Design and development of oblique micro-channel heat exchanger

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Abstract: **The advent of super bikes and bikes with engine capacity over 200 cc it was found necessary to use an alternative method as oil cooling to increase the effectiveness of the cooling. The conventional oil coolers utilize a radiator type arrangement which requires considerable space, volume and weight. The flat surface of the radiator results into maximum air resistance, thus there is need of another innovative method to transfer the engine oil heat to atmosphere.**
The cylindrical oblique micro channel heat exchanger comprises of a hollow tube of Aluminum that is fitted onto the surface of the heat exchanger through which the Hot fluid is passed. This hollow tube is in contact with bent Aluminum fins held onto a micro-channel staggered array of holder slots in a FDM (fused deposition method) printed holder. The arrangement of fins is done such that maximum surface area is in contact with fluid in minimum space.

Index Terms: **FDM Method, Oblique Channels, Cost, Space.**

I. INTRODUCTION

Heat Exchanger is a device used to exchange heat between two fluids by conduction or convection. Microchannel heat transfer has gained importance as a method to support very high heat transfer rates. This nascent technology is still being heavily researched and is simultaneously being developed into commercial applications. There is a very active discussion about what mode of heat transfer, single-phase or two-phase flow. A large percentage of the active research in micro-channel heat transfer involves two-phase flows. Two-phase heat transfer does indeed dissipate large heat fluxes on the order of tens of MW/m^2. However, the two-phase flow system comes with a few more complications versus a comparable single-phase flow system. The two-phase pressure drop will be much higher than the single-phase. In addition, the two-phase flow system would also require a condensation step in the closed loop system.

Utilizing single-phase micro-channel heat transfer for high heat flux is a viable option for several reasons. First, the overall system complexity is reduced for a single-phase system. Secondly, the channels can be enhanced to provide improved overall heat transfer coefficients.

Aim of the project

- Increase Heat Flux compare to straight fins.
- Reduce the cost of Manufacturing.
- Achieving maximum surface area in less space.

Need of Project:

The manufacturing of oblique slotted holder through conventional manufacturing process like cost more and the recent cooling system occupy more space. Hence to reduce system cost and space.

II. Problem Statement

The weight ,cost and space is main factors for any design .The system used in super-bikes and any oil cooling system occupies more space and complex design are expensive.
Therefore, if possible, there is a need to make such a heat exchanger with low cost incurred, less weight and simple to operate.

III. Literature review

Empirical studies have been carried out extensively over the years on macroscale pin-fin heat exchangers to determine their heat transfer characteristics in order to enhance their performance.
Van Fossen (1) early work was based on staggered pin-fins array for H/D values of 0.5 and 2.0 with Reynolds number varying from 300 to nearly 60000. He discovered that the heat transfer coefficient for short pins to be lower than longer pins.
Sparrow et al. (2) later examined the heat transfer behaviour for cylinder adjacent to the end wall and discovered that heat transfer was lower at the wall as compared to the regions of the cylinder away from the wall.
Chyu, et al. (3) also determined that the heat transfer coefficient on the pin surface was 10 to 20 percent higher than the uncovered end wall.
Metzger, et al. conducted an empirical study to investigate the stream wise row-averaged heat transfer coefficients for a staggered short pin-fin array. He used a two ten-row arrangements with H/D=1.0, S/D=2.5 and X/D=1.5 and 2.5 for Reynolds number spanning of approximately 103 to 105. They found that the heat transfer coefficient peaked between the third and fifth row of the array.

Donahoo, (4) conducted a numerical study on the optimization using a general-purpose viscous flow solver to simulate the flow through a staggered pin-fin array and the effect of heat transfer. The simulation was based on a 2-D only model to examine the tumultuous flow characteristics around the pins and near wall regions. Their results were consistent with the findings of Metzger et al. findings, and demonstrated that the maximum heat transfer coefficient occurs between row four and five although being 2-D in nature were unable to capture the pin-end wall interaction effects.

IV. COMPONENTS OF MACHINE

Fin holder

The fin holder is made up of ABS material using 3-D printer and UP-Next software by providing CAD file in STL. format. The dimensions for prototype stage of fin holder are dia.(diameter) 30mm, thickness 2.5mm and length 110mm.The fin holder consist of staggered oblique channel at 15^0 to hold the aluminum fins.

Primary base

Primary base is made out of circular billet of aluminum of the size 110 mm diameter and thickness 11.5mm,it is to hold secondary base and inlet aluminum pipe on it.The further operations are done using lathe machine.

Secondary base

Primary base is made out of circular billet of aluminum of the size 70 mm diameter and thickness 12mm and a drill of 42.5mm dia., then 45mm tap. It is use to hold pipe Casing.

Aluminum pipe

It is inlet pipe through which fluid flows to the fin holder. It is 105mm in length with OD (outer diameter) of 25mm with 2mm.

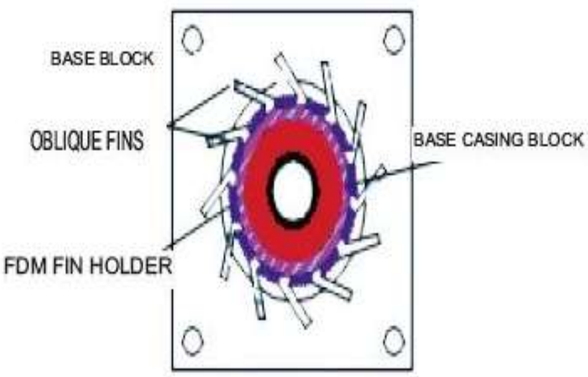
Pipe casing

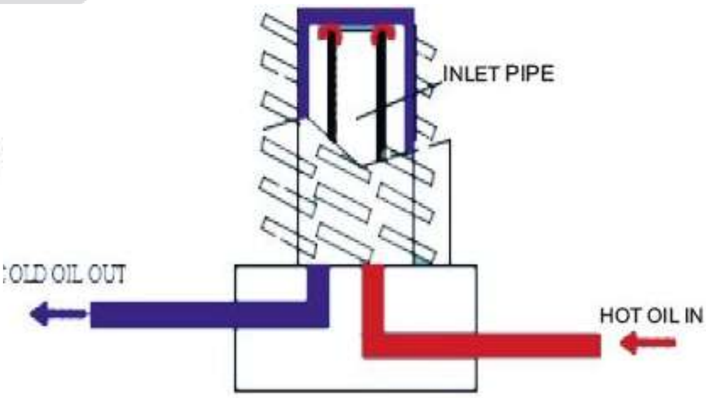
It is a hollow pipe having 6 slots made using milling machine along its periphery to support the fins. Its OD is 34mm and ID 32mm.

ASSEMBLY OF COMPONENTS

V. WORKING OF OBLIQUE CHANNEL HEAT EXCHANGER

- The hot fluid enters into an inlet pipe made of aluminum through the hose from reservoir.
- Then the fluid spills into the staggered array of aluminum fins held holder made of ABSand finally comes out.
- Firstly when aluminum pipe comes in contact with fluid there is convection between fluid and inlet pipe and then conduction through pipe and bent aluminum fins in contact with inlet pipe.
- Then the spilled fluid comes in direct contact with the fins and there is convection.
- The heat through the fins can be dissipated by natural convection of air.
- The governing equation used to calculate the overall heat transfer coefficient is $Q = U*A*(LMTD)_{corrected}$, Since it cross flow mixed type heat exchanger hence corrected LMTD is used.





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