THE “PSEUDO SINGLE ROW” RADIATOR DESIGN

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LITERATURE REVIEW

Radiator is a device used to cool internal combustion engine by radiating heat out via a fluid called coolant which is being circulated around the engine.

Current generation radiators consist of two header tanks placed on bottom and top interlinked by a passage of tubes, which are flattened in order to maximize the surface area. It is made up of brass or copper soldered to brass headers, but to save money aluminum tubes with plastic headers may also be used.

The coolant is circulated by a centrifugal pump, which forces cooled coolant around the engine block where it absorbs the engine heat. This results in the expansion of the fluid causing the pressure to increase in the system. A pressure valve is provided which in case of excess pressure will allow the out flow of some fluid in exchange of some air thus maintaining pressure.

The size of radiator is determined by the need of heat dissipation during the peak heat generation periods keeping in account the heat dissipation during idle speed conditions.

Now in the convention radiator design there is need to have some spaces between the tubes so as to add sufficient ligament in the head part so as to join the header with the flattened tubes. This results in a loss of thermal performance as the conduction across the tubes and to the fins is hindered.
ABSTRACT
This paper puts forth a new improved radiator design that may be used in place of the current radiator design. The multi row radiator tubes have spaces between them to accommodate sufficient ligament in order to join the tubes with the head. The average size of this ligament in commercial application is 5mm to 10mm.

This design has some limitations such as there is no contact surface between the tube rows so the conduction of heat is hindered; as a result the rate of heat conduction to the fins and across the tube rows decreases.

Other than this the current design has limited tube wall thickness. If the conventional tube wall thickness is beyond the maximum allowable value, then it would tend to distort, resulting in disturbed fin-tube bond, and hence the performance is affected. So the tube thickness and hence the performance is limited in the current design.

Now a way to circumvent the above limitation is fill up of the space with some material with light weight, good heat conduction in such a way that it does not undermines the structural integrity. The material will act as a superstructure which not only provides additional structural strength, but also increases the surface area for heat radiation, the heat flow across the tubes and to the fins would increase so as a result the design would be more efficient.

This May Be Regarded As Pseudo – Single Row Radiator Design.

CURRENT RADIATOR DESIGN AND ITS PERFORMANCE
The design if a standard radiator consists of two header tanks placed on bottom and top/ sides interlinked by a passage of flattened tubes such that the surface area is maximum and these passages form the core area of heat exchange. This network is typically called multi row radiator core and is made up of brass, aluminum or copper soldered to metallic headers. (As shown in figure 2)
FLOW SIMULATION REPORT
Solid works was used to simulate the flow in the heat exchanger. The units were kept in SI system with external analysis type.

The Size of computational domain is as follows

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<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>X min</td>
<td>-0.412 m</td>
</tr>
<tr>
<td>X max</td>
<td>0.412 m</td>
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<tr>
<td>Y min</td>
<td>-0.387 m</td>
</tr>
<tr>
<td>Y max</td>
<td>0.384 m</td>
</tr>
<tr>
<td>Z min</td>
<td>-0.346 m</td>
</tr>
<tr>
<td>Z max</td>
<td>0.353 m</td>
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The Basic Mesh dimensions i.e. the number of cells in X, Y and Z was 38, 36 and 39 respectively.

Additional physical calculation options were
Flow Type: Laminar and turbulent
Time-Dependent Analysis: Off
Gravity: On
Radiation: Off
Default Wall Roughness: 0 micrometer

In the material settings the fluids selected were air and water. And in solids copper and mild steel were used.

Inlet conditions
The static pressure was 101325 Pa with temperature 293.20K. The velocity vector was kept zero in all directions. Under the solid parameters the default material was copper with its initial temperature 293.20K.
The turbulence intensity was kept at 0.10% and the turbulence length 3.200e-004 m.

Boundary conditions
Type: Inlet mass flow
Coordinate system: Global coordinate system
X axis was selected as reference axis with mass flow rate 0.0010, temperature 500K and the boundary layer type turbulent.
The environmental pressure at temperature 500K was 101325.00 Pa

Surface Goals
The system was set to calculate the average value of the fluid temperature with convergence on

Results
Average temperature of outlet fluid is 345.69K.
The “Pseudo Single Row” Radiator Design

Figure 3 and 4 displays the temperature variation across the radiator body with color distribution described below in figure 4.
Appendix

Air
Path: Gases Pre-Defined
Specific heat ratio (Cp/Cv): 1.399
Molecular mass: 0.0290 kg/mol

Water
Path: Liquids Pre-Defined
Cavitation effect: Yes
Temperature: 0 K
Saturation pressure: 0 Pa

Solids
Copper
Path: Solids Pre-Defined\Metals
Density: 8960.00 kg/m^3
Conductivity type: Isotropic
Electrical conductivity: Conductor
Radiation properties: No
Melting temperature: Yes
Temperature: 1356.20 K

Steel (Mild)
Path: Solids Pre-Defined\Alloys
Density: 7870.00 kg/m^3
Specific heat: 472.0 J/(kg*K)
Conductivity type: Isotropic
Thermal conductivity: 51.9000 W/(m*K)
Electrical conductivity: Conductor
Resistivity: 1.7400e-007 Ohm*m
Radiation properties: No
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Melting temperature: Yes
Temperature: 1673.15 K

PROPOSED RADIATOR DESIGN AND ITS PERFORMANCE
In the proposed design of the radiator metal stripes have been added between the tubes of the radiator. These metal plates are illustrated in the Fig 6 with blue color.

Flow simulation report
Solid works was used to simulate the flow in the heat exchanger. The settings were kept same as the previous simulation.

Results
Average temperature of outlet fluid is 338.28K
Figure 7 displays the temperature variation across the radiator body with color distribution described below in fig 8.
Appendix

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CONCLUSION AND FUTURE SCOPE
The net temperature of the water coming out of the standard temperature is 345.69 K, whereas the temperature of water in the improved design is found out to be at 338.28K. So for the same radiator dimensions the cooling effect has been improved by 1.428%. This figure can further be improved if material of greater thermal conductivity is used as the filling material. Moreover the air drag resistance will also decrease in the new design, improving the resultant efficiency.

REFERENCE