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# Behaviour of Different Fluids For Replacement Of Engine Oil As Coolant In Circlular Mini Channel

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**Abstract-** *This paper represents study of different fluids in place of engine oil as coolant in circular mini channel. In this study solid material is same for all. Mini channel is under different conditions. Variation in values of heat flux on thermal characteristics (average bottom surface temperature and average heat transfer coefficient) of the mini channel is shown. Here the material of solid substrate of is taken as silicon and engine oil as fluid material is taken as reference combination. For the validation of this research predicted results is compared with those obtained by published research paper (By Mansour). For the analysis of thermal characteristics of the mini channel comparison of reference combination with different fluids and silicon as solid material is shown in this paper. Here fluids used for study are aniline and n-butyl alcohol as fluid.*

***Keywords****: ANSYS Fluent, Pro-E, Mini channel, Simulation, Modelling.*

## I. INTRODUCTION

Fluid flow inside channels is the heart of many natural and man-made systems. Heat and mass transfer is accomplished across the channel walls in biological systems, such as the brain, lungs, kidneys, intestines, blood vessels, etc., as well as in many man-made systems, such as heat exchangers, nuclear reactors, desalination units, air separation units, etc. In general, in mini channel transportation of heat occurs through the combination of fluid and solid region and fluid is passing through the fluid region means through holes of the block [4]. As some surface of the plate is heated so much so that the need of cooling this plate or slab is necessary so for that this mini channels are used. Block or slab is placed on that heated surface and cold fluid is passing through this holes as the fluid is passing through this holes hot surfaces exchanges heat from hot surface to the cold fluid so the fluid get heated and then this fluid is removed and new fluid is inserted again and again so that heat transfer takes place continuously.
Special characteristics of the mini channel are as discussed below [1]:

- High surface area per unit volume and high heat transfer coefficient.
- Since area of fluid domain is bigger than the area of fluid domain ratio of area cross- section of the solid substrate to that of the fluid domain is quite small. And the conduction resistance of the substrate is comparable to the convective resistance due to high heat transfer coefficient.
- Selecting only one domain among of all parallel domains which is forming a mini channel heat sink, the heat is supplied to bottom side of the heat sink and top side is assumed to be negligible heat loss while remaining two sides are assumed to be symmetric surfaces The result of this arrangement shows the mini channel to have variable heat flux around the channel perimeter.

All the above concerns imposes that domain is at uniform heat flux but the problem is converted in uniform wall surface heat transfer problem. A mini channel of circular cross section with diameter of 1.91mm is taken into account [1]. Engine oil as fluid and silicon as solid material is selected as base while the analysis involves the effect of fluid changes.

## II. MATHEMATICAL MODELLING

Geometry of the mini channel which is taken for simulation is as shown in Figure1. For the simulation of the heat transfer problem of mini channel certain assumptions are taken into account which are discussed as below [1]:

- No heat generation.
- No heat dissipation.
- Constant physical property of fluid and fluid is Newtonian and incompressible.
- Flow is assumed to be laminar.
- Property of solid such as thermal conductivity is constant for whole domain.
- No external force is taken into account.
- Radiation is assumed to be negligible.
- Hydrodynamic and thermal developing flow.

 

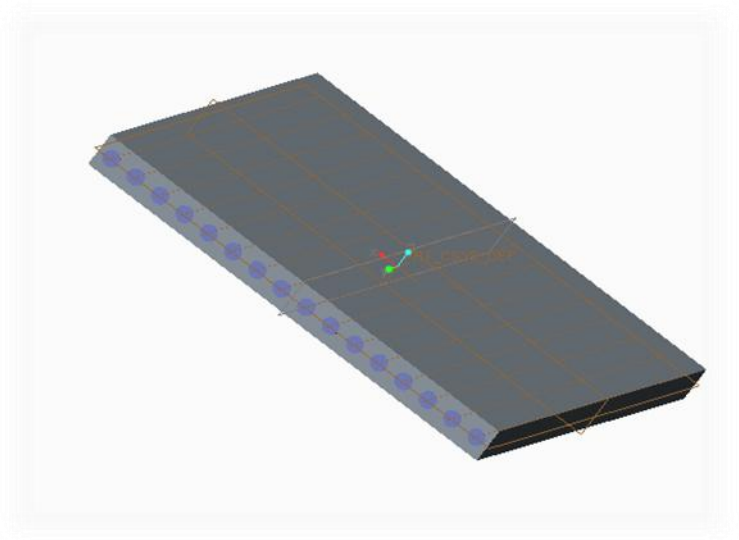

***Figure.1: Geometry of the mini channel***

The heat transfer problem consisting of solid domain and fluid domain is governed by 3D form energy equations and governing equations listed as below. Among all domains, one domain is selected for the calculation of the heat transfer in mini channel. Boundary condition for computational domain is as shown in figure 3.

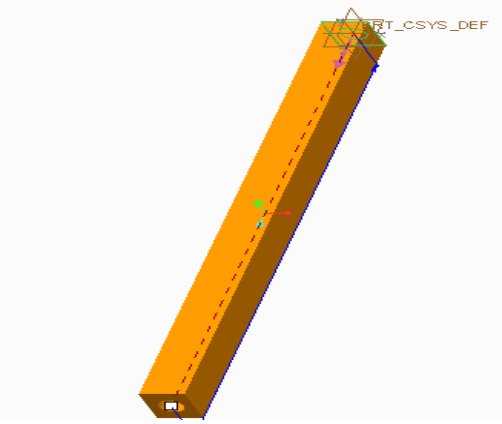


***Figure 2. Computational domain***

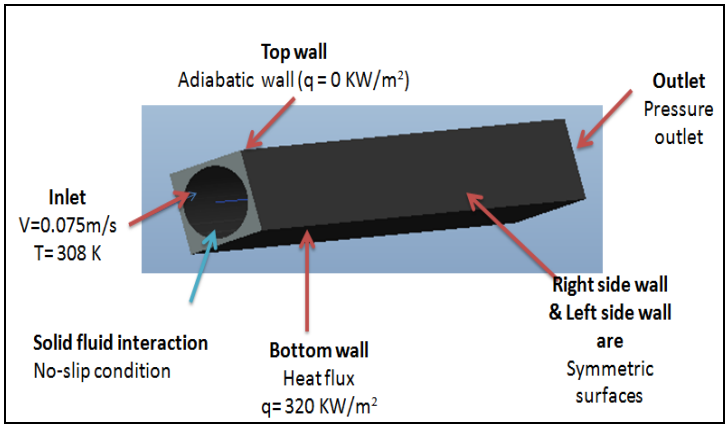


***Figure 3: Boundary conditions***

## III. MODEL VALIDATION

Using ANSYS software, simulation is carried out firstly with the combination used by researcher Mansour [1]. Before simulation grid independent test was performed. From this test numbers of nodes are selected as 126625 and number of elements are selected as 114780. Mansour [1] used three solid materials (copper, stainless steel and silicon) and three liquid materials (water, mercury and engine oil) as coolant. Here for validation simulation is carried out for all solid-fluid combination and results came from the simulation is nearly same as that of researcher. Results are super imposed to each other. So model is ready for further simulation. Here water as coolant fluid and solid material combination's results is shown in below graph. Red line graph is results obtained by researcher Mansour [1]. Similarly simulation is carried out with other fluid materials engine oil and mercury with solid material steel, copper and silicon, and results obtained from simulation are super imposed with the results of researcher [1].

 

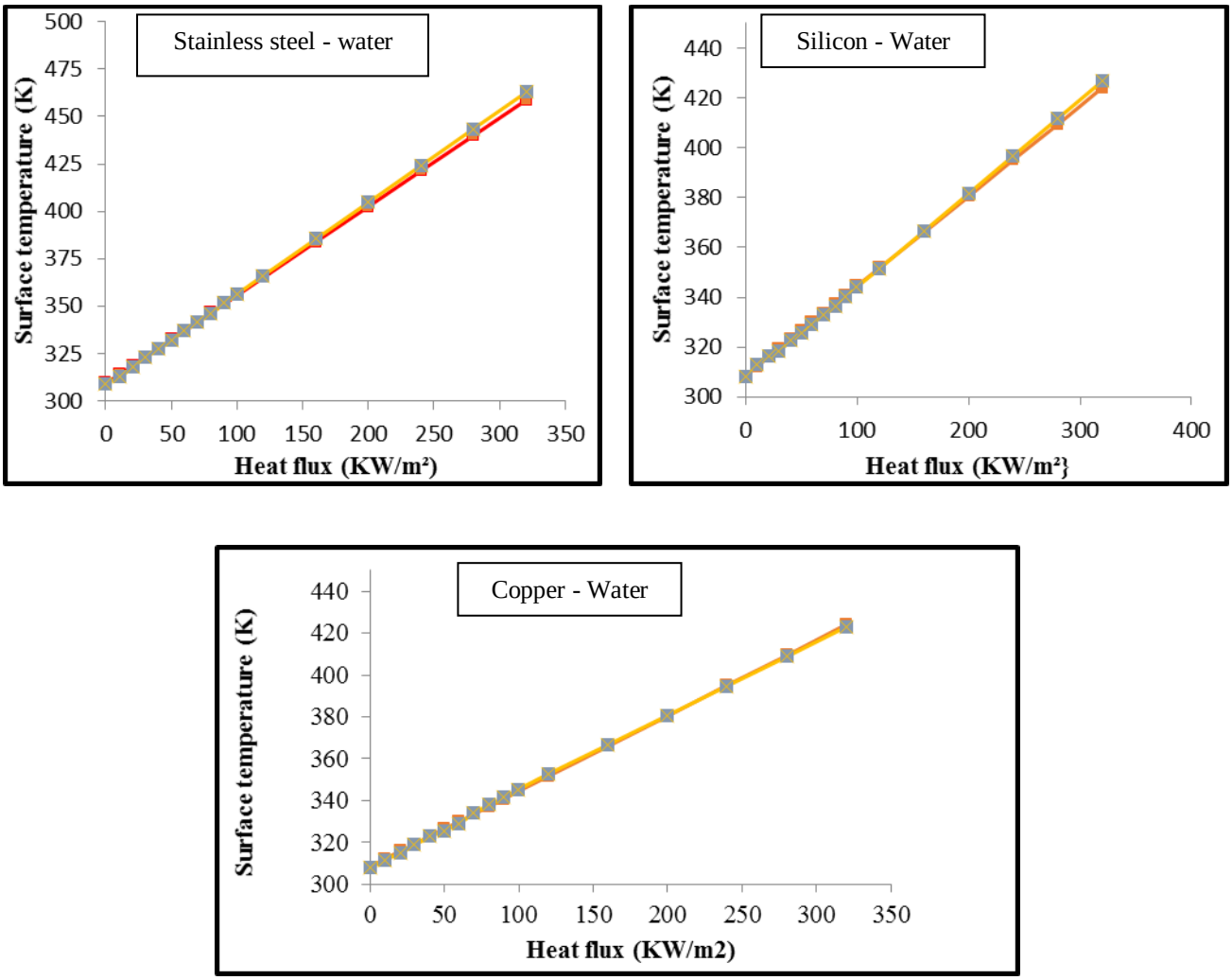


***Figure 4: Average surface temperature for water as coolant liquid***

According to researcher Mansour [1], when engine oil is used as coolant fluid and solid materials are taken as steel, silicon and copper, among these all combinations silicon and engine oil gives better results as compared to other combination. So here engine oil as fluid and silicon as solid material is taken as reference combination and simulation is carried out. Below discussion deals with behaviour of thermal characteristics of the mini channel for the combination of engine oil, n-butyl alcohol and aniline with silicon as solid material at heat flux value of 320 KW/m². Average value of heat transfer coefficient for combination of silicon and engine oil is 450.55 W/m². °C and average bottom surface temperature is 702.5 K. When n-butyl alcohol is referred as coolant fluid, value of heat transfer coefficient is 533.65 W/m². °C and surface temperature is 638.55 K. So if n-butyl alcohol is used as coolant fluid as compared to engine oil it gives better results. When aniline is used as coolant fluid the value of surface temperature for same solid material (silicon) and value of heat transfer coefficient is 627.88K and 551.12 W/m² °C respectively. As seen from Figure 5 and Figure 6 thermal characteristics of the mini channel is higher as compared to engine oil used as coolant fluid. So for better performance coolant fluid can be change from engine oil to n-butyl alcohol or aniline. Among this three fluids aniline gives best results (lowest surface temperature and highest heat transfer coefficient).

 

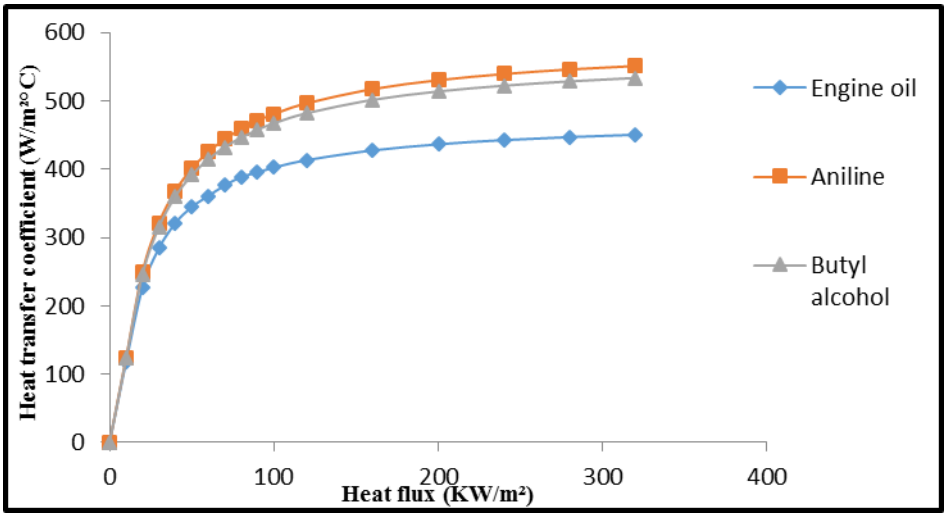


*Figure 5: Average heat transfer coefficient for silicon as substrate material*

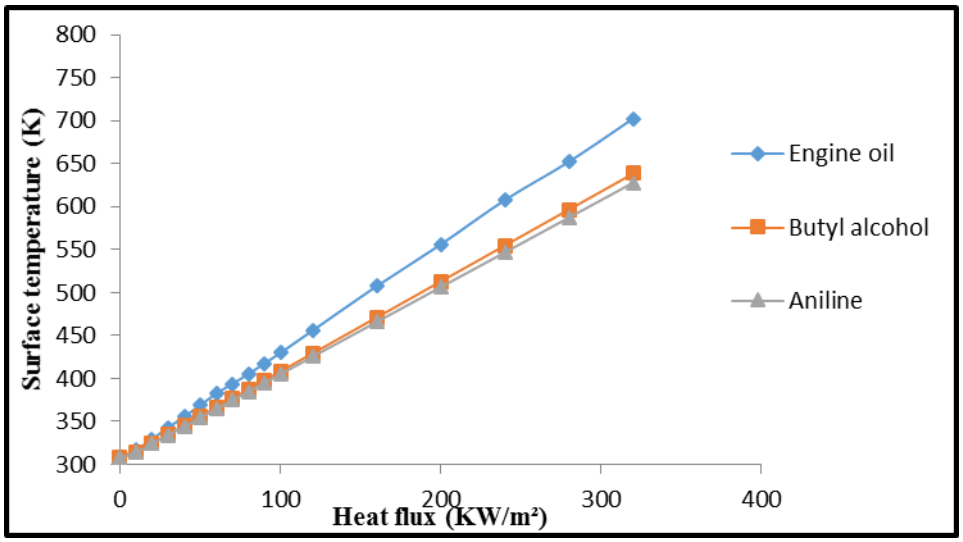


*Figure 6 - Average surface temperature for silicon as substrate material*

## IV. CONCLUSION

In this study three dimensional heat transfer of laminar flow of liquids flowing inside circular shape mini channel is addressed. The effect of heat flux variation on heat transfer characteristics for the mini channel is investigated. Silicon as solid material is implemented to highlight the effect of variation of heat flux on the performance of mini channel. Two fluids (n-butyl alcohol & aniline) are used for the comparison of results of reference combination engine oil and silicon, the conclusions obtained from the study is summarized below:

Aniline and butyl alcohol gives best results as compared to engine oil when solid material is taken as silicon. So both the combination can be used instead of engine oil and silicon combination which gives better results according to Mansour [1]. Among these two combinations aniline as fluid material and silicon as solid material gives better results as compared to other two combinations.

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