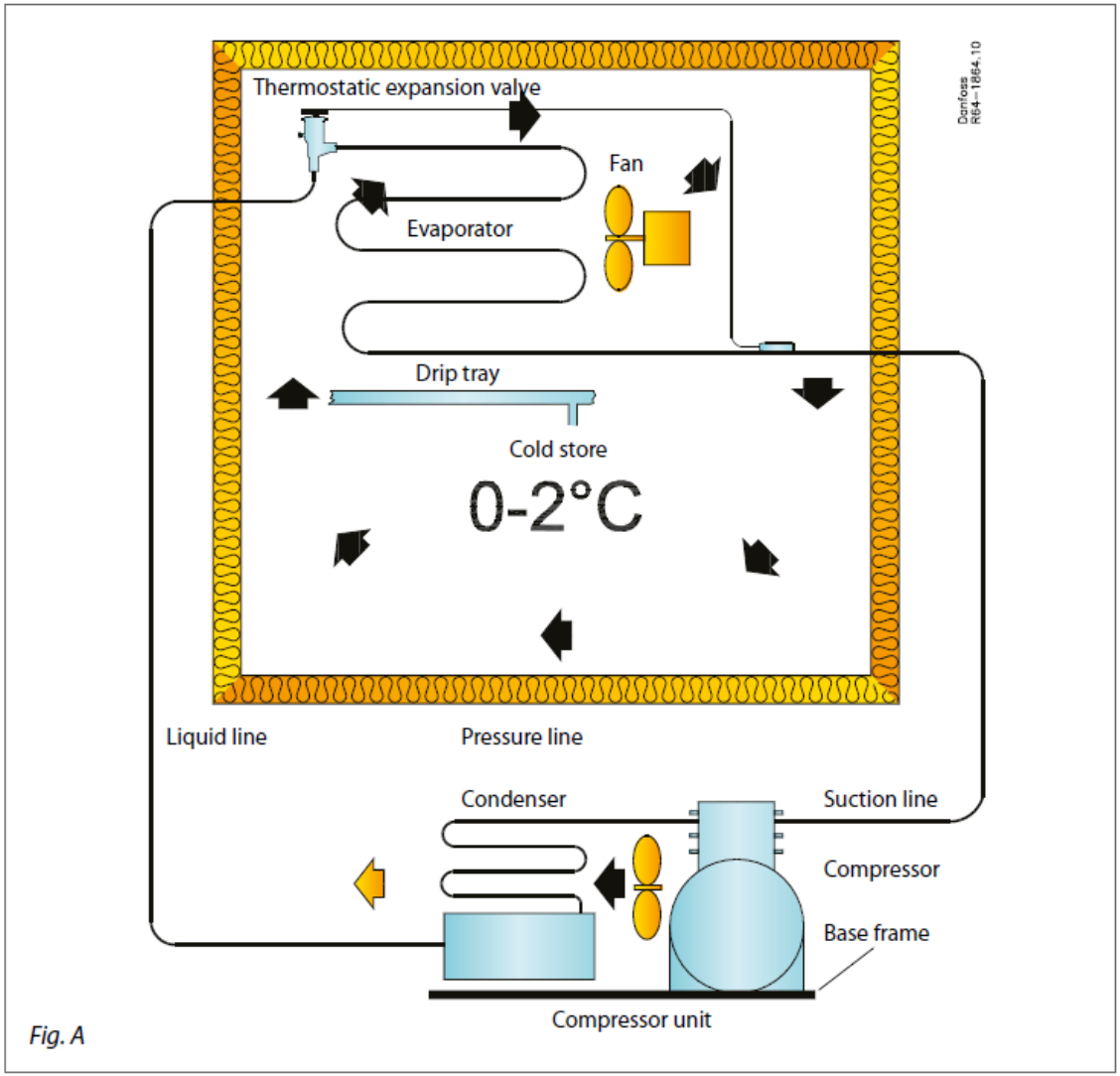
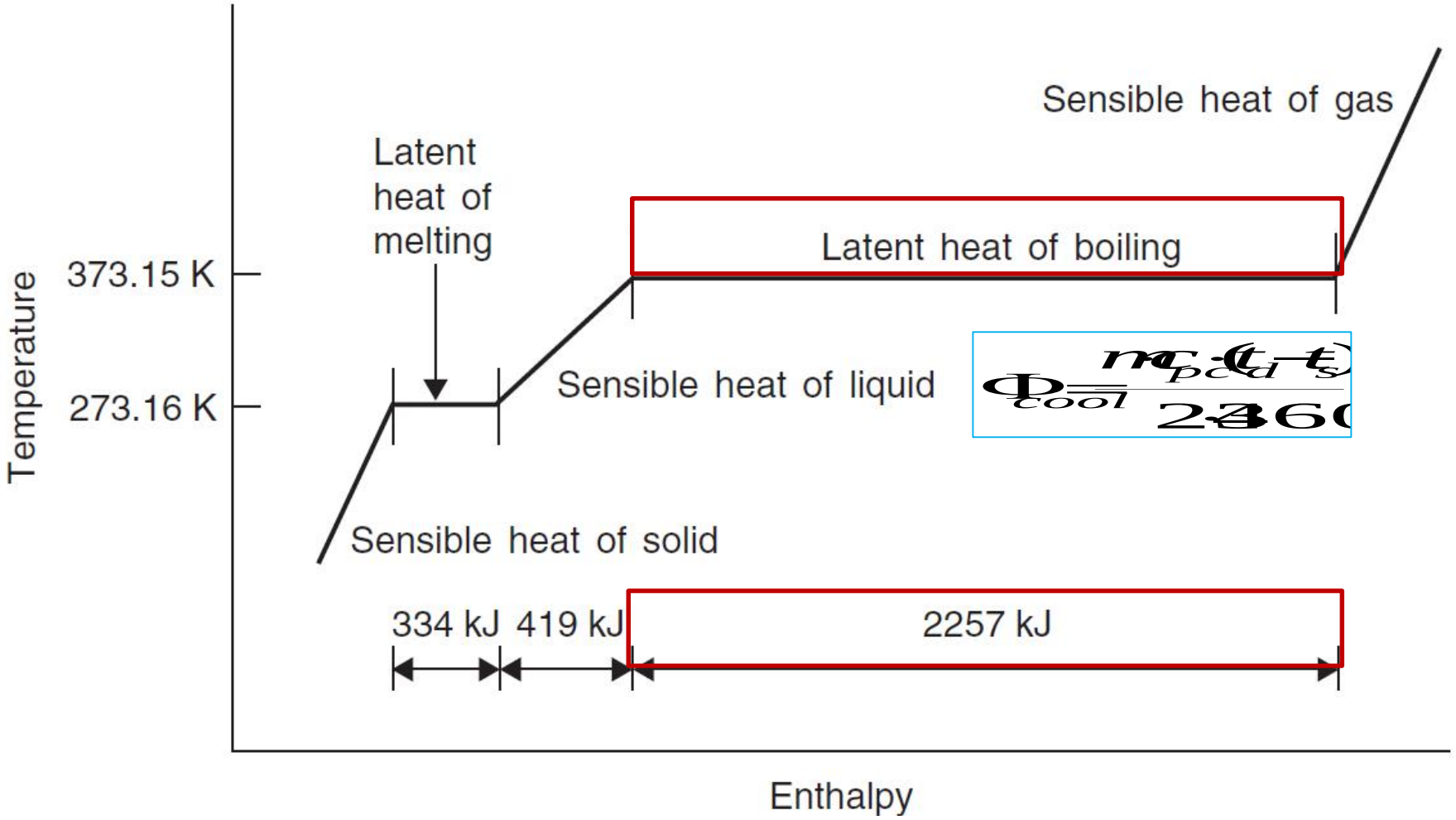


Fig. A

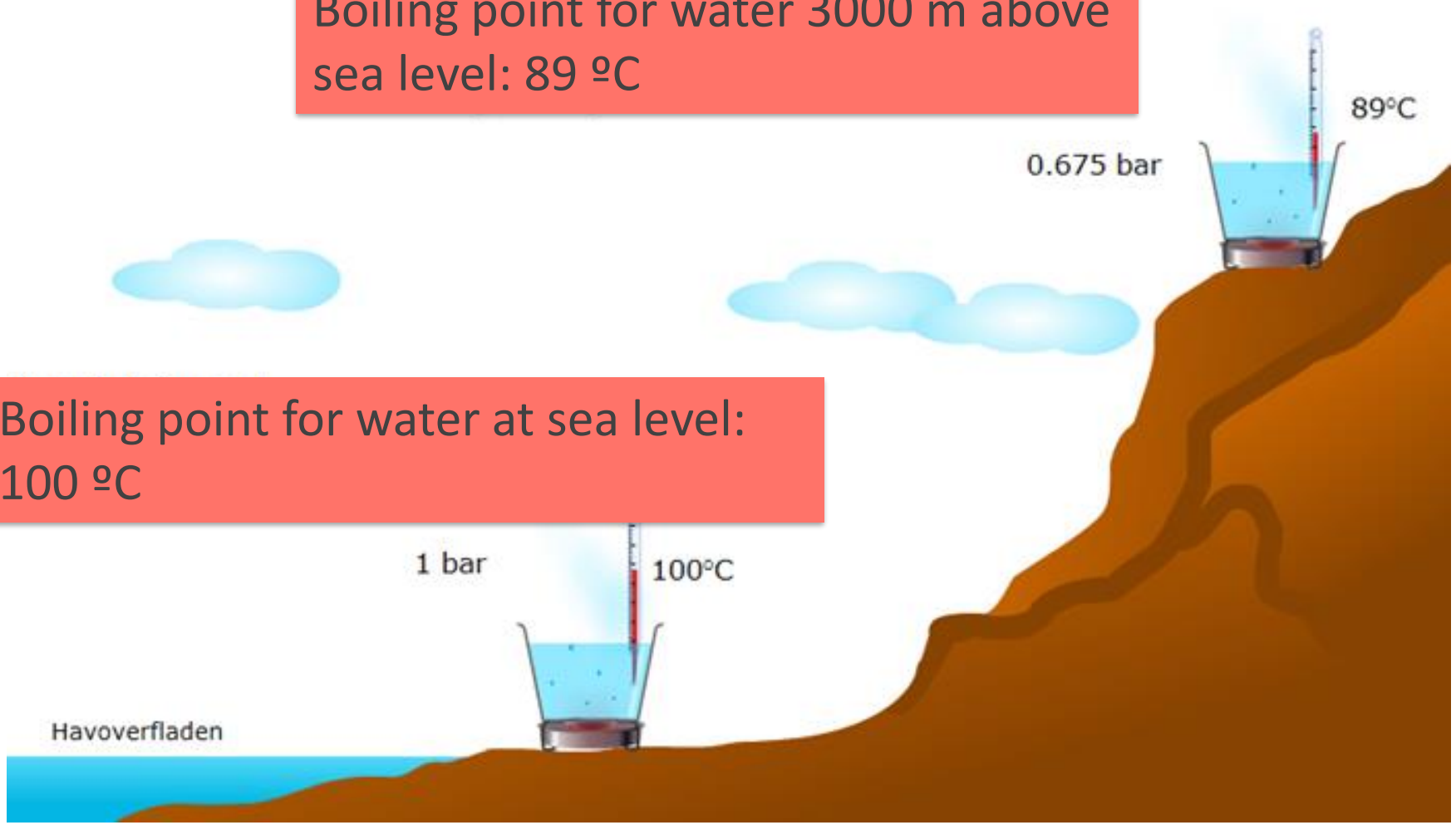
Boiling point Enthalpy



Boiling point
Pressure

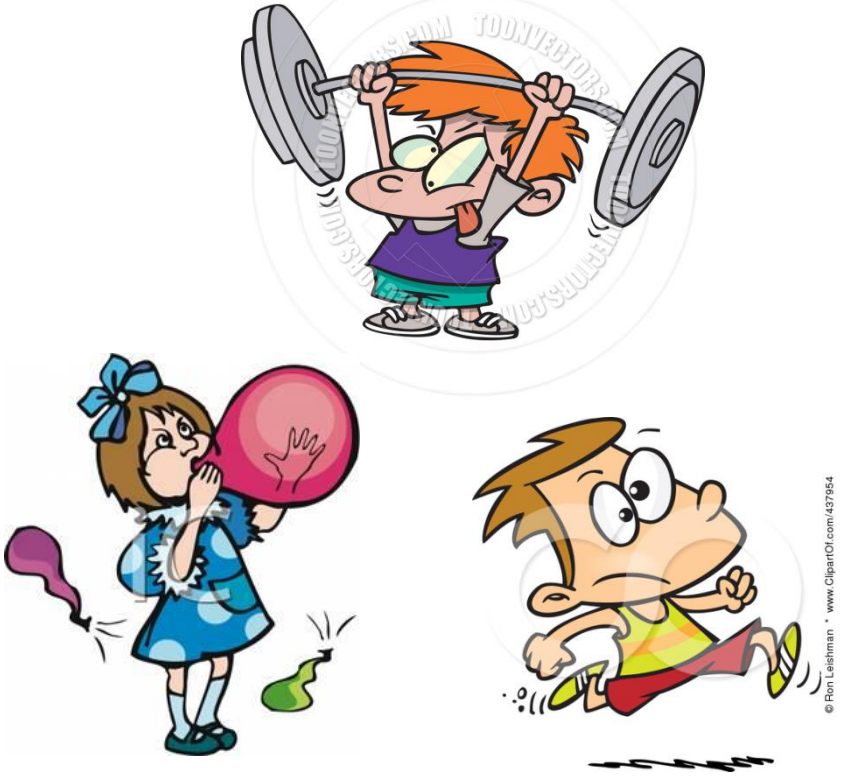
Boiling point for water 3000 m above sea level: 89 ºC

Boiling point for water at sea level: 100 ºC



Heat and work

Heat



Work

Refrigeration system Purpose

- Transport a quantity of heat from an area with low temperature (cold side) to an area of higher temperature (hot side).
- Purpose (cold side): Food production, cold or freezing storage, air conditioning, cooling of machinery etc.
- Cooling source (hot side): Outdoor air or heat recovery (heating of buildings or hot water).

Heat pump
Purpose

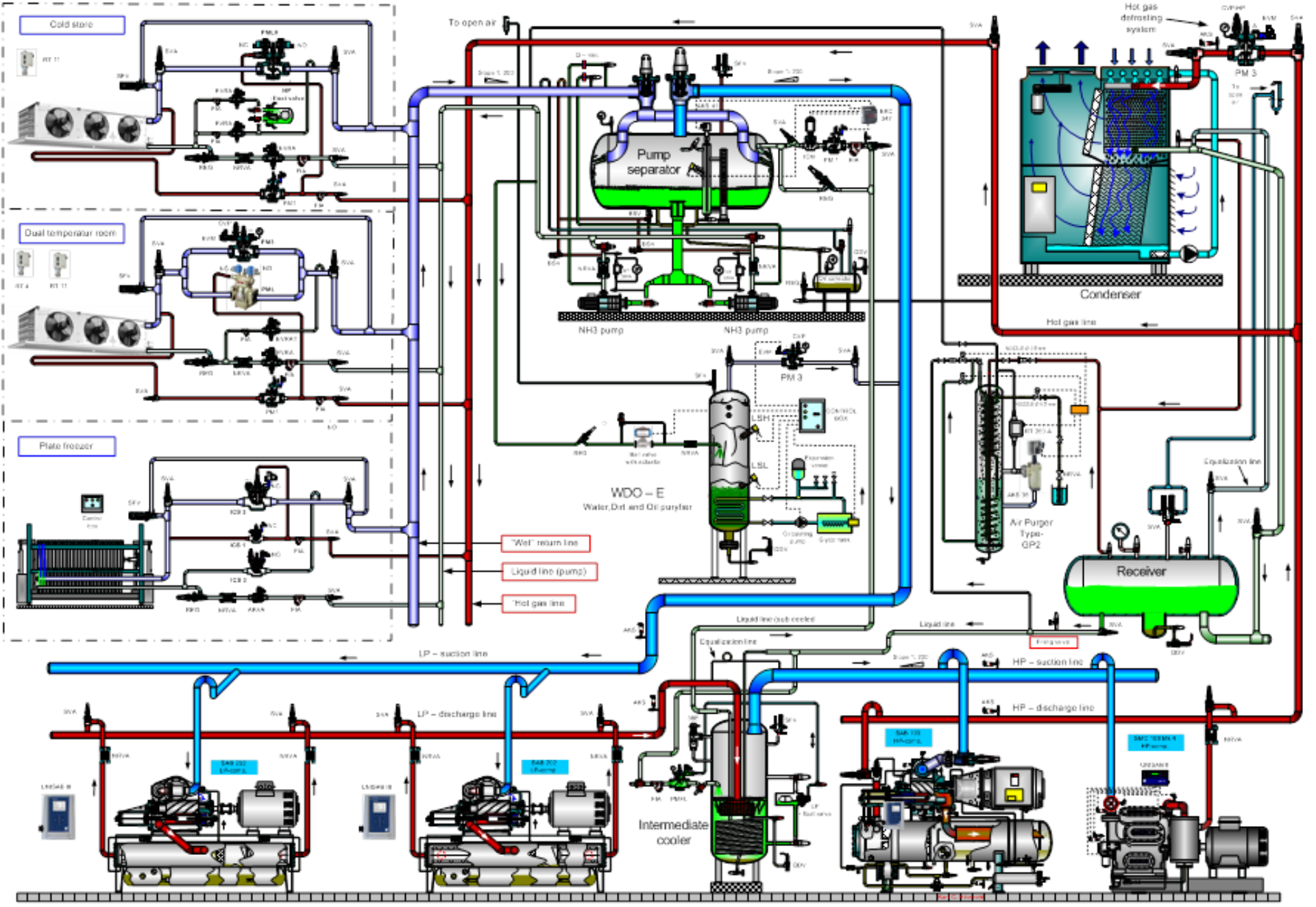
- Transport a quantity of heat from an area with low temperature (cold side) to an area of higher temperature (hot side).
- Purpose (hot side): Heating of buildings or hot water
- Heating source (cold side): Outdoor air, ground, sea/lake or waste heat from industrial processes

Refrigeration principles

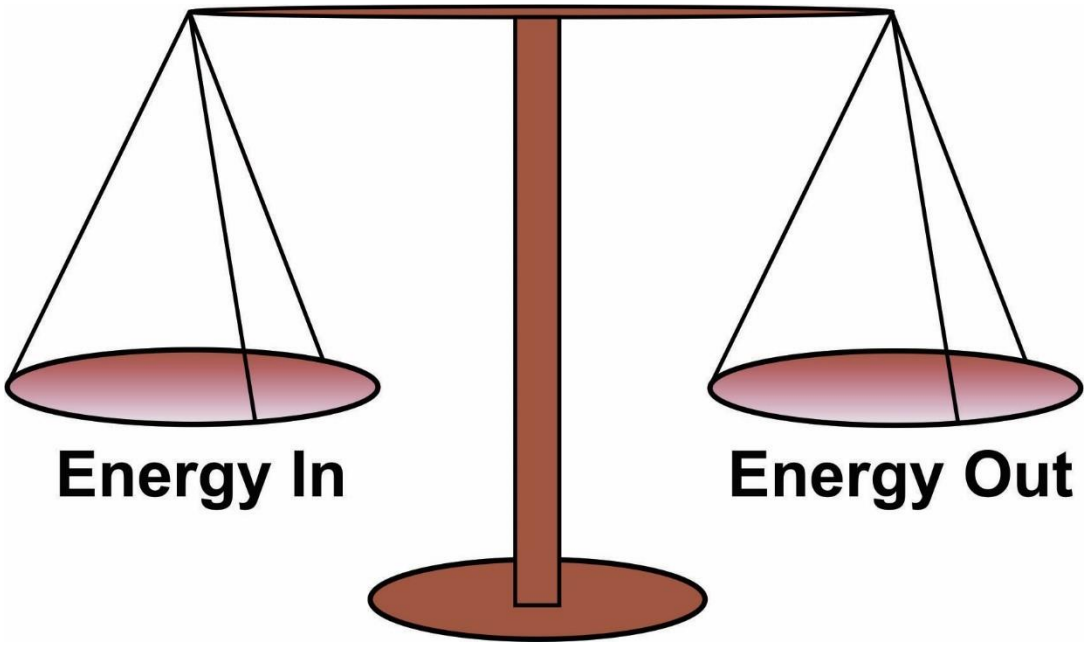
There are a number of different principles which can be used for refrigeration:

- Absorption cooling
- Peltier element
- Gas compression, cooling and expansion (in aeroplanes)
- Steam ejector cooling
- Compression refrigeration system

This course will focus solely on vapour compression refrigeration systems.


Cold store
Dual temperatur room
Plate freezer
To open air
Hot gas defrosting system
PM 5
Pump separator
NH3 pump
NH3 pump
Condenser
Hot gas line
PM 3
WDO – E
Water,Dirt and Oil purifier
"Wet" return line
Liquid line (pump)
"Hot gas line
Air Purger Type- GP2
Receiver
Equalization line
Liquid line (sub cooler)
Liquid line
LP – suction line
LP – discharge line
HP – suction line
HP – discharge line
Intermediate cooler

Energy balance Example



Energy balance

1st law of thermodynamics (law of conservation of energy):

The total energy of an *isolated* system is constant. Energy can be transformed from one form to another, but…… energy cannot be created or destroyed.

For a stationary system:

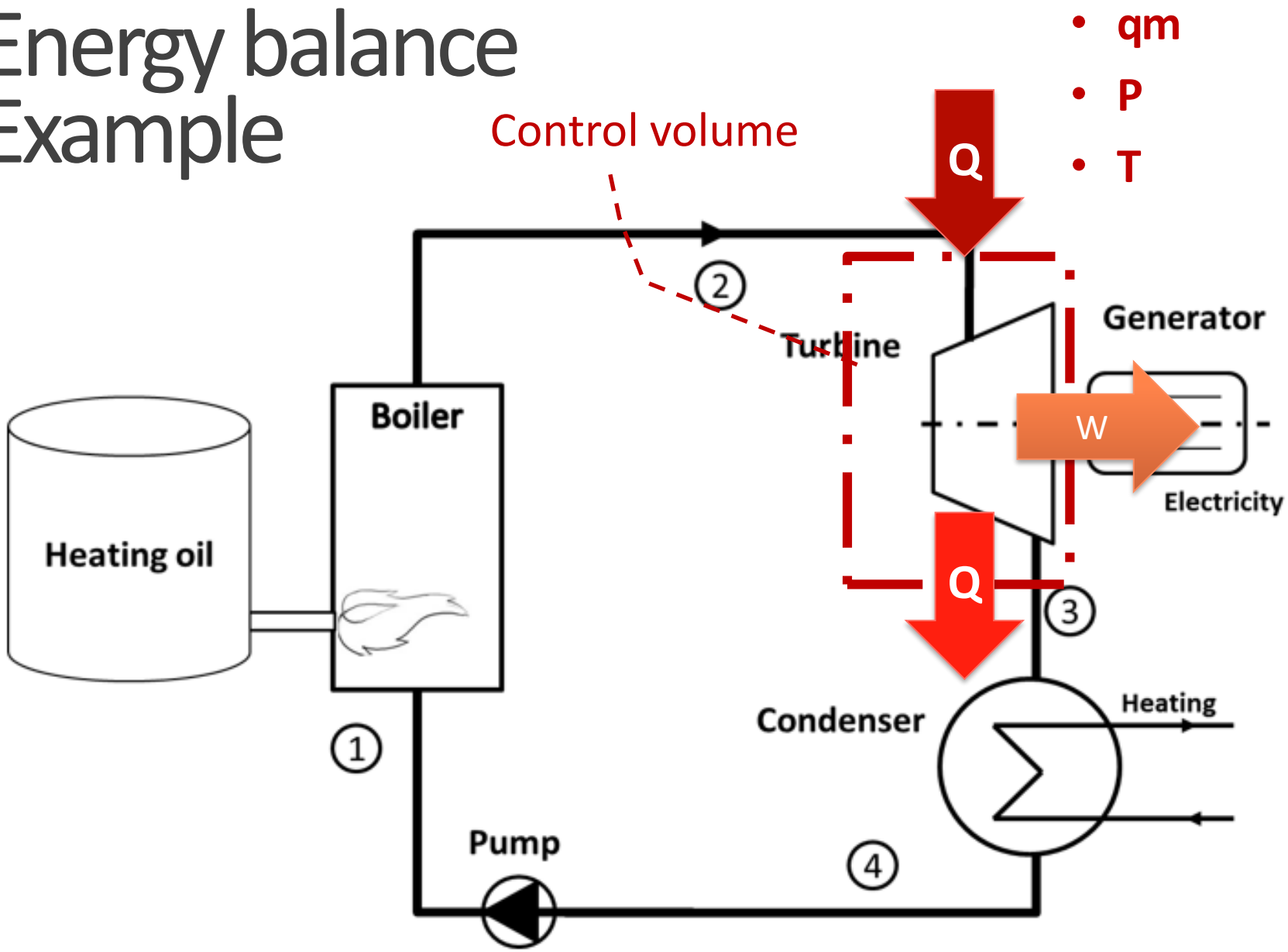
$$\Sigma E_{in} - \Sigma E_{out} - \Sigma E_{storage} = 0$$

Energy balance methodology

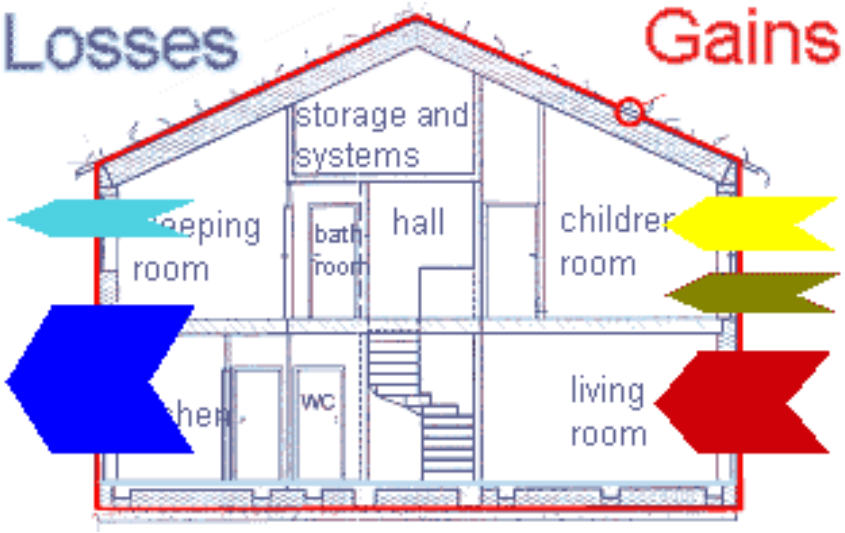
- Draw a simple model of the system using standard symbols
- Add numbers to identify the different parts of the process
- Add know information on eg. massflow, temperatures, pressure to the drawing
- Draw Control Volumes for the total system and parts of the system to be analyzed.
- Find enthalpies for latent processes: Refrigerants (log P h-diagram), air with condensation or humidification (hx-diagram). Find c_p values for sensible processes: Water, dry air and other substances (tables)
- Calculate energy flow in and out of each control volume using energy balance equations.

Exercise Energy Balance 1

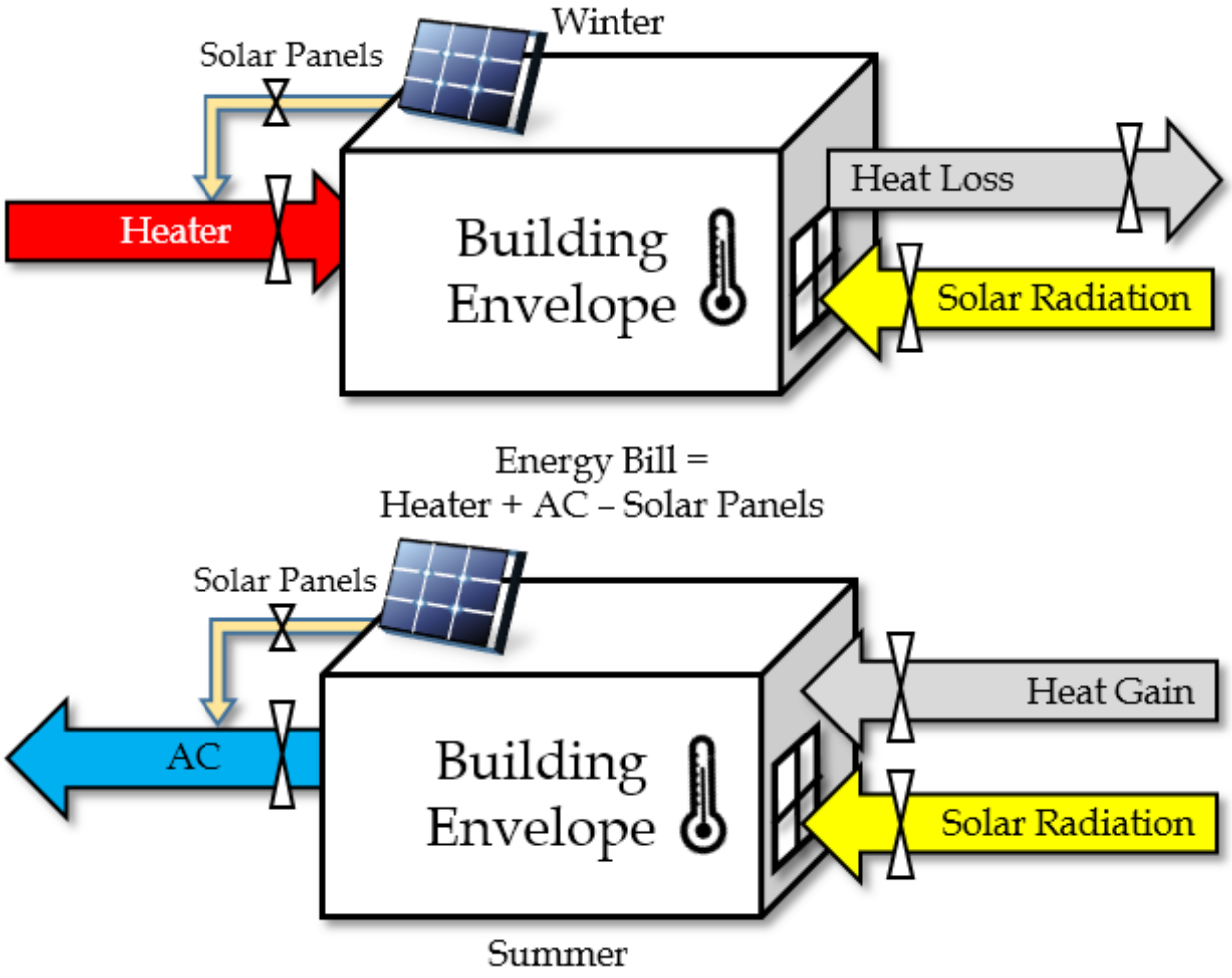
Energy balance Example



Energy balance Example



Energy balance Example



Energy balance Example

Energy balance Example