**3. WORK & HEAT**

**THERMODYNAMIC ANALYSIS OF WORK:**

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| General Definition of Work |  | F= Force | dx = Distance |

**Thermodynamic Work:** External to the system can be reduced to raising of weights. In Actual, Weight may be raised may not be raised. But the effect is equivalent to raising of weight.

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| Boundary Phenomena | It’s Transit. |
| Transient Form of energy | If no Energy crosses the boundary no work. |

**CLOSED SYSTEM WORK/ MOVING BOUNDARY WORK/ DISPLACEMENT WORK:**

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| **Note:** | |  | | It’s Derived from piston movement in cylinder. |
| Closed System | Reversible Process | Where, Pressure inside cylinder,  volume of the Cylinder. |
| **Work Done by The System** | | | **Work Done on The System** | |
| (Expansion Process) | | | (Compression Process) | |

**WORK TRANSFER IN VARIOUS NON-FLOW PROCESSES:**

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| --- | --- | --- | --- | --- |
| **Processes** | **Work Done/ Work Transfer** | | | |
| Constant Volume or Isochoric or Isometric |  | | | |
| Constant Pressure or Isobaric or Isopiestic |  | |  | |
| Constant Temperature or Isothermal |  | |  |  |
| Adiabatic Process or Polytropic Process |  | |  |  |
| **Isochore:** Constant Volume line in P-V Diagram.  **Isobar:** Constant Pressure line in P-V Diagram. | | **Isotherm:** Constant Temperature line in P-V Diagram. | | |

**Closed System Work Transfer on P-V Diagram:** Area under the process when projected to volume axis represents closed system reversible work transfer.

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| (Depends on the path) | Work transfer is path function |  |
| Work transfer is inexact differential. | It denoted by or |
| Work transfer is not property. |  |  |

**TYPES OF WORK TRANSFERS:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Moving Boundary Work** | **Electrical Work Transfer** | **Paddle Wheel Work Transfer** | **Spring Work Transfer** |
|  |  | Where, RPM or No. of Revolution |  |

**Net Work Transfer:**

**Net Work Transfer on P-V diagram:** TheArea Enclosed in the cycle on P-V diagram represents Net Work Transfer.

**SPECIAL CASE OF WORK TRANSFERS:**

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| **Free Expansion Process** | **Paddle Wheel Work** | **Work Transfer in increasing P&V** |
| It’s gas expansion against vacuum.  No Resistance from vacuum.  , But  It’s irreversible process. | It’s Paddle Wheel work in closed rigid chamber filled with fluid.  But .  It’s irreversible process. | It’s arrangement of spring-loaded Piston Cylinder Arrangement.  Here, Spring is liner. hence, PV diagram is like linear curve because of increasing P&V. |

**THERMODYNAMIC ANALYSIS OF HEAT:**

**Heat:** Heat is a form of energy which crosses the boundary due to temperature difference.

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| Boundary Phenomena | It’s Transit. |
| Transient Form of energy. | No across the boundary no Heat Flow. |
| **Heat Supplied to The System** | **Heat Supplied by The System** |
| (Expansion Process) | (Compression Process) |

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| --- | --- |
| **Generalised Equation of Heat Transfer:** | **Specific Heats of Substances:** |

Generalised form of heat transfer can be applied to Solid, Gas & Liquid.

**Specific Heat:**

It’s Amount of heat required to raise unit mass of substance through one-degree temperature difference.

|  |  |
| --- | --- |
| Specific Heat at constant Pressure | Specific Heat at constant Temperature |
| **For Gases:** | **For Solid & Liquid:** |

|  |  |
| --- | --- |
| **Heat Capacity ()** |  |

**HEAT GENERATION:**

Electrical energy directly converts into heat energy (100% conversion). Hence,

**HEAT EXCHANGING PROCESS:**

Due to Temperature Difference, Heat Flows from higher energy to low energy region.

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| **DIFFERENCE BETWEEN HEAT & WORK TRANSFER** | **SIMILARITIES BETWEEN HEAT & WORK** |
| It’s completely depends on the selection of the boundary.  E.g. Arrangement of insulated vessel filed with fluid and putting heater inside. | * Both are Boundary Phenomena. * Both are Transit. * Both are Transient Form of energy. * Both are Path function. * Both are not properties. * Both are inexact differentials. |