Process Heat Transfer

Basic Fundamentals and Definitions

Basic Fundamentals and Definition

Process: A change of A state of a system.

Heat: A type of energy ‘ thermal energy”

Heat transfer: Energy in transit due to temperature difference

Process Heat Transfer: A study which focuses on the heat transfer during the physical or chemical processes. For Examples: Heating of crude oil in heat exchangers and pipe still heater

Modes of Heat Transfer:

- Conduction
- Convection
- Radiation

- Temperature: it is a measure of the amount of thermal energy in a body.
- Temperature difference ΔT: It is the difference of temperatures between hot and cold surfaces or streams. It represents the driving force in heat transfer phenomena.
- Temperature gradient: change of temperature w.r.t. distance.
- Temperature distribution: it is very important to be known in order to compute the heat flow.

Applications of Heat Transfer in Process Industries

Heat is transferred out of or into the process

1. Chemical Reactions: ‘Exothermic’ or ‘Endothermic’ such as combustion, pyrolysis, polymerization

2. Biological Reactions: such as cooling and freezing of foodstuffs, fermentation

3. Physical Changes: such as ‘Evaporation’ and ‘Condensation’ ,e.g., distillation, Melting and freezing

4. Power Generation
5. Air conditioning and Space Heating
6. Waste Heat Recovery
7. Insulations
8. Control of temperature
9. Process Integration
10. Enhancement of heat transfer

Examples

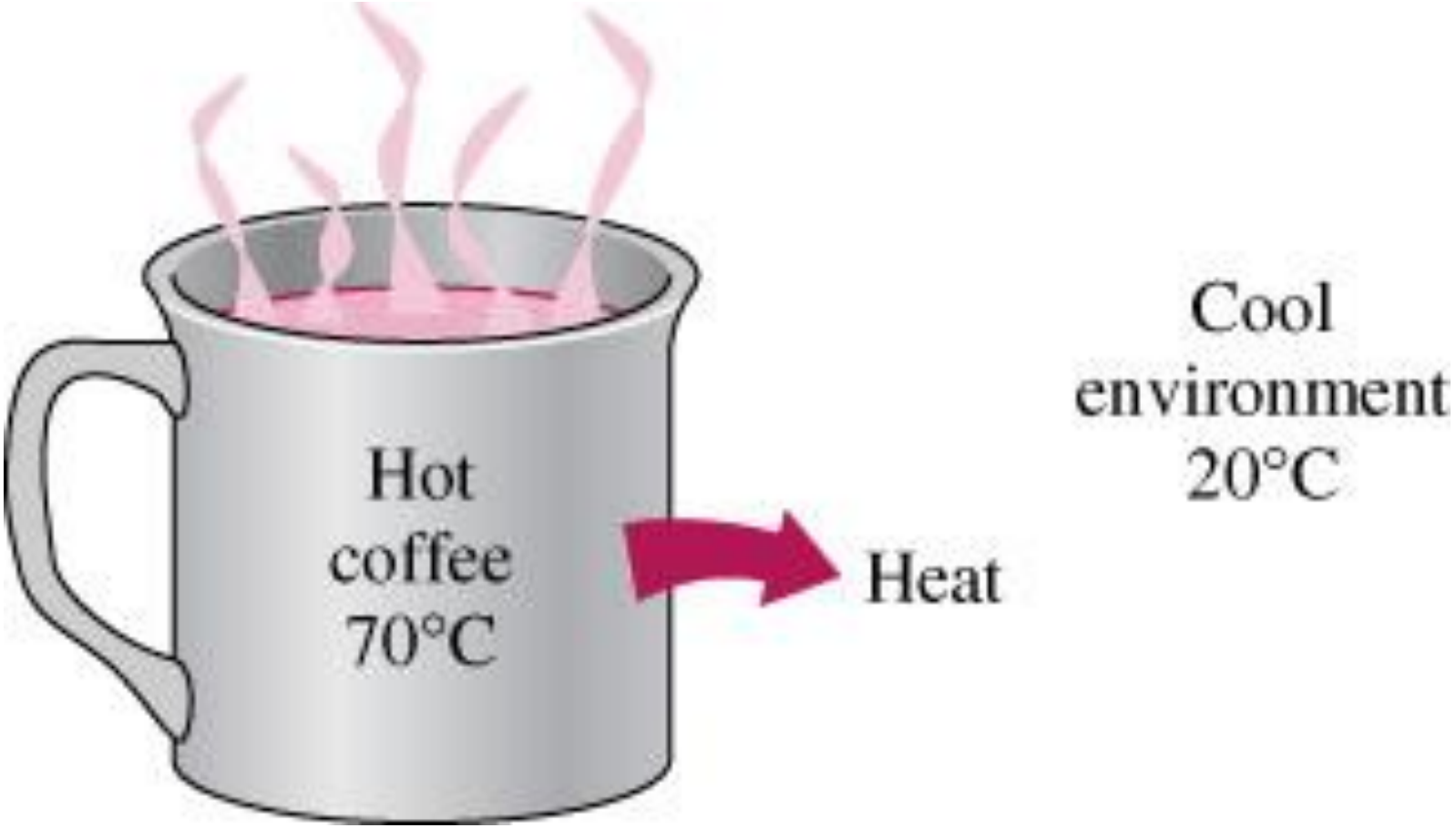
Domestic examples:

- Broiling a turkey
- Roasting bread
- Heating water

Industrial examples:

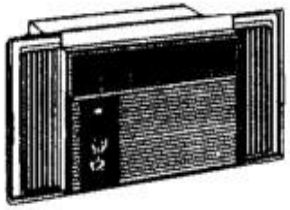
- Curing rubber
- Heat treating steel forgings
- Dissipating waste heat from a power plant

Examples

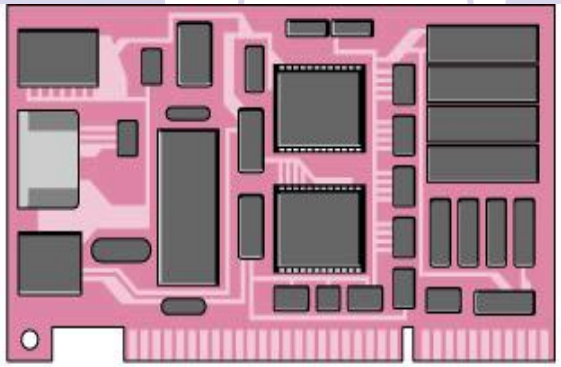


Examples

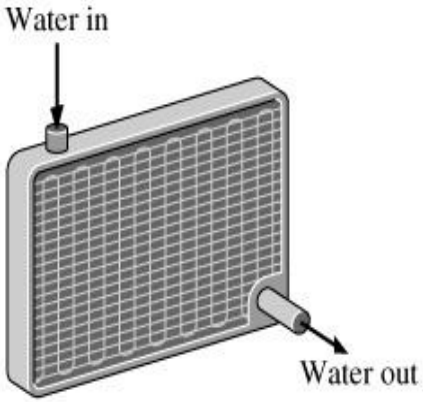
The human body



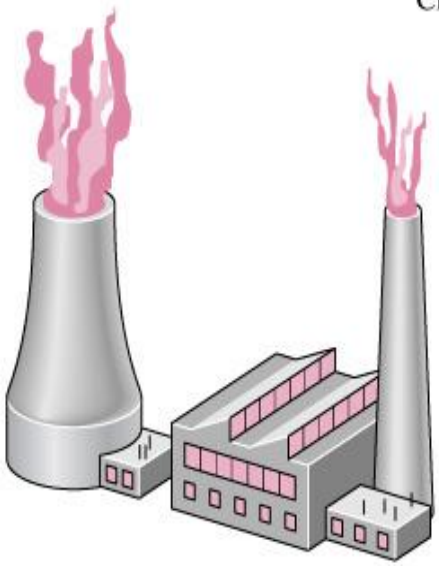
Air-conditioning systems



Circuit boards



Car radiators



Power plants

Refrigeration systems

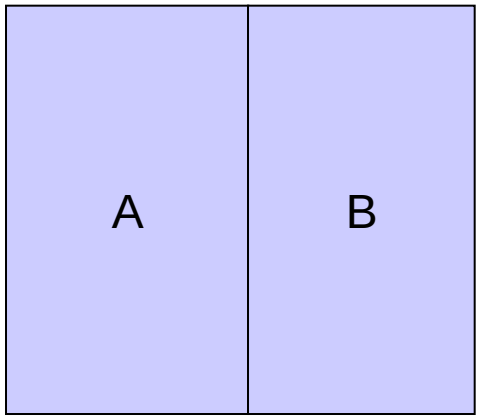
Energy will always go from high temperature to lower temperature, this kind of energy transfer is called heat transfer.
Examples of systems, where heat transfer is important

Relation between Thermodynamics and Heat Transfer

- Consider Heat transfer Between two blocks; one is hotter than the other ($T_A > T_B$).
- Applying the 1st law or energy balance gives:

  Heat gain$_B$ = Heat loss$_A$

- Energy transfer is exchange of internal energy.



- To know the direction of the heat transfer, apply the 2nd law of thermodynamics:

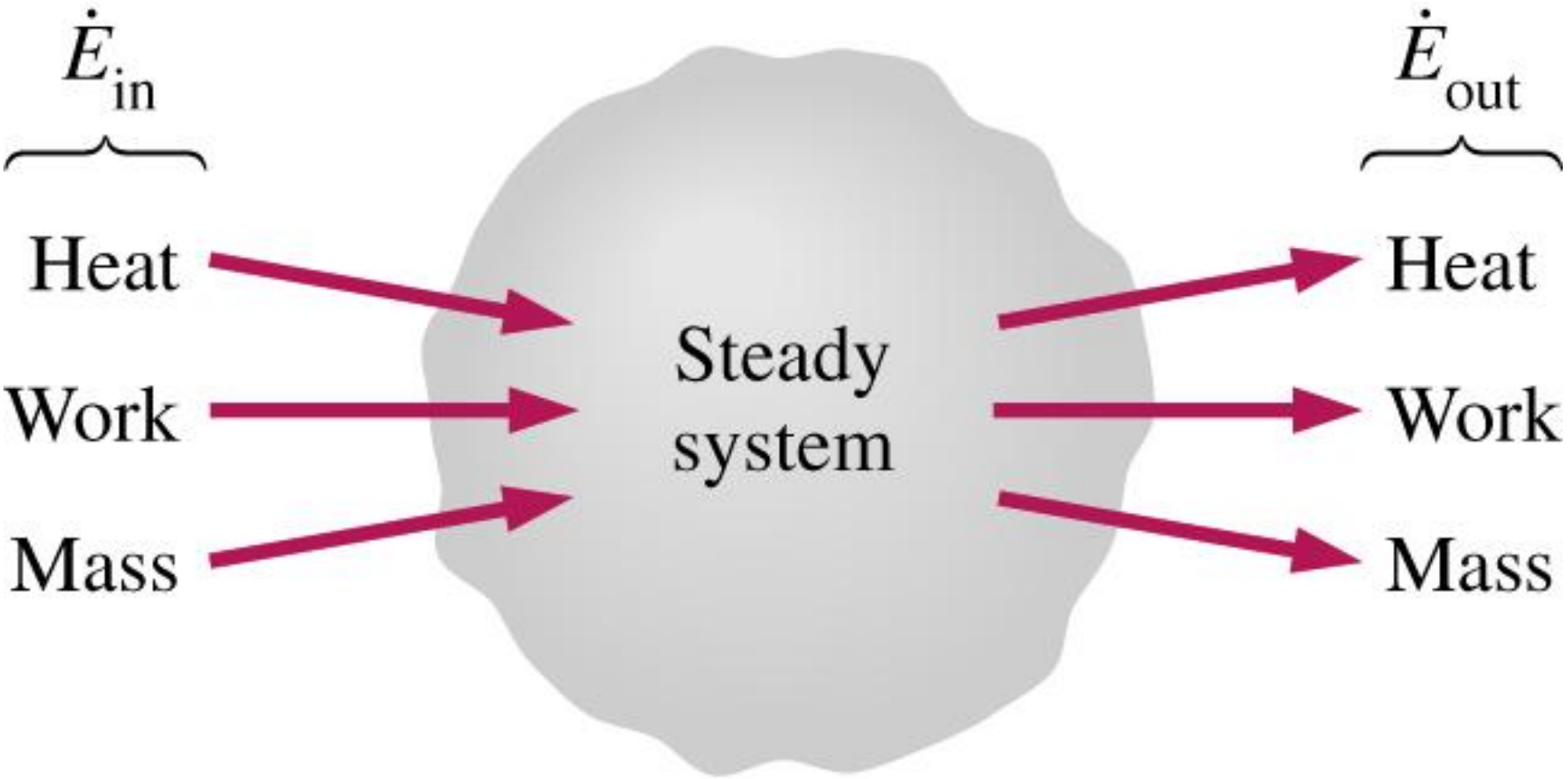
The natural direction of heat transfer is in the direction of decreasing temperature.

$S_{Final} > S_{initial}$; Irreversible process

notes:

1. System is the two block
2. $(U+KE+PE)_E = (U+KE+PE)_B + (H+KE+PE)_I - - (H+KE+PE)_O + \Sigma Q - \Sigma W$
3. For closed system; No KE, and PE differences

$$\Delta U = Q - W$$



$$\dot{E}_{in} = \dot{E}_{out}$$