Heat Transfer Analysis of Louver - Fin Radiator and Plain-Fin Radiator

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Abstract— Louvered fins constitute a major method of heat transfer enhancement. For evaluating the worthiness of such fins it is significant to compare the plain and louvered fins considering the heat transfer and pressure drop. So far the tubular construction was more satisfactory but now a days louvered fins are being employed for the duty. The present paper Intends to compare the performance of plain and louvered fins for automobile radiators.

Key words: Louver, Fin Radiator, Plain-Fin Radiator

I. INTRODUCTION

In radiators the louver-fins are used for improving its performance. The louver-fin offers periodic interruptions in the flow and due to the interruptions the flow gets mixed followed by the increase in the pressure drop. The Louvered fins heat are classified into two categories. They are Type I i.e. circular tubes and Type II i.e. flat rectangular ducts with rounded edges.

Here, in order to evaluate the performance of a louver-finned radiator in terms of heat transfer and pressure drop characteristics, we will compare it with plain-fin radiator. The information of Type I is available abundantly. But there is no information regarding comparison of louver-finned and plain-finned radiator for Type –II

II. MATERIAL USED

A. *Selecting a Template (Heading 2)*

- Radiator with aluminium fins 0.05 mm thick.
- 16 inch Fan for providing air supply

III. REVIEW PAPER

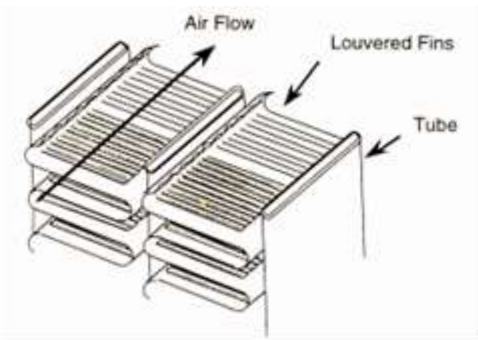

Fig. 1: Louver-finned radiator of Type II

Here, the louvered fins are bonded to the flattened rectangular tubes. We pass one of the fluid through the flat rectangular tubes and the other fluid over the louvered fins.

A louvered plate, forms the flow channels through which air passes over the louvers. It is also certain that the pressure and temperature characteristics of the fluid in the whole radiator will be the same as for a single fin.

To supplement the schematic representation of louver-finned radiator, a photograph of an actual Type II louvered radiator is displayed in Fig. 2.

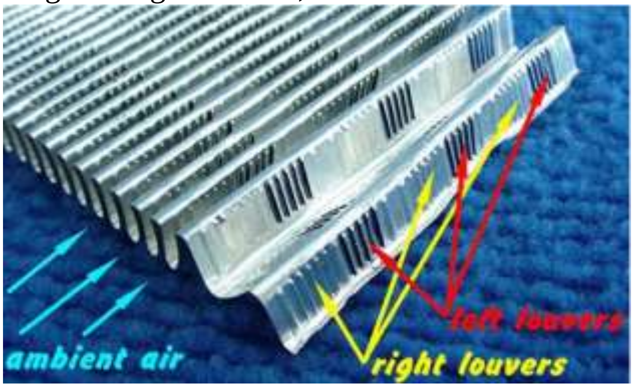

Fig. 2: Photograph of an actual Type II louver-finned radiator

The louver-fin dimensions and shapes are shown in the figure given in figure 3

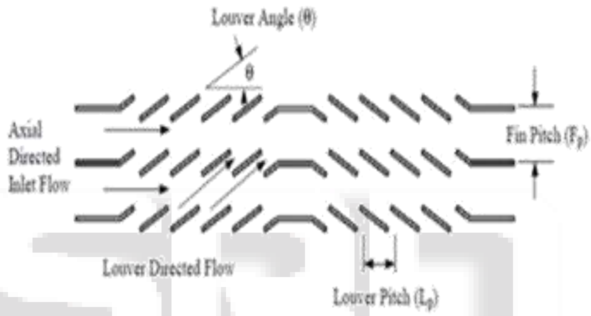

Fig. 3: louver-fin Dimensions and Shapes

The problem under consideration is having a turbulent flow. Here the mode of heat transfer is convection type in the fluid and the conduction type in the fins. Here we will analyse this in detail. We will analyse the flow of fluid and heat transfer by Navier stokes equations, the continuity equation, and the First Law of Thermodynamics.

For the fins, we will use the First Law of thermodynamics. We used ANSYS CFX for finding numerical solution. This software uses the finite volume approach to the governing partial differential equations.

As shown in the figure 4, we are passing the air through the fins. The air at inlet is having uniform velocity. As the flow is incompressible, the average air velocity at any cross section in the interfin space will be equal i.e. U. The temperature of the entering air is uniform. The inlet velocities are 7.7, 9.3, 10.5, 18.7, and 36.9 m/s . The flow of the air passing from the radiator fin is also uniform. The temperature at the interface of flat tube and the fin, is uniform and equal to base temperature. The fins are of the aluminium alloy 3003 with a thermal conductivity of 161.2 W/m-C. At the exit the pressure is equal to the ambient pressure.

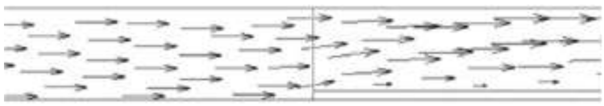

Fig. 4: displays the flow pattern for the plain-fin case.

The area above and below the plain fin is the same. Therefore displaying the results for one of the side of the fin would be suffice. The below figure shows the entry of the air on the left side of the dividing line. The dividing line develops the boundary layer. The vector diagram for the louver-fin case is displayed in Fig. 5

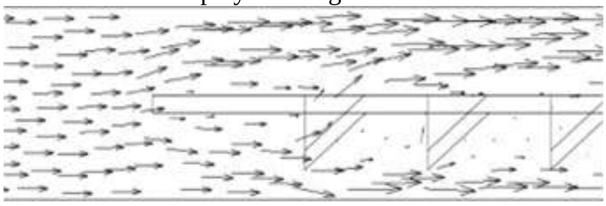

Fig. 5: Vector diagram for the louver-fin case.

But when we talk about the louvered fin, the gap above and below the fin is not symmetrical. Therefore for analysis we will take both the gaps i.e. above and below the louver fin. At the entry of the leading edge of the fin, the flow is simple channel type flow. At the forward end of the fin, the flow splits into two that pass above and below the fin. In the upper side of the flow, the flow is generally straight and laminar. At the forward edge of fin there seems to be an upflow, as the flow turns to escape the forward-edge hindrance. The second zone of upward flow is due to the flow deflected from below the fin by the first louver. The flow below the fin is turbulent. As the flow passes the forward edge of the fin, downward flow starts, which is caused by the downstream blockage which is due to the presence of the first louver. This blockage forces the flow to pass through the narrow cross section between the tip of the louver and the surface of the adjacent fin. The eddy effect is seen between the region between each of the successive louvers, causing reduction in the velocity and weak recirculating flow. The louvers that extend deep in the downward direction provide better heat transfer. Also as seen in figure, the first louver affects the flow differently from all subsequent louvers. The first louver enables the fluid to pass through from the lower side of the fin to the upper side of the fin, whereas the downstream louvers do not do the same thing

IV. Results and Discussions

We will draw our attention towards the pressure drop result and the heat transfer. Let Q be the rate of heat transfer from the heat exchanger. For the sake of accuracy different values of Q were obtained from the First Law of Thermodynamics and from the integration of the local heat fluxes over the participating surfaces of the fin. Qlouver indicates heat transfer rates for the louver- finned radiator and Qplain indicates heat transfer rates for the plain-finned radiator. Here our focus is the ratio of Qlouver/Qplain. This ratio is represented by one of the curves in in Fig. 7.

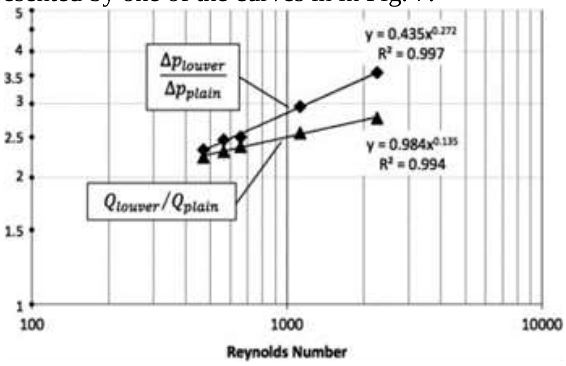

Fig. 7: Results

Δp= pressure drop of the air passing through the radiator fin. The other curve in Fig. 7 represents the ratio of Qlouver and Qplain. Both of the curves are plotted as a function of the Reynolds number, where Reynolds number (Re)= ρVD/ µ where ρ= density and µ= dynamic viscosity of the air and U = average velocity of the air

Fig. 7 proves that the use of louver fin increases the rate of heat transfer in the fins in radiators. The ratio of heat transfer varies approximate 2.2–2.8. Over the range of same Reynolds number, the ratio of the respective pressure drops is 2.33–3.56. Also the percentage increase in pressure drop due to louvering is greater than the percentage increase in the heat transfer. It is interesting that the two percentage increases are virtually the same at the lowest investigated Reynolds number and deviate with increasing values of the Reynolds number. The outcomes identified in the preceding paragraph can be attributed to the different sensitivities of the pressure drop and the heat transfer rate to the velocity. For the plain-finned radiator pressure drop experienced is 1.37 and for the louver-finned radiator the pressure drop experienced is 1.64. The rate of heat exchange in the radiator is directly proportional to the rate of pressure drop at the conducting medium. The velocity drop in louver-finned radiator is 0.70 and that of plain-fin is 0.563. These results indicate that the rate of heat transfer is less sensitive to the velocity than that of the pressure.

V. Concluding Remarks

For the first time there is a detailed comparison of louver-finned radiator with the plain-finned radiator where the fluid passed through the flat tubes. All of the previous comparisons of louver- and plain-finned radiators were restricted to the circular tubes. The study was done by numerical simulation over a Reynolds number. As the pressure drop increased the heat transfer between the two fluids. Also with the increase in the value of Reynolds number, the pressure drop increases thereby increasing the heat transfer. The finding is also based on the fact that the rate of heat transfer through the louver-fins is more sensitive to the pressure drop than the velocity.

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