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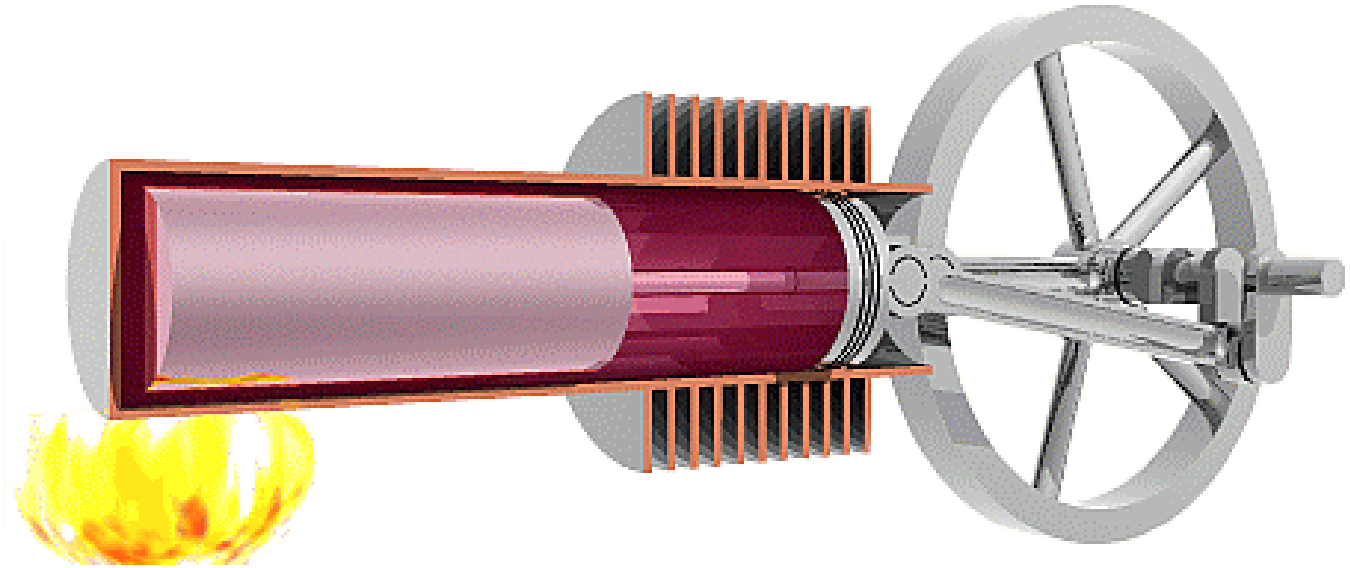
FOLLOWING POINTS ARE COVERED

- Heat Engine
- Heat Pump
- Refrigerator

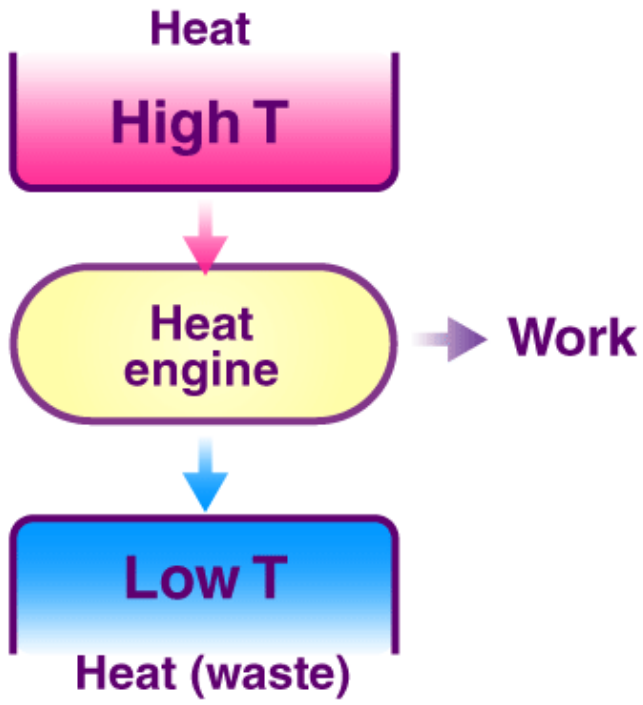


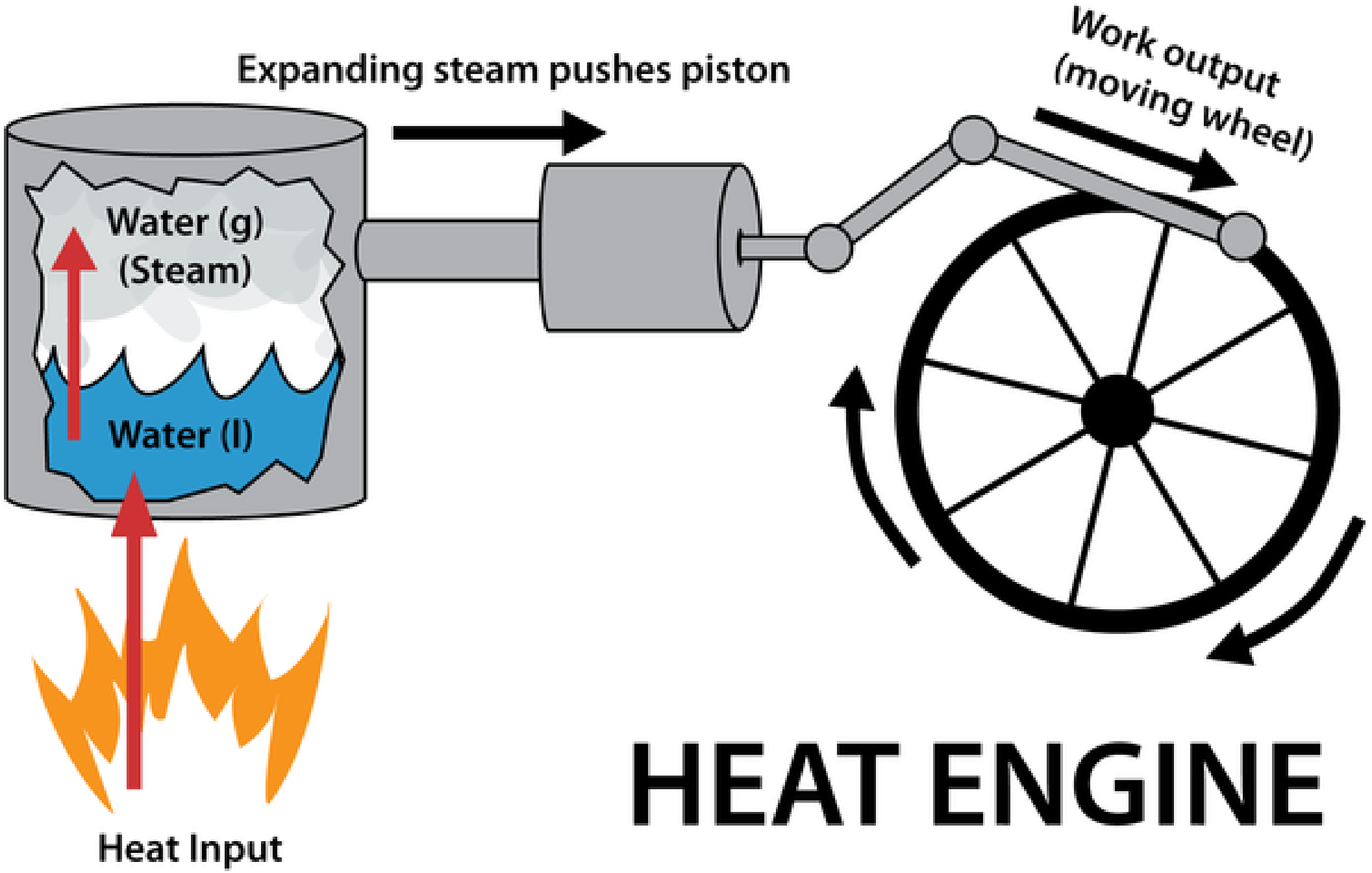
1.HEAT ENGINE

Heat Engine

- A heat engine cycle is a thermodynamic cycle in which there is a net heat transfer *to* the system and a net work transfer *from* the system.
- The system which executes a heat engine cycle is called a *heat engine.*
- Any device that transforms heat into work or mechanical energy is called a heat engine.
- In the simplest kind of engine, the working substance undergoes a cyclic process.

Heat Engine block diagram

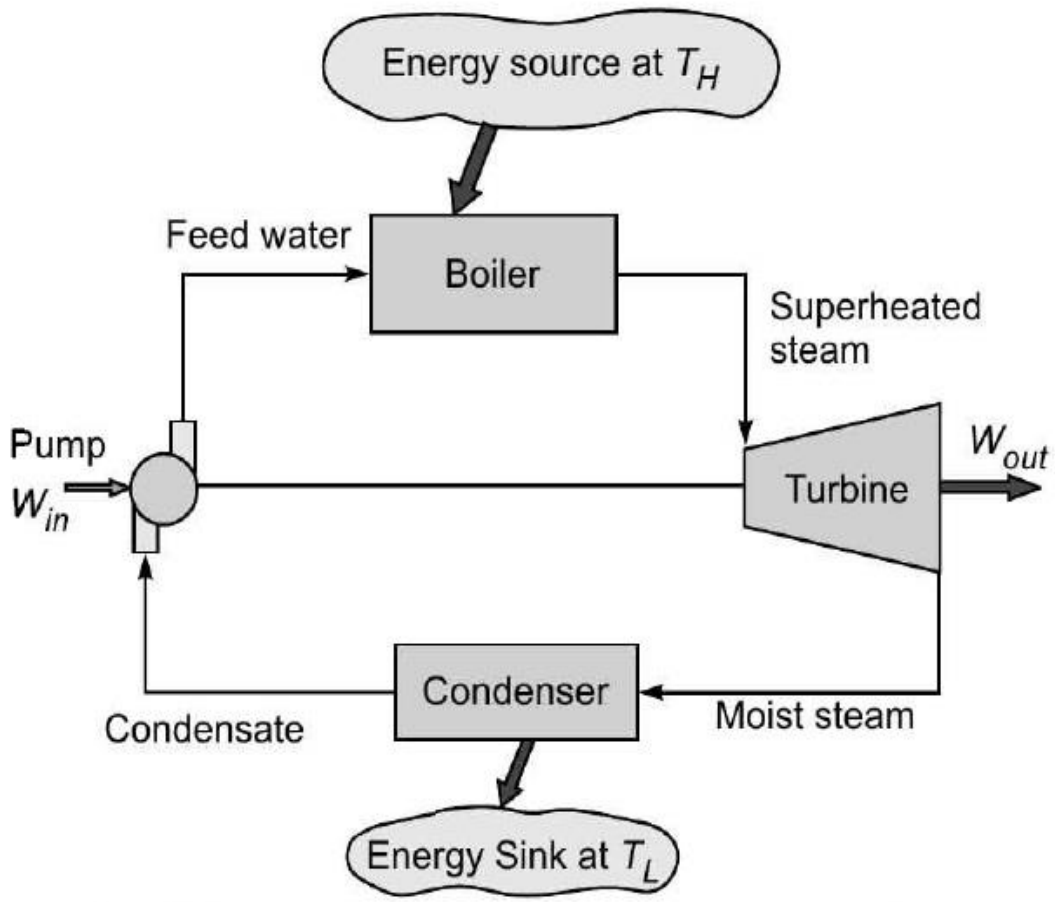



Expanding steam pushes piston
Work output
(moving wheel)
Water (g)
(Steam)
Water (l)
Heat Input

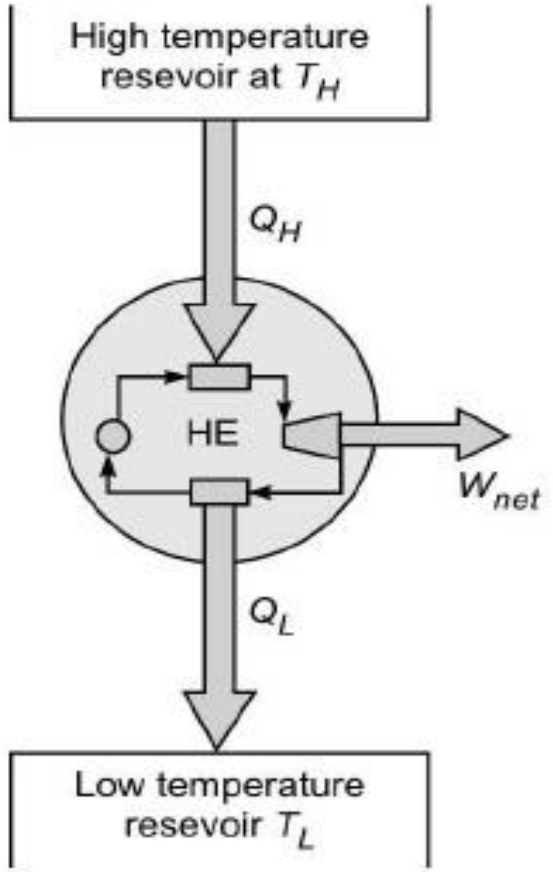
HEAT ENGINE

- It receives heat Q-H from the high temperature Reservoir (Source) at T-H
- It converts the part of the heat supplied into the useful work As W-Net.
- It rejects remaining heat Q-L to low temperature reservoir (Sink) at T-L.

Heat Engine Block Diagram



(a) Schematic diagram of a steam power plant



(b) Schematic diagram of a heat engine

The Net output of the heat engine is difference between the total work done by turbine and total work input by feed pump.

$$W_{net} = W_{out} - W_{in}$$

We can also calculate the Net Work out put is Difference between Heat supplied and Heat Rejected.

$$\mathbf{W_{net} = Q_H - Q_L}$$

THERMAL EFFICIENCY OF HEAT ENGINE

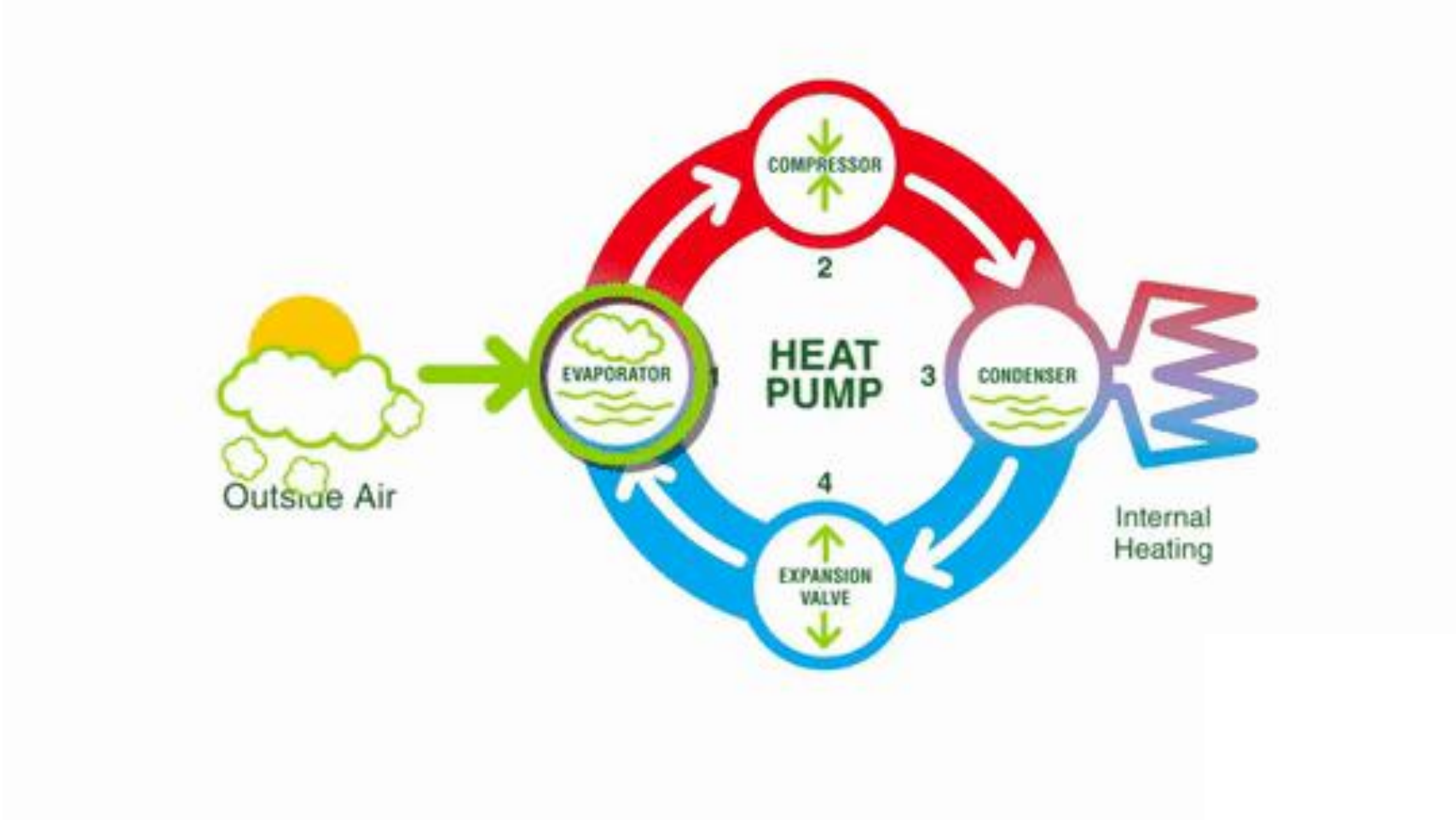
- Thermal Efficiency is performance measuring parameter.
- It is the Ratio of Heat Engine Output to Heat Engine Input.

$$\eta_{th} = \frac{Heat\ Engine\ Net\ Workdone}{Heat\ Supplied}$$

$$= \frac{W_{Net}}{Q_H}$$

$$= \frac{Q_H - Q_L}{Q_H}$$

$$= 1 - \frac{Q_L}{Q_H}$$


COMPRESSOR
2
EVAPORATOR
HEAT
PUMP
3
CONDENSER
4
EXPANSION
VALVE
Outside Air
Internal
Heating

Heat Pump

HEAT PUMP

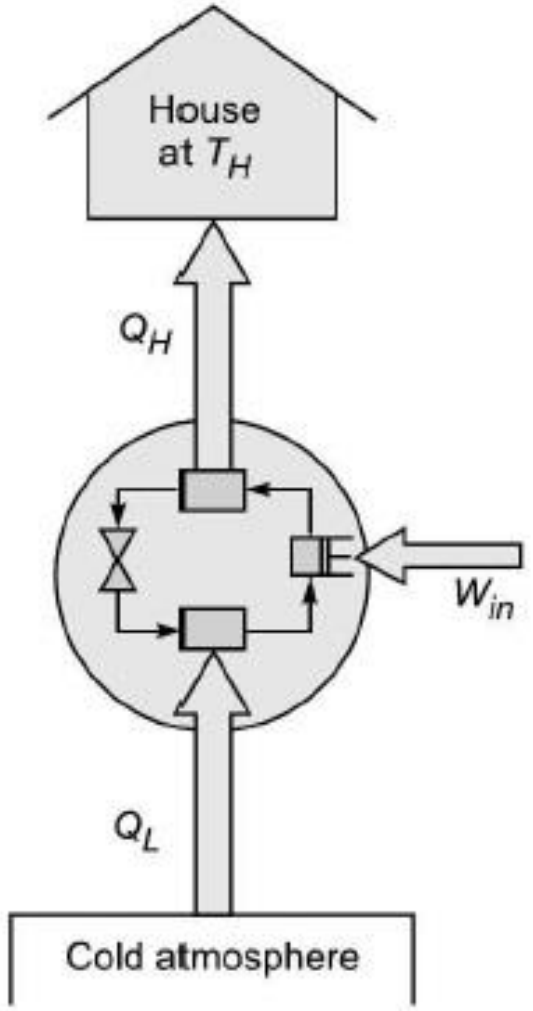
- Heat Pump is device that operating in a cycle that maintains a space at higher temperature than the surrounding.
- The Heat Pump absorbs the heat from low temperature surroundings and supplies its to higher temperature space.

Heat Pump Diagram

Let an amount of heat Q-L be absorbed from the low temperature region and W-in be the work Input.
Then the heat supply Q-H to the room is desired effect for heat pump.

The coefficient of performance of heat pump is

$$(COP)_{Heat\ Pump} = \frac{Heat\ Suppplied}{work\ Input}$$



$$(COP)_{Heat\ Pump} = \frac{Heat\ Suppplied}{work\ Input}$$

$$(COP)_{HP} = \frac{Q_H}{W_{in}}$$

But $Q_H = Q_L + W_{in}$

$$(COP)_{HP} = \frac{Q_L + W_{in}}{W_{in}}$$

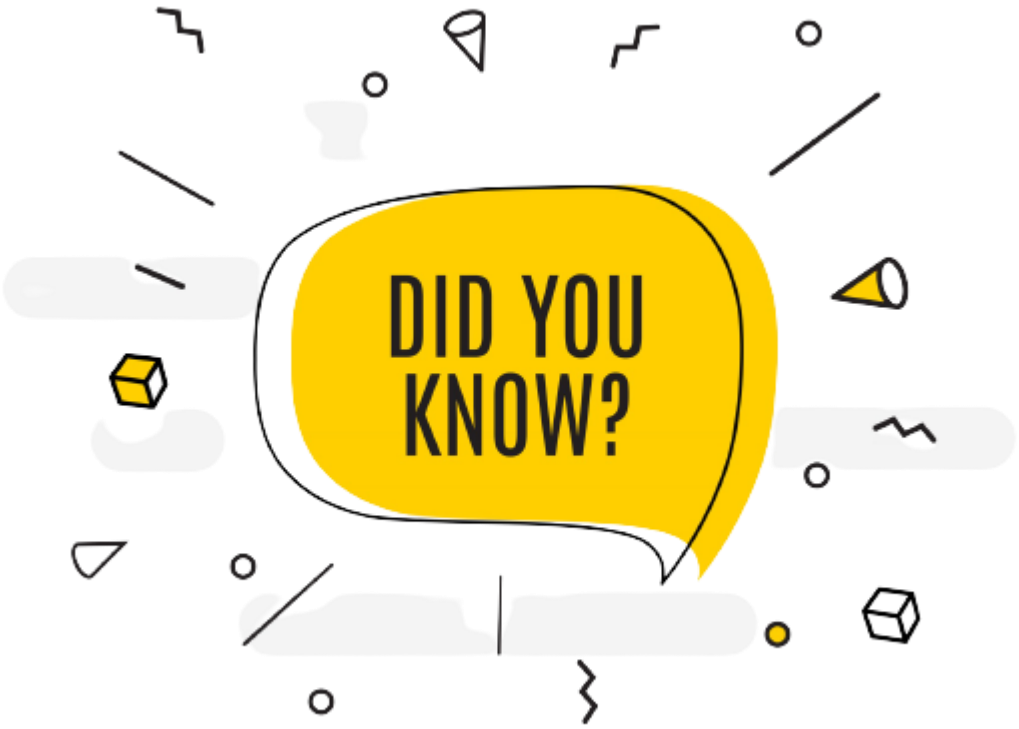
$$(COP)_{HP} = 1 + \frac{Q_L}{W_{in}}$$

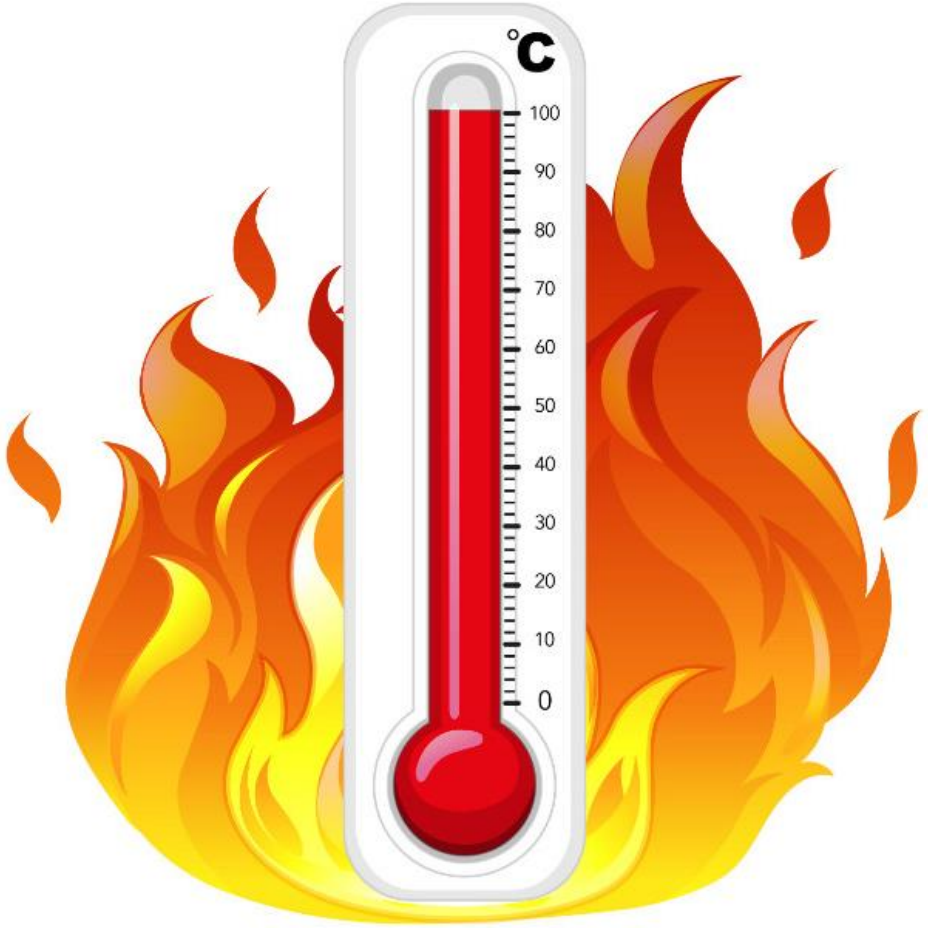
$(COP)_{HP}$ always greater than 1


REFRIGERATOR

- A refrigerator is a device operating in a cycle, that maintains a body at lower temperature than its surroundings.
- A refrigerator extract heat continuously from controlled space.
- Most of cases, Vapour compression cycle is used in refrigerator
- Its basic components are Compressor, Condenser, Expansion Device and Evaporator.

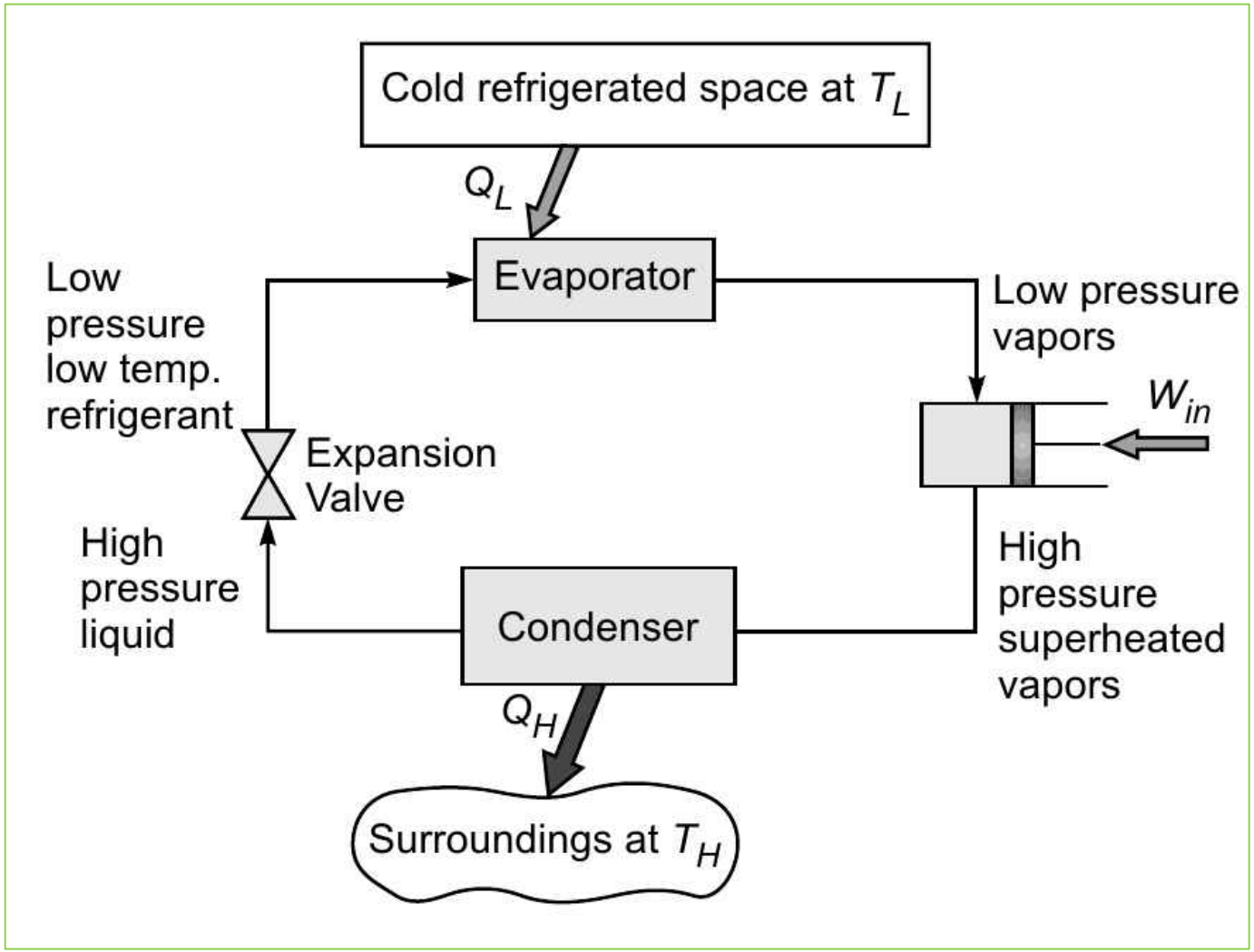
Heat & Temperature are Not Same

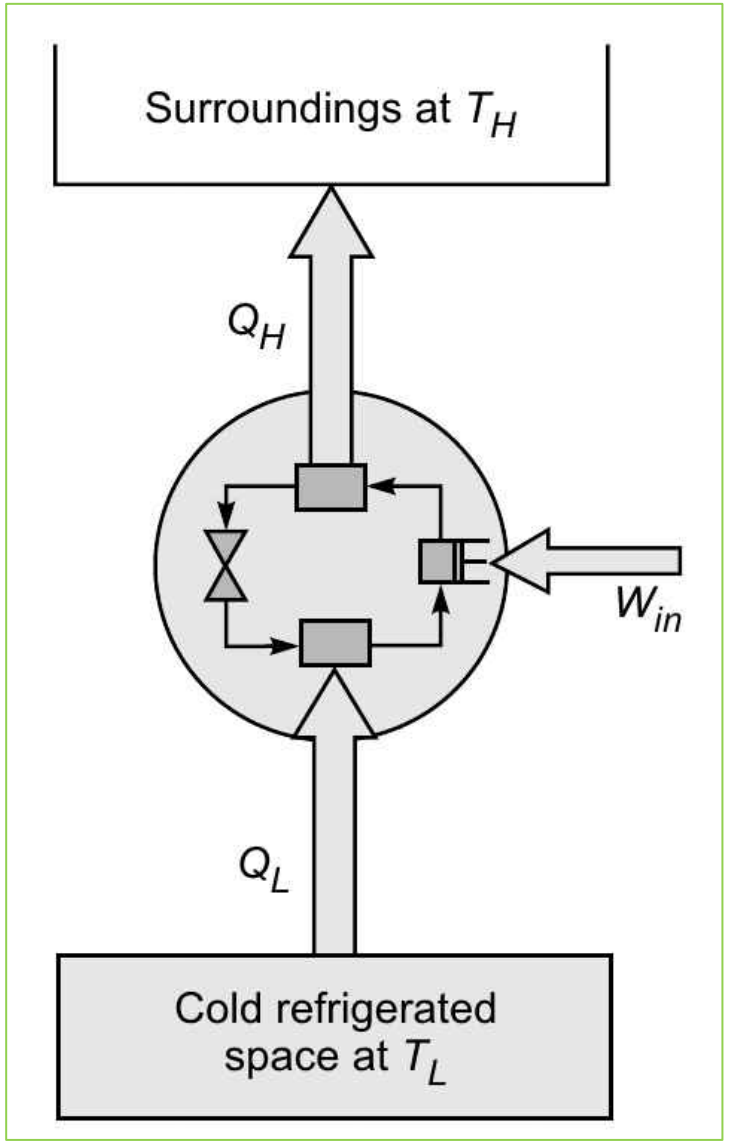




- Heat is thermal energy transferred from a hotter system to a cooler system that are in contact.
- Temperature is a measure of the average kinetic energy of the atoms or molecules in the system.
- We can calculate the heat released or absorbed using the specific heat capacity the mass of the substance and the change in temperature in the equation
- $Q = M \times C \times \Delta T$

REFRIGERATOR DIAGRAM





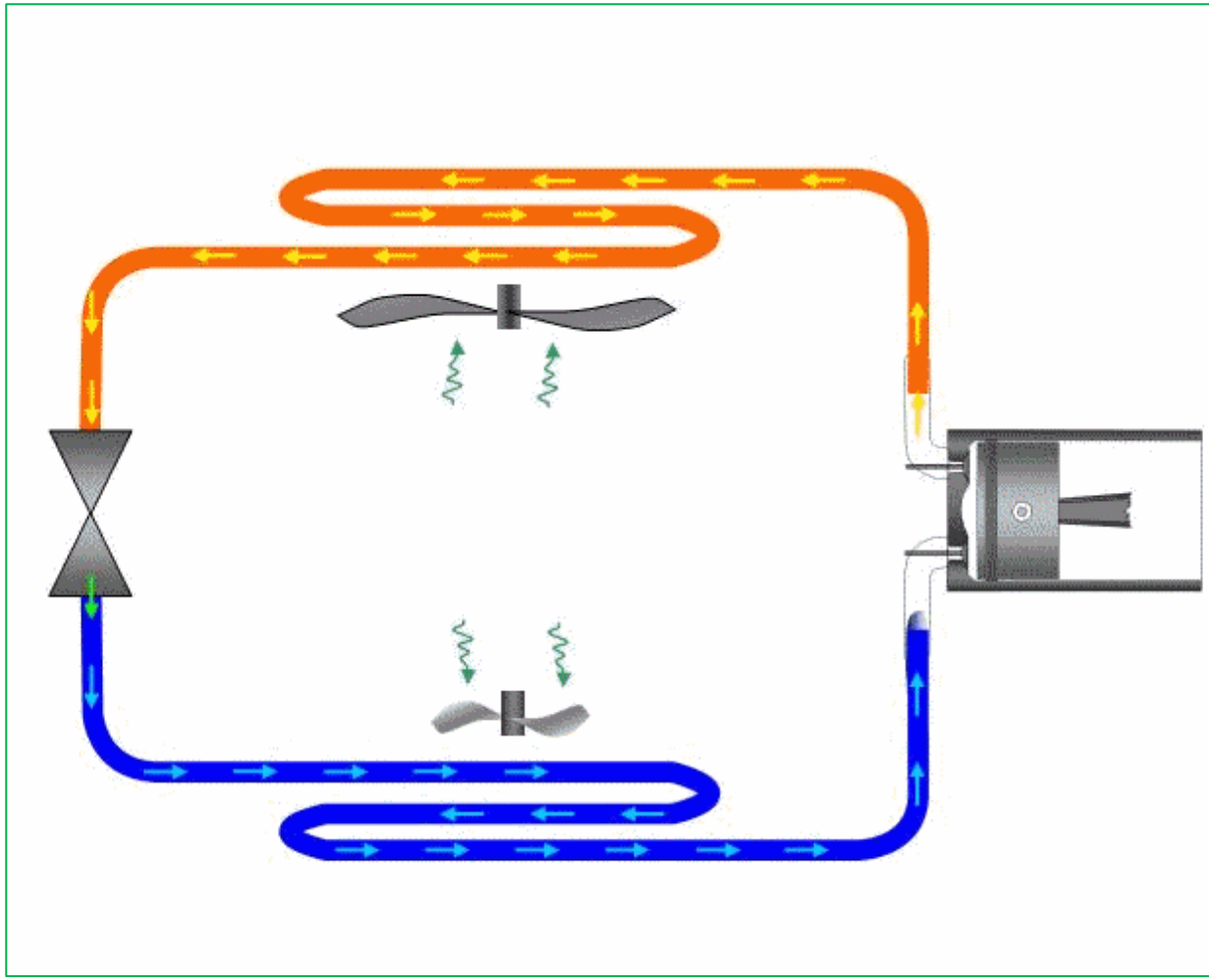
VAPOR COMPRESSION REFRIGERATION CYCLE

Step 1 - compression takes place to raise the temperature and refrigerant pressure.

Step 2 - Heat is transferred from the refrigerant to a flow of water.

Step 3 - When the refrigerant enters the throttling valve, it expands and releases pressure. Consequently, the temperature drops at this stage.

Step 4 - At this stage of the Vapor Compression Refrigeration Cycle, the refrigerant is at a lower temperature than its surroundings. Therefore, it evaporates and absorbs latent heat of vaporization.



COEFFICIENT OF THE REFRIGERATOR

- The performance of the refrigerator is measured in term of Coefficient of Performance (COP).
- It defined as the ratio of the desired output to the energy input.
- Consider an amount of heat Q_L is removed from the refrigerator space at temperature T_L
- The work input to the compressor is W_{in} and the heat rejected at the condenser is Q_H.

$$(COP)_{Refrigerator} = \frac{Refrigeration\ Effect}{work\ Input}$$

$$(COP)_{RE} = \frac{Q_L}{W_{in}}$$

But $W_{in} = Q_H - Q_L$ $\quad\quad$ $\because Q_H = Q_L + W_{in}$

$$(COP)_{RE} = \frac{Q_L}{W_{in}} = \frac{Q_L}{Q_H - Q_L}$$

$(COP)_{RE}$ most of the times is less than 1 but some times greater than 1

- $(COP)_{HP} = 1 + (COP)_{RE}$
- $(COP)_{RE}$ most of the times is less than 1 but some times greater than 1
- $(COP)_{HP}$ always greater than 1

Difference Between Efficiency & COP

Efficiency	COP
• Convert Energy • Heat is Low grade energy • =Work output/Heat Supplied • When heat is input • Always less than 100%	• Transfer Energy • Work is high grade Energy • =Required Effect/Work input • When work is input • May be less than or more than 1 • Heat pump always more than 1 • Refrigerator less than 1 but some times may more than 1


Any Questions

Today's Amazing Fact??????

HUMMINGBIRD

- Wing Flapping speed is 80 per Second
- Heart Beats can be 1260 per Minute
- Brain weight is 4.3% of body weight which is highest in a birds.

Did You Know?

धन्यवाद

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