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Numerical Modelling for Recuperative Flat Plate Heat Exchanger

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ABSTRACT: The plate heat exchanger is also known as a plate and frame heat exchanger or flat plate heat exchanger. In plate heat exchangers, heat is transferred from one fluid to another through a flat metal heat exchanger plate, instead of through a heat exchanger tube wall as with double pipe or shell and tube heat exchangers. Inlet and outlet holes at the corners of the plates allow hot and cold fluids through alternating channels in the exchanger so that a plate is always in contact on one side with the hot fluid and the other with the cold.

Here we have considered a flat rectangular plate of length 1 m and width of 0.5 m. The left edge was considered the inlet of the flow velocity of 1 m/s and 328 K and right edge as the pressure outlet and 303 K. The top and bottom edge was considered for the two cases i.e., for no slip condition and for shear force condition along the two wall edges.

The pressure (static pressure), velocity (velocity magnitude) and temperature (static and wall temperature) were displayed and for the same the plots to be plotted by considering all the edges.

KEYWORDS: Flat plate, Heat Exchanger, Static pressure, Velocity Magnitude, Static and Wall Temperature.

I. INTRODUCTION

The Plate Heat Exchanger consists of a Specific number of plates arranged between the pressure and the fixed frame. The plates are having corrugations with different designs which helps to increase the total surface area for the Heat Exchanger.

The Plates Heat Exchangers are movable within the frame. The plates are opposite in direction and it forms like a honey comb pattern when viewed sideways. The plate corrugations promote fluid turbulence and increase the heat transfer. The fixed and the pressure plate are supported by the supporting column. The plates are fitted with each other with gaskets which seal the material from coming out sideways as well as through the holes on the plates.

This research paper focuses to examine the flow pattern and heat transfer effect of the cold and hot fluids under the water-to-water heat transfer by using the simulation software. This is done by using 2D numerical model of the local computation domains for the plate-type heat exchanger are simulated at different parameters.

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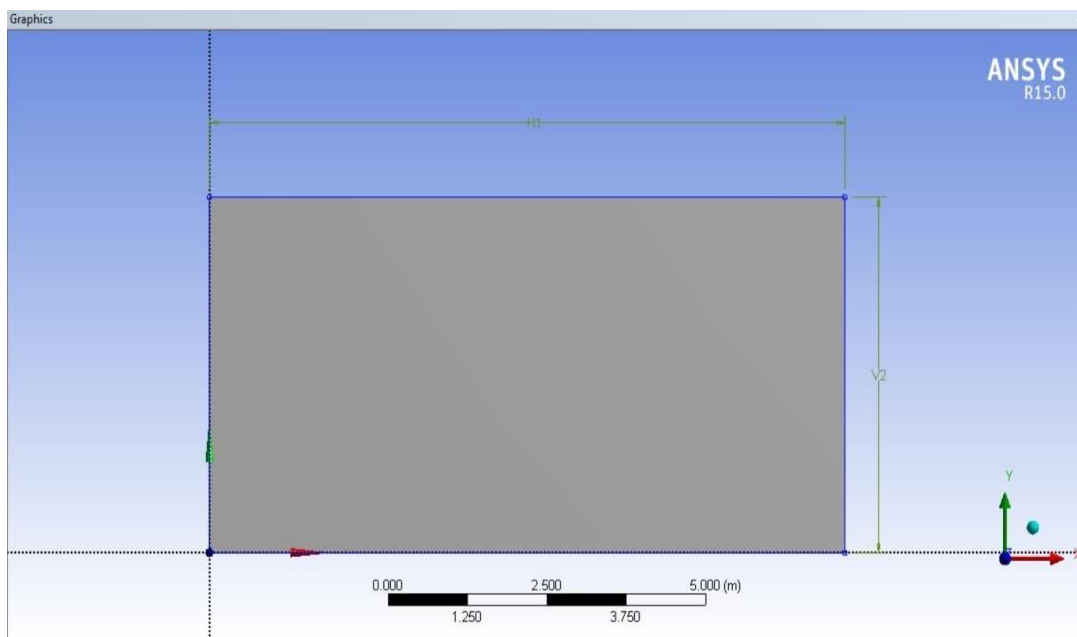
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II. RELATED WORK

The following things can be summarized for Fig. (a), (b) and (c) as it is related to the other related works as follows:

- Thermal properties density induced by convection of the fluid and tube wall temperature of the shell should be constant in the whole analysis.
- Leaks and heat loss are to be neglected i.e., well insulated and designed HE. The fluid flow and heat transfer processes should be turbulent and in steady state.
- Fluid is taken as incompressible Newtonian fluid flow with constant ρ and k , this paper discusses with the study to provide more complete understanding flow maldistribution in plate heat exchanger by studying area weighted and mass weighted temperature profiles for maldistribution without back flow and maldistribution by taking it as shear condition in laminar condition.
- The cooling efficiency for the dimpled plate heat exchanger increases with the increment of the height whereas for the flat plate heat exchanger, the cooling efficiency increases at first and then decreases.

III. EXPERIMENTAL RESULTS



Geometry:

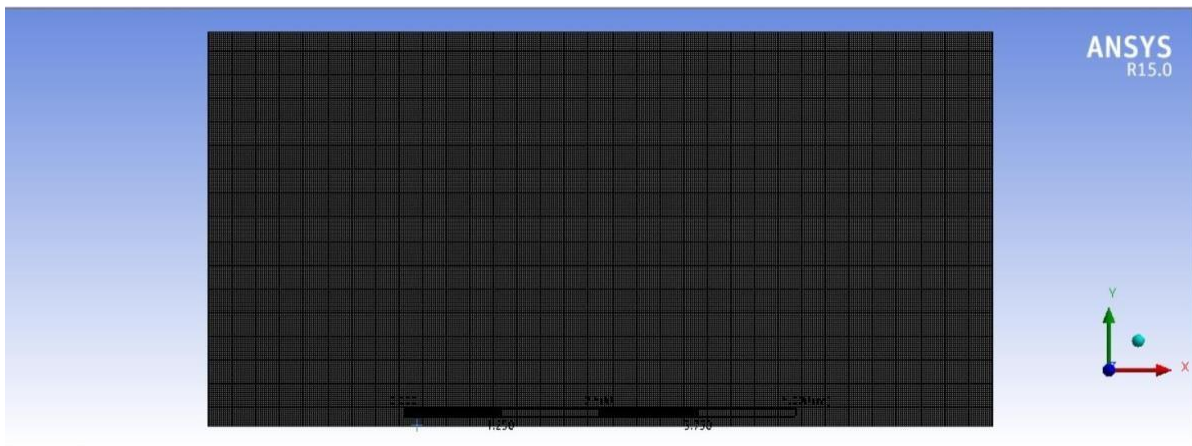
(a)

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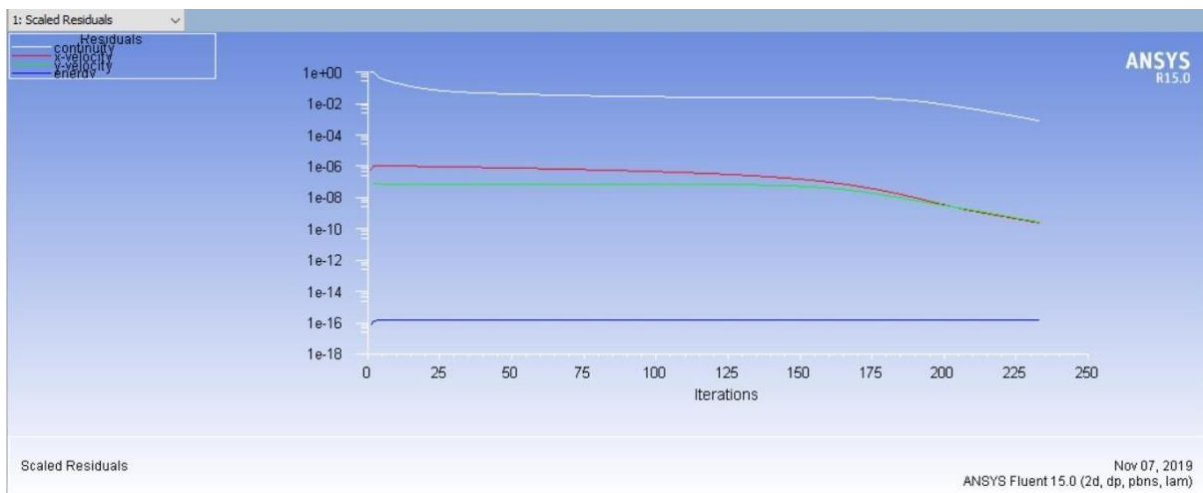
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Meshing:

(b)



Set-Up:

(c)

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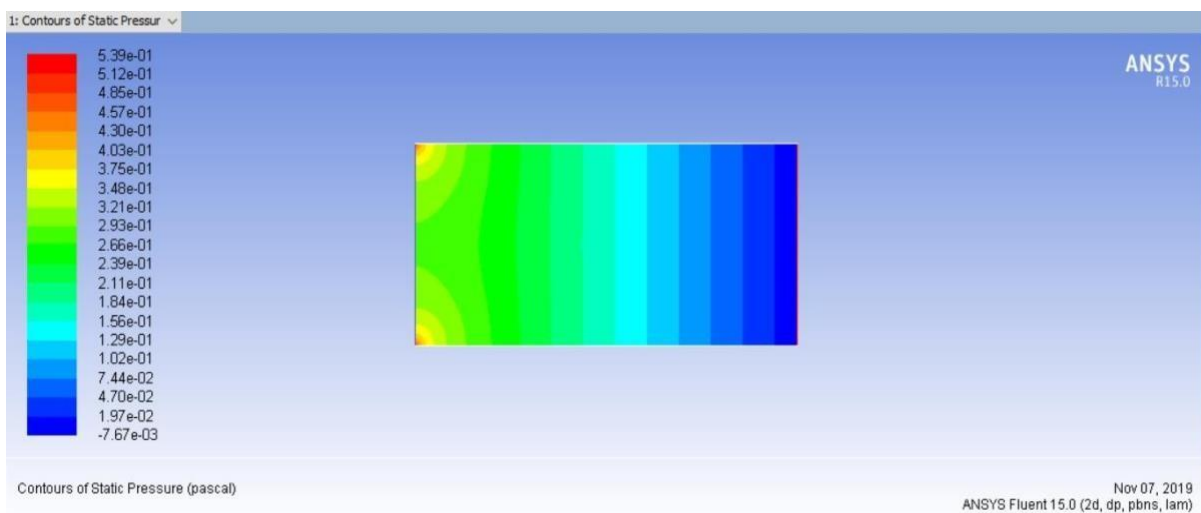
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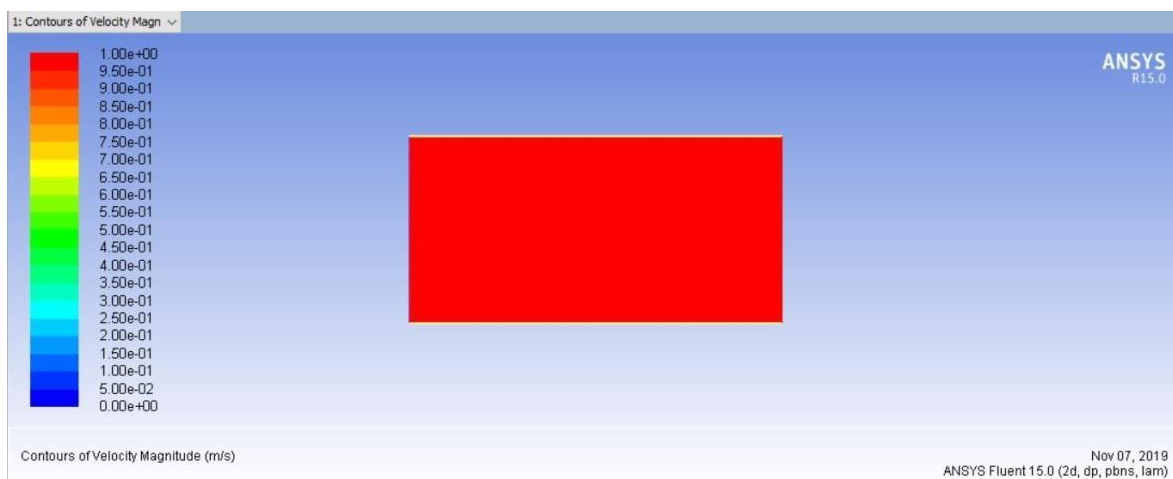
Contours:

For No Slip Condition:

Pressure (Static Pressure):



(d)



Velocity (Velocity Magnitude):

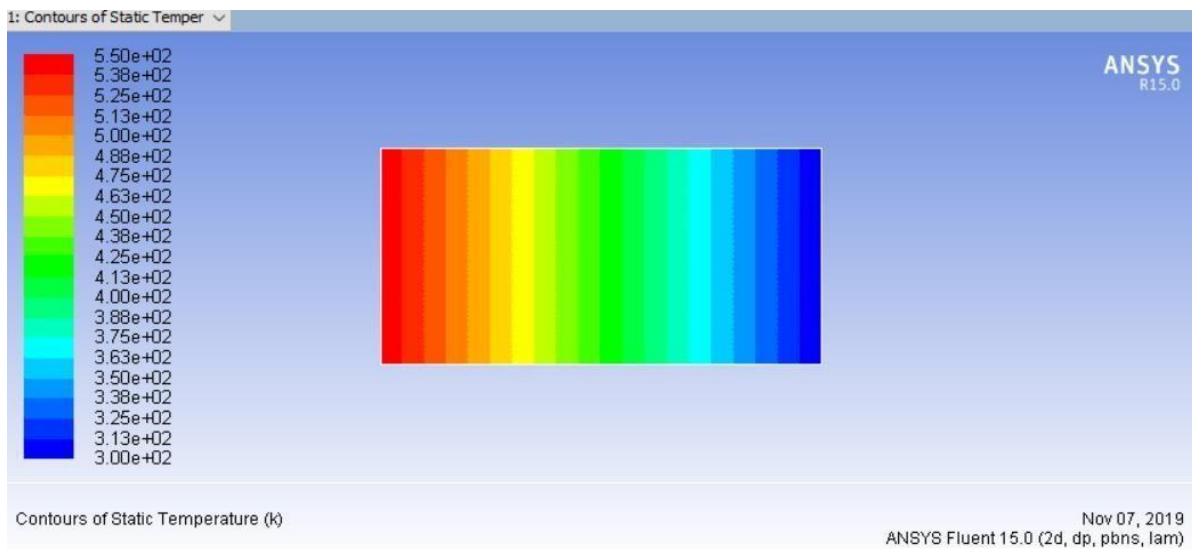
(e)

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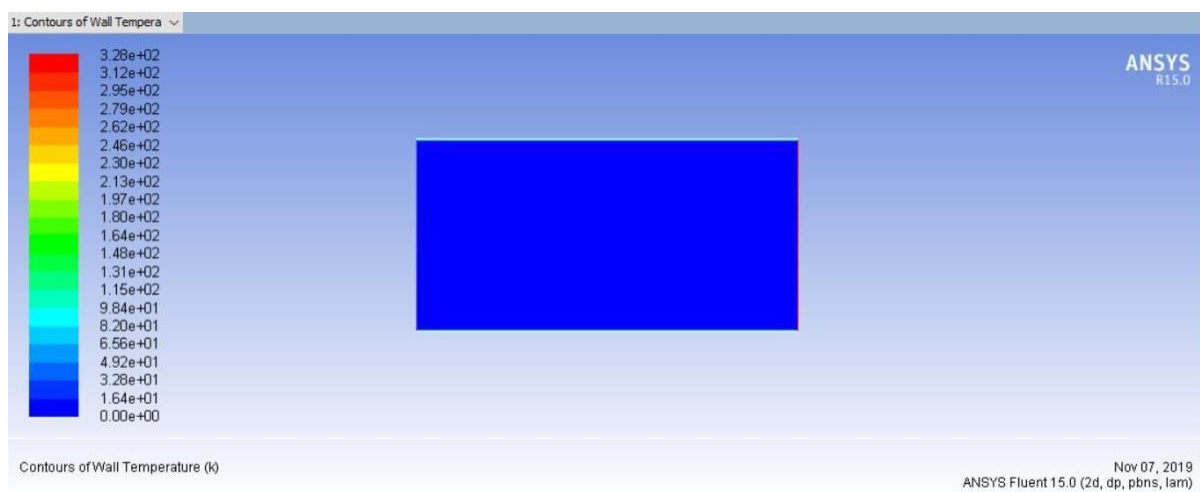
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Temperature (Static Temperature): (f)



Temperature (Wall Temperature): (g)

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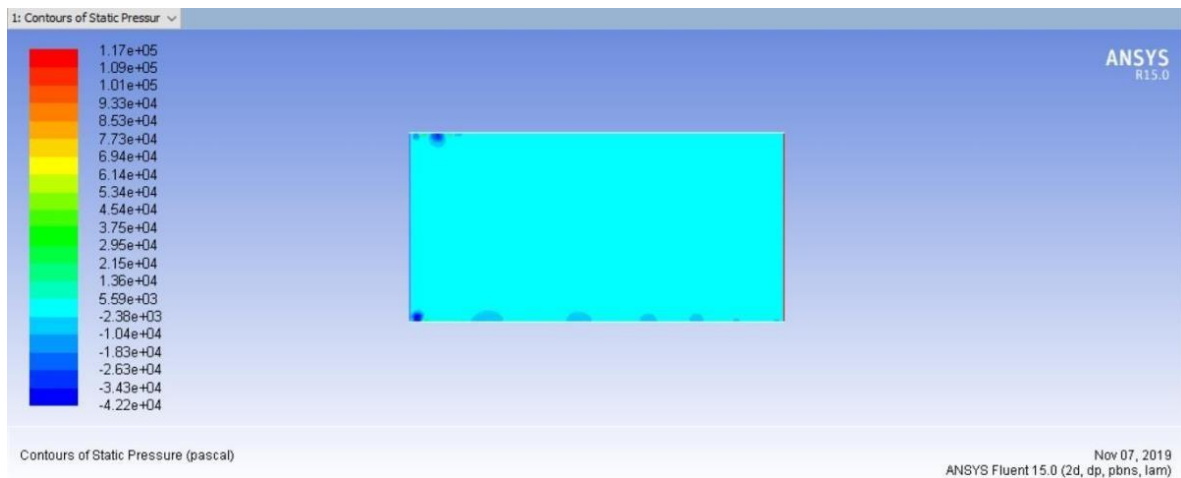
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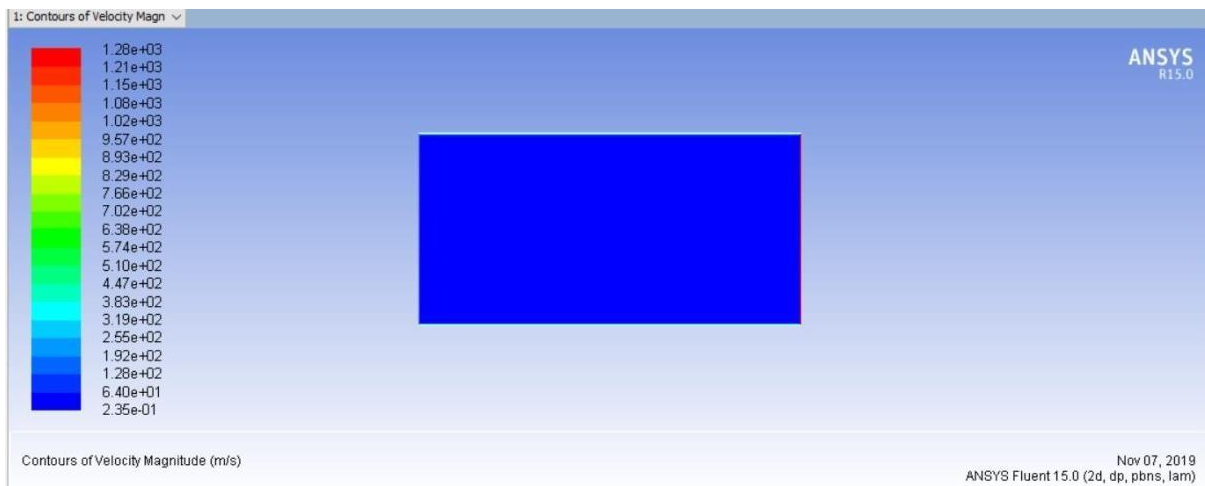
For Shear Force Condition:

Pressure (Static Pressure):



(h)

Velocity (Velocity Magnitude):



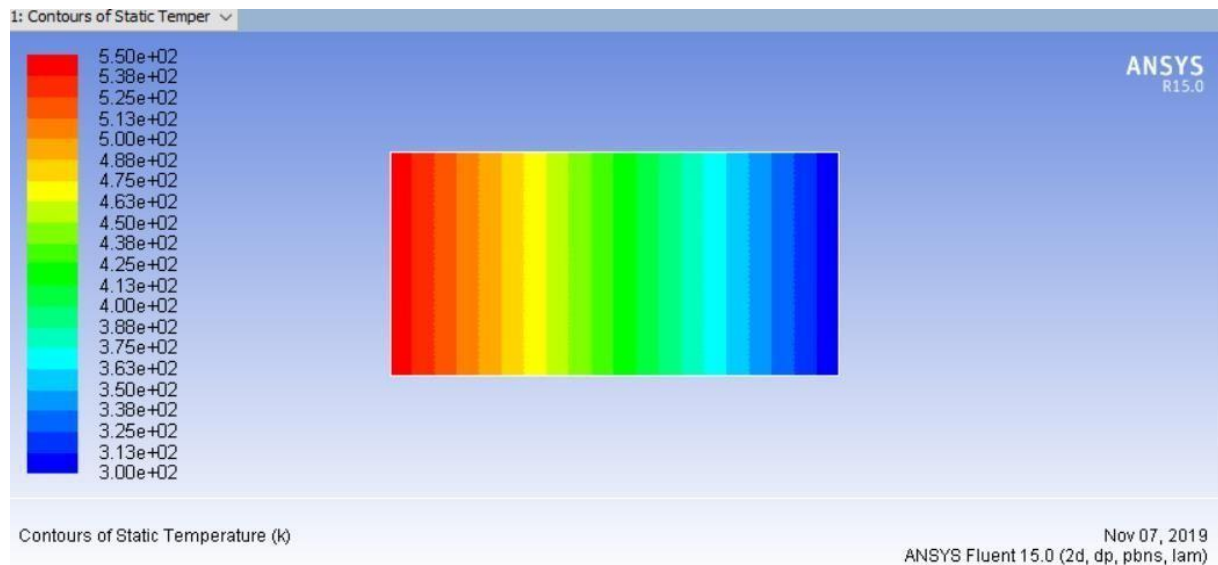
(i)

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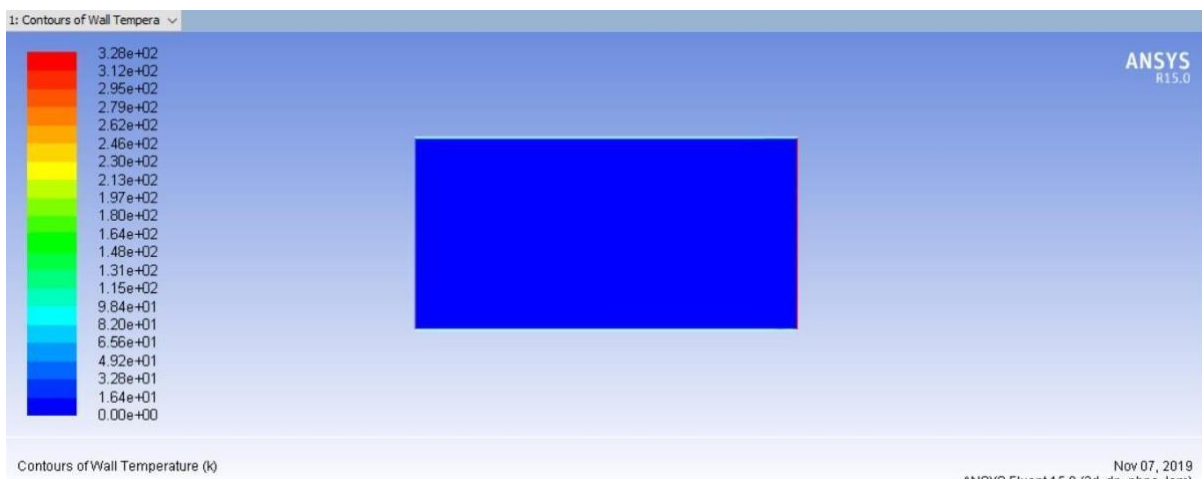
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Temperature (Static Temperature):

(j)



Temperature (Wall Temperature):

(k)

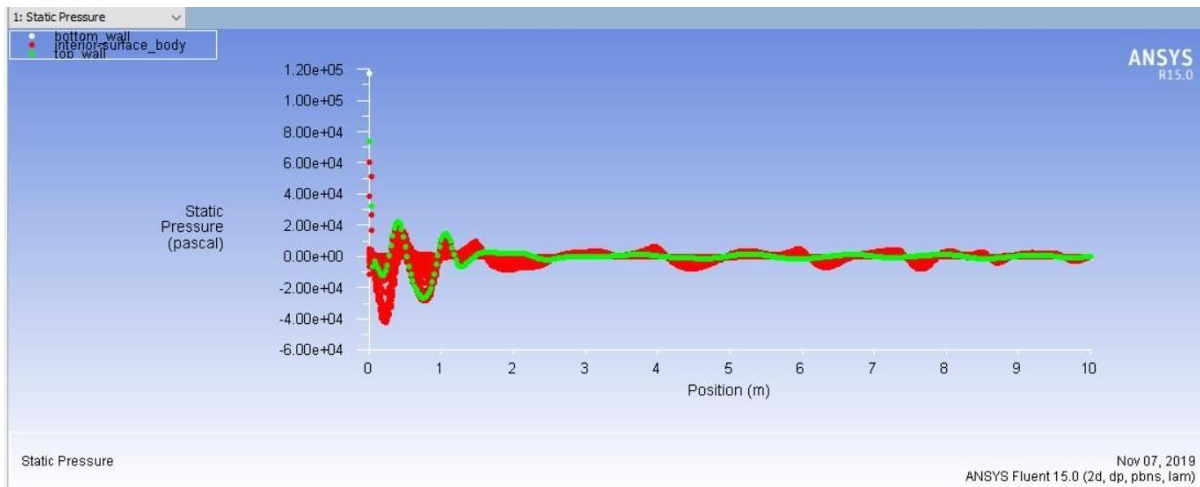
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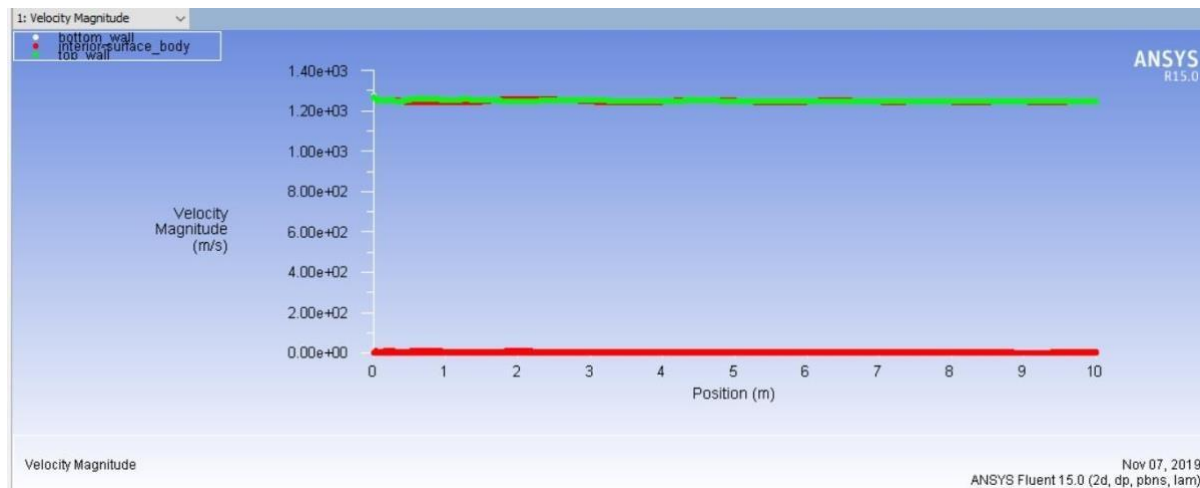
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Plots and Graphs (Shear Condition):



Pressure (Static Pressure):

(l)



Velocity (Velocity Magnitude):

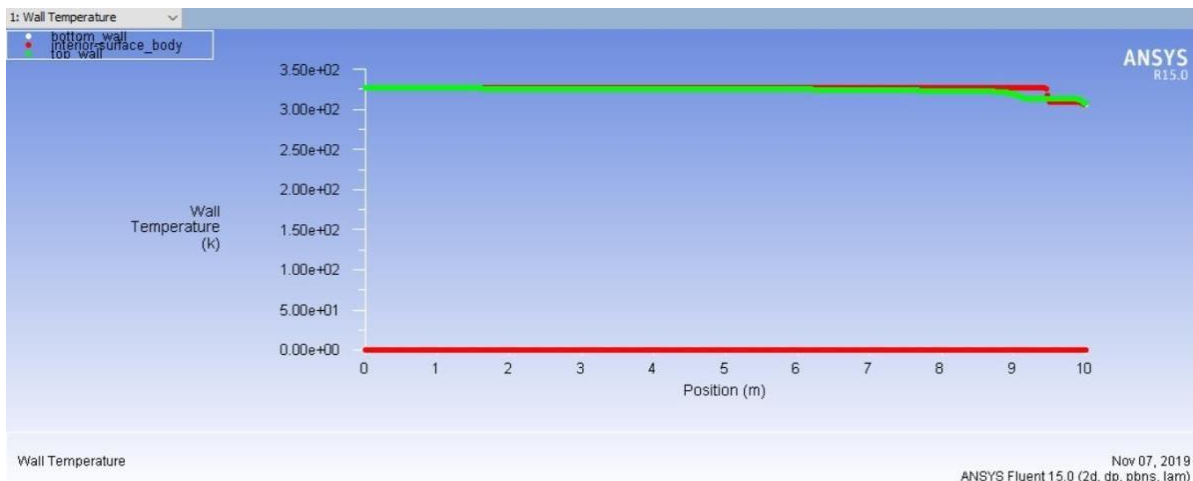
(m)

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Temperature (Wall Temperature):

(n)

IV. RESULTS FROM THE GRAPH

- ❖ From static pressure contour and plot (l) with the respect to the position of the plate for the no slip condition, it can be inferred that maximum pressure can be seen at the entrance as the edges were subjected to maximum pressure 0.5 Pa which may create damage but observed to be decreasing (d) as moved towards the outlet as for the shear condition slight pressure drop was observed at the top and bottom edge of the plate (h).
- ❖ From velocity magnitude contours and plots for both the cases it was observed that the flow rate was almost constant for no slip condition of about 1 m/s (e) but for the shear condition was significantly decreased of about 0.235 m/s, it is because of the shear force imposed by the walls ultimately affecting the overall flow on the plate (i).
- ❖ From the wall temperature contours and plots (n) for both the cases the same pattern was observed as above as there was no change in temperature with the position (g),(k). But for the static temperature constant decrement in the temperature was observed from inlet to outlet (f),(j).

V. CONCLUSIONS

- ❖ Plate crevices should be converted into the curved edges it may cause eddies at the inlet which may result to the entry loss and plate damage. Geometry should be of smooth and curved surfaces.
- ❖ Uniformity was observed in all the contours except a slight deviation was seen in the pressure contours.
- ❖ Velocity was decreased significantly due to the applied shear stress which indicates that fouling effect may be increased if wall are not smooth.
- ❖ All the properties may tend to increases when subjected to large number of corrugated plates as the depths and angles leads to the flow decrement and pressure loss resulting in the increased fouling effect unless if the water used is completely free of ions which is practically near to the impossible for the commercial sector.



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