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THERMAL DISTRIBUTION ANALYSIS ON FINS IN RADIATOR ENGINE COOLING SYSTEM

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Abstract:

The effects of heat and thermal management of structures is more and more critical as performance limits are pushed further by the need to have lighter, smaller and more efficient designs. Convection, radiation and conduction loads are obvious, but the need to include the effect of power losses and thermal energy from friction and external sources such as pipe flows means that analysts need to have more tools at their disposal to simulate thermal models accurately. Radiators transfer the heat energy from one source to another source through fin tubes for cooling the engine in automobiles. Radiators not only used in automobiles also in thermal plants, aerospace engines, railway locomotives. When Automobiles are in working conditions huge amount of heat transferred through engine. This heat will form around $400^{o}C$. Fins available in tubes of radiator pass the coolant. The coolant flows from the inlet to the outlet through many tubes mounted in a parallel arrangement. The fins conduct the heat from the tubes and transfer it to the air flowing through the radiator. Here, the air temperature is around $30^{o}C$. Here the problem find out that efficiency of cooling system depends on thermal distribution on different material properties. Previously focused on thermal analysis of radiators with different materials. Current project focused on thermal distribution at different locations (50mm, 100mm, 200mm, 350mm) of infinite fin tubes (which are have 350 mm length) in radiator with different materials i.e, ALUMINIUM and GRAPHITE-TUBES. The aim of current project is developing design of radiators with fin tubes using CAD software.

Keywords:-Thermal Distribution, Analysis, Fins, Cooling System

1 INTRODUCTION

Radiators transfer the heat energy from one source to another source through fin tubes for cooling the engine in automobiles. Radiators not only used in automobiles also in thermal plants, aerospace engines, and railway locomotives. When Automobiles are in working conditions huge amount of heat transferred through engine. This heat will form around 400^{o}C. Fins available in tubes of radiator pass the coolant. The coolant flows from the inlet to the outlet through many tubes mounted in a parallel arrangement. The fins conduct the heat from the tubes and transfer it to the air flowing through the radiator. Here, the air temperature is around 30^{o}C.

FINS:

Fins are used to increase the heat transfer rate from surfaces. Addition of fins increases heat transfer from surface by several locations.

Applications:

1. Cylinder head of IC engines in automobiles.
2. Radiators in engine cooling systems of vehicles.
3. Steam power plant.
4. Cooling of electronic chips, I.C boards.
5. Cooling of electronic motors .
6. Cooling of electric transformers.
7. Heat exchangers.

2 CONVECTION

Convection is heat transfer between solid surface and a moving fluid inside surface.

According to Newton's cooling law:

$$Q = hA(T_s - T_\infty)$$

Tsis surface temperature and T∞ is fluid temperature.Q is convective heat transfer rate , h is heat transfer coefficient, A is surface area.

Assembly's concepts:

Components:

Assembly part files point to geometry and features in the subordinate parts rather than creating duplicate copies of those objects at each level in the assembly. This technique not only minimizes the size of assembly parts files, but also provides high levels of Associativity. For example, modifying the geometry of one component causes all assemblies that use that component in the session to automatically reflect that change. Some properties, such as translucency and partial shading (on the Edit Object Display dialog), can be changed directly on a selected component. Other properties are changed on selected solids or geometry within a component. Within an assembly, a particular part may be used in many places. Each usage is referred to as a component and the file containing the actual geometry for the component is called the component part.

Top-down or Bottom-up Modeling:

You are not limited to any one particular approach to building the assembly. You can create individual models in isolation, and then later add them to assemblies (bottom-up), or you can create them directly at the assembly level (top-down). For example, you can initially work in a top-down fashion, and then switch back and forth between bottom-up and top-down modeling.

Design in Context:

When the displayed part is an assembly, it is possible to change the work part to any of the components within that assembly (except for unloaded parts and parts of different units). Geometry features, and components can then be added to or edited within the work part. Geometry outside of the work part can be referenced in many modeling operations. For example, control points on geometry outside of the work part can be used to position a feature within the work part. When an object is designed in context, it is added to the reference set used to represent the work part.

Associativity Maintained:

Geometric changes made at any level within an assembly result in the update of associated data at all other levels of affected assemblies. An edit to an individual piece part causes all assembly drawings that use that part to be updated appropriately. Conversely, an edit made to a component in the context of an assembly results in the update of drawings and other associated objects (such as tool paths) within the component part. See the next two figures for examples of top-down and bottom-up updates.

Mating Conditions:

Mating conditions let you position components in an assembly. This mating is accomplished by specifying constraint relationships between two components in the assembly. For example, you can specify that a cylindrical face on one component is to be coaxial with a conical face on another component. You can use combinations of different constraints to completely specify a component's position in the assembly. The system considers one of the components as fixed in a constant location, then calculates a position for the other component which satisfies the specified constraints. The relationship between the two components is associative. If you move the fixed component's location, the component that is mated to it also moves when you update. For example, if you mate a bolt to a hole, if the hole is moved, the bolt moves with it.

Using Reference Sets to Reduce the Graphic Display:

Large, complex assemblies can be simplified graphically by filtering the amount of data that is used to represent a given component or subassembly by using reference sets. Reference sets can be used to drastically reduce (or even totally eliminate) the graphical representation of portions of the assembly without modifying the actual assembly structure or underlying geometric models. Each component can use a different reference set, thus allowing different representations of the same part within a single assembly. The figure below shows an example of a bushing component used twice in an assembly, each displayed with a different reference set. When you open an assembly, it is automatically updated to reflect the latest versions of all components it uses. Load Options lets you control the extent to which changes made by other users affect your assemblies. Drawings of assemblies are created in much the same way as piece part drawings. You can attach dimensions, ID symbols and other drafting objects to component geometry. A parts list is a table summarizing the quantities and attributes of components used in the current assembly. You can add a parts list to the assembly drawing along with associated callout symbols, all of which are updated as the assembly structure is modified.

3 3D MODELING OF FIN TUBES WITH RADIATOR

2D DIAGRAM OF PLANE WALL

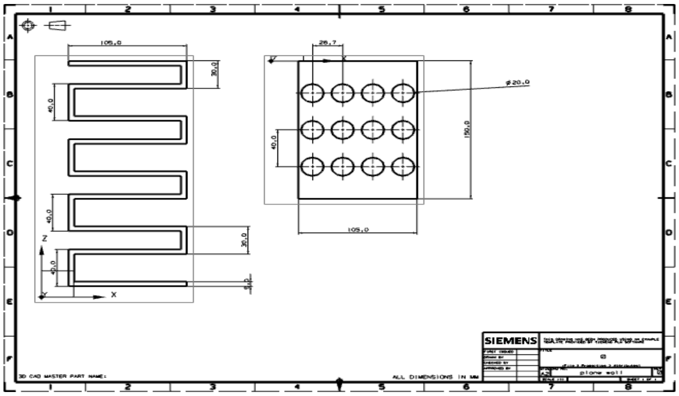

Fig 1 2D diagram of side wall

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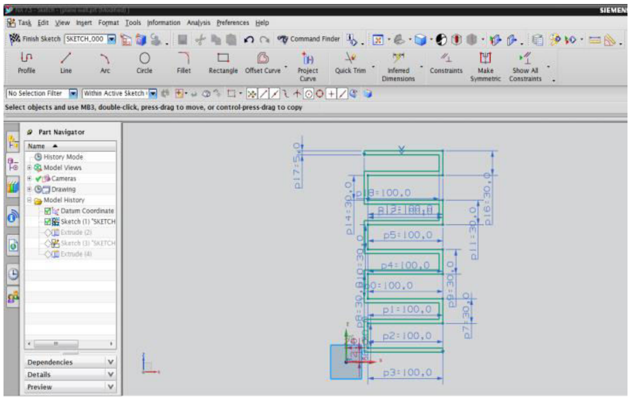

Fig 2 2D sketch of plane wall

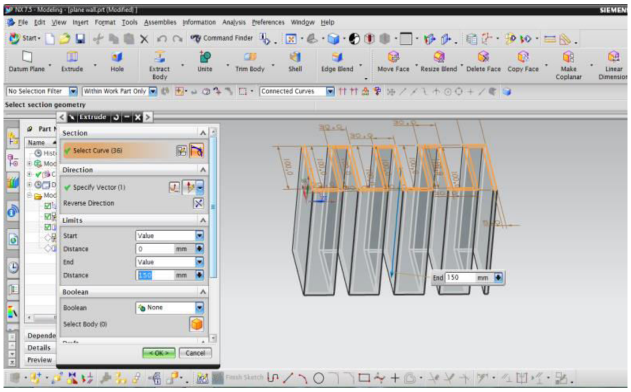

Fig 3 extrude option

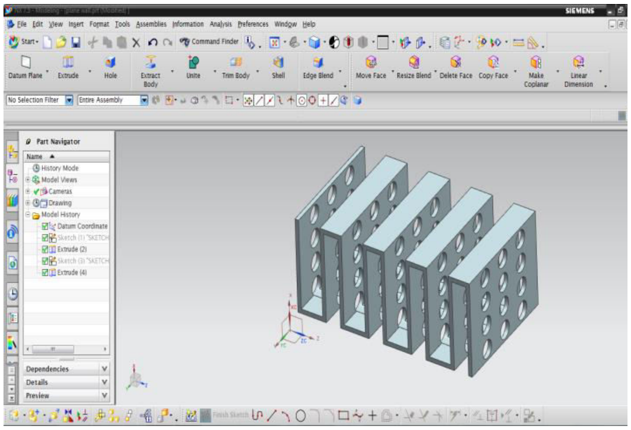

Fig 4 final 3D model of plane wall

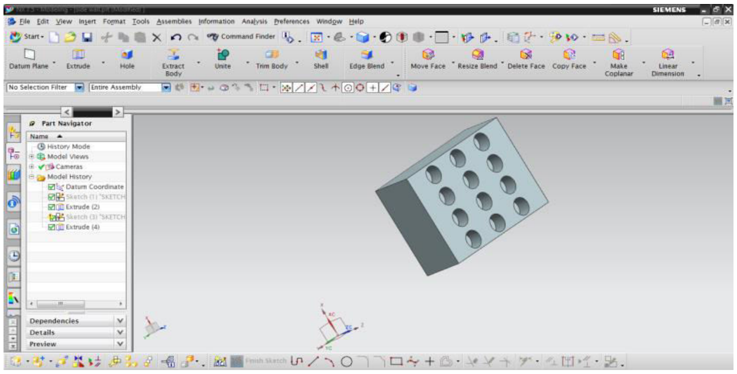

Fig 5 Final 3D model of side wall

4 THERMAL DISTRIUTION ANALYSIS ON FINS IN RADIATOR

CALCULATION OF THERMAL DISTRIBUTION:

Outer Diameter of tube (D)= 20 mm

Perimeter of tube (P) = π*(D)= 62.8mm

Cross sectional area of tube(A)= $(\frac{\square}{4}) * (\square^2)$

= 314 mm^2

Fin tube's base working under temperature(T_b) = 400°C

Tubes contact with air at (T_a) = 30°C

Number of tubes(N) = 12

Slope of temperature distributor(m) = $\sqrt{\frac{\square\square}{\square\square}}$

FOR Aluminium tubes

Thermal conductivity (k) = 204 W/mk

Heat transfer coefficient (h) = 10 W/m^2K

Slope (m) = $\sqrt{\frac{10*0.0628}{204*314*10^{-6}}}$ = 3.13

1. Temperature distribution at 50 mm(x= 0.05m) in given long fin tube

$T-T_a= (T_b-T_a)*e^{-mx}$

$T-T_a= (400-30)*e^{-3.13*0.05}$

$T-T_a= 447^oC$

$T= 477^oC = 750\ K$

2. Temperature distribution at 100 mm(x= 0.1m) in given long fin tube

   $T-T_a= (T_b-T_a)*e^{-mx}$

   $T-T_a= (400-30)*e^{-3.13*0.1}$

   $T-T_a= 343.68^oC$

   $T= 373.68^oC= 646.68\ K$

3. Temperature distribution at 200 mm(x= 0.2m) in given long fin tube

   $T-T_a= (T_b-T_a)*e^{-mx}$

   $T-T_a= (400-30)*e^{-3.13*0.2}$

   $T-T_a= 251.32^oC$

   $T=281.32^oC= 554.32\ K$

4. Temperature distribution at 350mm(x= 0.35m) in given long fin tube

   $T-T_a= (T_b-T_a)*e^{-mx}$

   $T-T_a= (400-30)*e^{-3.13*0.35}$

   $T-T_a= 157.15^oC$

   $T= 187.15^oC = 460.15K$

For Graphite Tubes

Thermal conductivity (k) = 150 W/mk

Specific heat (Q) = 750 j/kgK

Heat transfer coefficient (h) = 10 W/m^2K

Slope (m) = $\sqrt{\frac{10*0.0628}{150*314*10^{-6}}} = 3.651$

1. Temperature distribution at 50 mm(x= 0.05m) in given long fin tube

   $T-T_a= (T_b-T_a)*e^{-mx}$

   $T-T_a= (400-30)*e^{-3.651*0.05}$

   $T-T_a= 391.5^oC$

   $T= 421.5^oC$

   $T= 694.5K$

2. Temperature distribution at 100 mm(x= 0.1m) in given long fin tube

   $T-T_a= (T_b-T_a)*e^{-mx}$

   $T-T_a= (400-30)*e^{-3.651*0.1}$

   $T-T_a= 256.8^oC$

   $T= 286.8^oC$

   $T = 559.8K$

3. Temperature distribution at 200 mm(x= 0.2m) in given long fin tube

   $T-T_a= (T_b-T_a)*e^{-mx}$

   $T-T_a= (400-30)*e^{-3.651*0.2}$

   $T-T_a= 178.27^oC$

   $T = 208.27^oC$

   $T= 481.27K$

4. Temperature distribution at 350mm(x= 0.35m) in given long fin tube

$$T-T_a = (T_b-T_a)*e^{-mx}$$

$$T-T_a = (400-30)*e^{-3.651*0.35}$$

$$T-T_a = 103.13^{o}C$$

$$T = 133.13^{o}C$$

$$T = 406.13K$$

5 GRAPHS:

FOR GRAPHITE TUBES

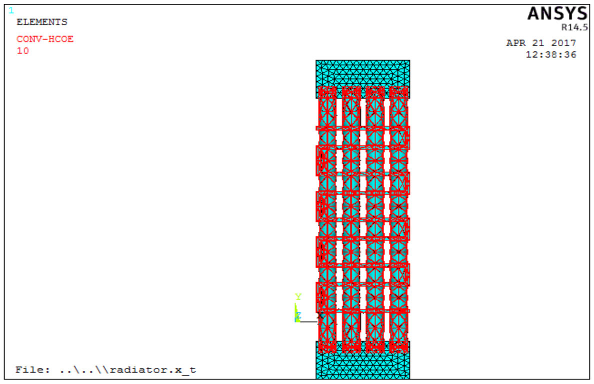

Fig 6 applied initial temperature and convection coefficient

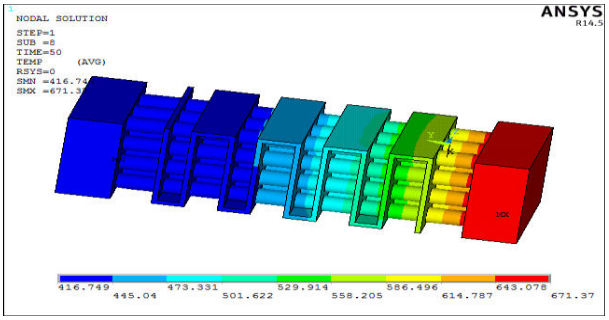

Fig 7 nodal temperature distributors along fin tubes

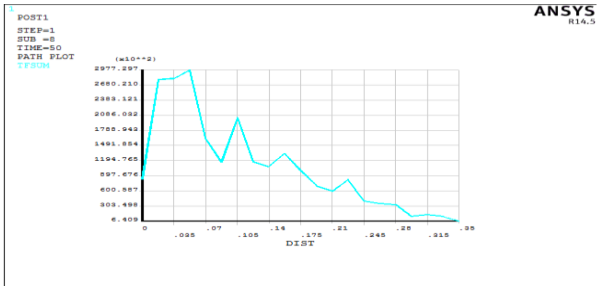

Fig 8 Thermal gradient verses length

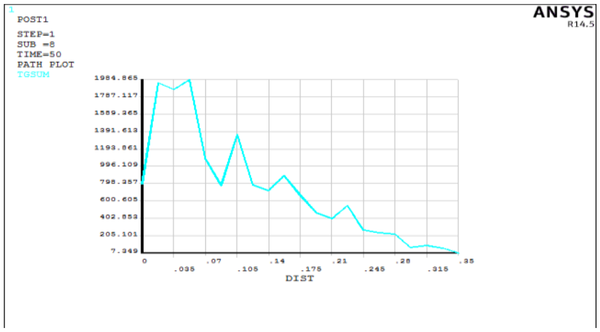

Fig 9 Temperature Verses Length

6 CONCLUSION

Radiators in automobiles which are made by fin tubes used for cooling the engines with high fin efficiency. This fin efficiency performs major role in cooling system based on heat transfer rate. Fin efficiency increases with increasing in Heat transfer rate. From above results heat transfer rate is more for graphite tubes when compare to aluminum tubes.Nodal temperature distribution increases based on material properties. In current project temperature distribution lower in graphite tubes compared to aluminum tube. Here found out that cooling rate is more in graphite tube when compare to aluminum tube. Also theoretical calculation of thermal distribution at different locations on fin tubes almost equal to analytical results.

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