13. THERMODYNAMICS

IMP DEFINITIONS & FORMULAS

1. **Zeroth law of thermodynamics:** If two bodies A and B are individually in thermal equilibrium with a third one, then the two bodies are also in thermal equilibrium with each other.
   This law gives the concept of temperature.
2. **First law of Thermo dynamics :** The heat supplied to a system is equal to the algebraic sum of increase in its internal energy and external workdone.
3. **Heat Capacity:** The amount of heat required to raise the temperature of a substance through 1^oc. S.I unit : JK^{-1}.
4. **Specific heat:** The amount of heat required to raise to the temperature of unit mass of a substance through 1^oC or 1K.

5.1. **Specific heat at constant pressure (C_p):** At constant pressure, the quantity of heat necessary to increase the temperature of unit mass of a gas through one degree ,is called specific heat of the gas at constant pressure.

5.2. **Specific heat at constant volume (C_v) :** At constant volume, the quantity of heat necessary to increase the temperature of unit mass of a gas through one degree ,is called specific heat of gas at constant volume.

5.3 **Relation between C_p and C_v :** $C_p - C_V = R$

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THERMODYNAMICS [1 LAQ]

Zeroth Law of Thermodynamics: If A≡B and B≡C then A≡B≡C

First Law of Thermodynamics: Heat Energy Cannot be Created or Destroyed.

Just like Mass, It can be converted from one form to another. **Law of Conservation of Heat.**

Second Law: In this World, 'There is no 100% Efficient Heat Engine',

Just Like, 'There is no 100% Refrigerator', There is no 100% perfect Black Body.

Thermodynamics లో జరిగే Main process: Conversion of Heat into Work (Mechanical).

ఇది అర్థం కావాలంటే మన Body లో జరిగే Heat generation & Conversion Process అర్థమైతే చాలు.

SPECIFIC 'HEAT CAPACITY'

వెలిగించిన Gas Stove మీద ఒక kg Pan ఉందనుకోండి. దాని Temperature ను 1^oK కి పెంచడానికి ఎంత Heat(J) కావాలో అదే ఆ Pan యొక్క Specific Heat Capacity (J / Kg / K).

వస్తువు యొక్క State మారే కొద్దీ వాటి Heat Capacities మారుతూ ఉంటాయి!

Solid Iron కి Heat Capacity Low అనగా 1^oK Temperature పెరగడానికి Iron కు తక్కువ Heat చాలు. అంటే అది వేగంగా 1^oK Temperature పెంచుకోగలదు లేదా వేగంగా cool అవుతుంది.

Liquid Water కి Heat Capacity High.అంటే water వేడెక్కడానికి కొంచెం ఎక్కువ Heat కావాలన్నమాట.

Specific Heat Capacity అనేది Solids కు వందల్లో ఉంటే, Liquids కు వేలల్లో ఉంటుంది.

Gases కి మాత్రం ఈ నిర్వచనంలో కొంచెం variation ఉంది. Gas ని వేడి చేయాలంటే ముందు బంధించాలి కదా?

అందుకే Gases కి రెండు రకాల Specific Heat Capacities ను నిర్వచించారు.

Constant Presure వద్ద కొలిచే Specific Heat Capacity ను C_p తోను,

Constant Volume వద్ద కొలిచే Specific Heat Capacity ను C_v తోను సూచిస్తారు.

ఏదైనా ఒక నిర్దిష్ట వాయువుకు దాని యొక్క C_p విలువే C_v కంటే ఎక్కువగా ఉంటుంది. ∴ $C_p = C_v + R$

6. **Quasi - Static process:** A Quasi-Static process can be defined as 'an infinitesimally slow process' in which the system remains in thermal and mechanical equilibrium with the surroundings at each and every intermediate state.
7. **Isothermal Process :** The process in which pressure and volume changes occur at constant temperature is called isothermal process.
8. **Adiabatic Process :** A process in which changes in pressure and volume of a gas takes place at constant amount of heat energy is called Adiabatic process.
9. **Isochoric Process**: In an isochoric process, volume V is constant. No work is done on or by the gas. The heat absorbed by the gas goes entirely to change its internal energy and its temperature.
10. **Isobaric Process**: In an isobaric process pressure P is fixed.
Here, temperature and internal energy change. The heat absorbed goes partly to increase internal and partly to do work.
11. **Heat Engines :** 'A device used to convert heat energy into mechanical energy is called a heat engine. Usually in a heat engine, a system is made to undergo a cyclic process that results in the conversion of heat into work.
12. **Refrigerators :** The refrigerator is just the reverse of a heat engine.

IMP FORMULAE

1) 1st Law of Thermodynamics: $\Delta Q = \Delta U + \Delta W$
2) Heat capacity $S = \frac{\Delta Q}{\Delta T}$
3) Specific heat capacity $s = \frac{1}{m}\frac{\Delta Q}{\Delta T}$
4) $C_p - C_v = R$
5) In an adiabatic process of an ideal gas $PV^{\gamma} = \text{constant}$, $\gamma = \frac{C_p}{C_v}$
6) Efficiency of heat engine $\eta = \frac{W}{Q_1} = 1 - \frac{Q_2}{Q_1}$
7) Efficiency of Carnot engine $\eta = 1 - \frac{T_2}{T_1}$

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THERMODYNAMICS

You Know! Our Body is a Model Heat Engine.

First Law ప్రకారం మన Body లోని Heat (dQ)= మనం తిన్న Food అనే Internal Energy (dU)+ ఆ Food ని నోటినుండి పొట్టలోకి పంపడానికి జరిగిన పని(dW). $\therefore dQ=dU+dW$

Our Body / Bike / Car / Rail Engine అనేవి Heat Engines.

Carnot Engine is a 'Theoretical Thermodynamic Cycle' to find the efficiency of Heat Engine.

Thank you SUN !

[Without U we can't survive]

What do we do in Thermodynamics?

1) We convert Heat into Work

2) We convert Heat Energy into Mechanical Energy, Electrical Energy,....

3) We study how Heat is Transferred from Sun to Earth

IPE POINT OF VIEW: LAQ: Carnot Engine

IMP. CONCEPTS : Three Laws of Thermodynamics (Zeroth Law, First Law, Second Law) Isothermal and Adiabatic Changes; Reversible & Irreversible Process;

IMP. Definitions: Specific Heat Capacity of Solids, Liquids; Specific Heat Capacity of Gases (C_p, C_v); Latent Heat

Imp. Applications: Heat Engine-Carnot Engine, Refrigerator