**4. EXTERNAL SURFACES (FINS)**

**WHY WE NEED FINS:** From the Newton’s Law of cooling, for increasing heat Transfer,

|  |  |  |
| --- | --- | --- |
| : Practically not Possible | : Practically not Possible | : Practically Possible |

**FINS:** It’s extra solid material attached to the base to increase heat transfer by increasing the surface area.

|  |  |
| --- | --- |
| Length of Fins | Width of Fins |
| Thickness of Fins | Base or Source Temperature of Fins |
|  | Thickness |

Heat Transfer in fins:

|  |  |
| --- | --- |
| **IMPORTANT POINT W.R.T. FINS:**   1. Fins should have higher thermal conductivity 2. Fins should be Strong and Anti-corrosive in nature 3. Fins should have Low Weight (Due to cantilever Struct.) 4. Fins should be environment friendly. 5. Fin cost Should be low or moderate. | **USE-CASES:**   1. Fin is used when h is less (Free Convection with gases) 2. Aluminium Material generally used. |

**GENERALISED DIFFERENTIAL EQUATION FOR FINS:**

**ASSUMPTIONS:**

|  |  |
| --- | --- |
| * 1D Heat Flow. * Steady State. * No internal heat generation * Material homogenous and isotropic * Thermal conductivity is constant. * Base or Source temperature is constant. | * Surrounding fluid temperature is constant. * Heat transfer coefficient value is constant. * Radiation heat loss neglected. * Prefect contact between fin and base material. * Fin having constant cross-sectional area. |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Excess Temperature | |  |
|  |  |  | | |
| From the energy Balance, |  |  |  | |
| **Constant** |  | | | |

**NOTE:** At the Base Surface:

|  |  |  |  |
| --- | --- | --- | --- |
| Circular Fin | Square Fin | Rectangle Fin | Equilateral Triangle Fin |
|  |  |  |  |
|  |  |  |  |

**VERY LONG OR INFINITE LENGTH OF FIN:**

|  |  |  |
| --- | --- | --- |
|  |  |  |

At the Base Surface:

**CASE-I:** Same temperature at different length for different fins with same base temperature.

|  |  |  |
| --- | --- | --- |
| For Fin-1: | For Fin-2: |  |

For Circular Fins,

|  |  |  |  |
| --- | --- | --- | --- |
|  | For , | For , | For ,  If , There is impurities |

**CASE-II:** Different temperature at different length in same fin with unknown base temperature.

|  |  |  |
| --- | --- | --- |
| For Fin-1: | For Fin-1: |  |

**FIN OF FINITE LENGTH:**

**CASE-I:** Insulated tip or adiabatic tip.

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | |  |
| At Tip, , | |  | |

**CASE-II:** Convective Heat Loss from tip

|  |  |  |
| --- | --- | --- |
|  |  | |
|  | | We can use corrected length approach for the same problem, |

**CORRECTED LENGTH () APPROACH:**

|  |  |
| --- | --- |
|  |  |

|  |  |  |
| --- | --- | --- |
|  | For Circular Fin, | For Rectangular Fin, |

**SIGNIFICATION OF :**

|  |  |  |
| --- | --- | --- |
|  |  |  |
| Fin Acts as Heat Conductor | No use of fins | Fin Acts like a heat insulator |

**HEAT TRANSFER WITHOUT USE OF FIN:**

**CONDITION FOR INFINITE LENGTH:**

|  |  |
| --- | --- |
|  |  |
| For |  |
| (Cost is more) | (Cost is Less) |

**TWO RESERVOIRS AT DIFFERENT TEMPERATURE:** Fin of finite length connected between two reservoirs.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  |  |  |
|  | |  | | |
|  | |  | | |
|  | | * Draw the Diagram & Show L | | |

At ,

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |

**FIN EFFICIENCY :**

|  |  |  |
| --- | --- | --- |
| **Real Fin** | **Ideal Fin** |  |
| Temperature varies w. r. t. () | Temperature doesn’t vary w. r. t. () |
|  |  |

|  |  |  |
| --- | --- | --- |
| For very long or infinite length of Fin, | For Finite length Fin, Insulated Tip with Adiabatic Tip, & as | For Finite length Fin, Convection at tip, |

**OVERALL EFFICIENCY ():** It’s used for multiple fins.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | | Area of all finned surfaces,  Area of un-finned surfaces , | | |
|  |  | |  |  |
|  |  | | | At , |

**FIN EFFECTIVENESS ():**

|  |  |  |
| --- | --- | --- |
|  |  |  |
| Fin Acts as Heat Conductor | No use of fins | Fin Acts like a heat insulator |

**Note:** To justify the cost

|  |  |
| --- | --- |
| For Very long or Infinite length of fin,   1. (Thin fins are more effective) | For finite length of fin & Insulated tip or adiabatic tip,  increases and decreases with length. So, to get higher both values select the optimum length. Effectiveness is related to Thermal & economics. |

|  |  |
| --- | --- |
|  | For Circular Fin, |

Fin Effectiveness can be increased by,

1. Select a fin material high thermal conductivity.
2. Attach a fin in environment having low value of heat transfer coefficient (Free convection with Gases).
3. Select a geometry having high value of ratio of perimeter to cross sectional area (Thin fin preferred).

**Note:**

1. In actual practice short, thin multiple fins in closed space arrangement required.
2. With increasing length if fin effectiveness increases but efficiency decreases.

**OVERALL EFFECTIVENESS ():** It’s used for multiple fins.

|  |  |
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