

CFD Analysis of Various Design Aspects in Baffle Tube Heat Exchanger

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Abstract: To improve temperature difference, a computer simulation assessment for a rectangular duct with right angle confounds heat exchanger with small displacements and baffle height was carried out. A total of 10 There were three separate two half Autocad models of rectangular shaped channel with bewilders spacing of 40 milimetre, 80 milimetre, and 120 milimetre and baffle heights of 10 mm, 12.5 milimetre, and 15 milimetre developed. The major goal of this study is to run computer simulations to see how Cu water nanoparticle affect the architecture and thermally hydrodynamic characteristics of a rectangular duct with baffles exchanger. The bottom walls of the canal, as well as the baffles, are regarded isothermal zones, whereas the sidewalls are termed regular zones. This approach employs a second derivative upwind mass and energy equation. The baffle pitch and height have a significant influence on the temperature distribution from the rectangle shaped channel heating element, with a maximal temperature fluctuations of 9.831oC and a maximum heat transfer of 6.571 KW for baffle spacing 40 mm and height 15 mm for rectangle channel without opposite baffles. In comparison to the base design of rectangle shaped channels exchanger, the temperature difference increases nearly 1.5 times as even the width is decreased.

Keywords: Baffled channel, Cu-water, nanofluids, thermo hydraulic performance, CFD

I. INTRODUCTION

In the manufacturing systems, heating systems are amongst the most commonly utilised items of equipment. Heat exchanger is a device that transfer heat from one product stream to another. Any process that involves cooling, warming, condensing, melting, or evaporating, for example,

will necessitate the use of an exchanger. Well before procedure, process fluids are frequently heated or cooled, or they go through a phase transition [6,7].

Various thermal exchangers have different names depending on what they are used for.

Condenser microphones, for instance, are exchangers that are used to condense water, whereas boilers are exchangers that are used to boil water. The presence of heat transmission using the smallest area of heat transfer and pressure drop are used to determine the performance and reliability of exchangers [8,10]

There are various reasons for utilising baffle in exchangers, as seen in figure 1, and we'll go through a few of them here,

- To sustain tubes in plate heat exchanger - Tubes must always be maintained at distances of not more than 1.5 m (5 ft), depending on tube diameter and building supplies. Where circulation vibration occur in particular procedures, the support intervals can be reduced. Retaining the tubes with baffle also avoids noise and vibration that can cause tubes to collide, causing leaks and failure, particularly at the pipe [9,14].

- To improve heat transfer by guiding the flow through into the shell in a specific pattern - increasing agitation and reducing stagnant spots in the heat transfer [13].

- We can also use baffles to preserve a significant beneficial.

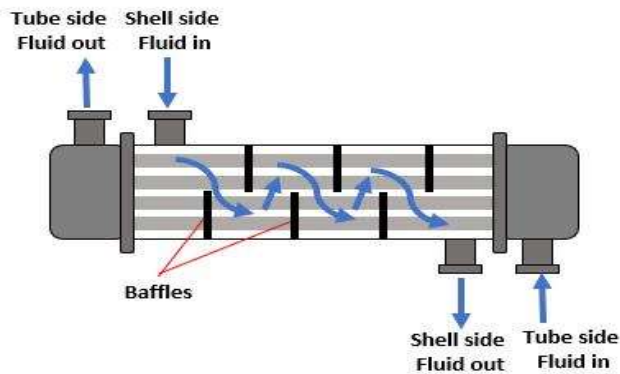


Figure 1: Baffles in Heat Exchanger

There are several different types of heat; the most common are listed here.

1. Segmental baffles
2. Disk and Doughnut baffles
3. Orifice baffles

The most beneficial barrier configuration, on the other hand, is determined by the exchanger's intended application, the parameters of the operations it will be utilised for, and the anticipated effects [12]. Not every process necessitates the same structure, and in many circumstances, a customized shell and tubes heat exchangers is the best fit for the job [15].

II. LITERATURE REVIEW

(1) **Cao et al., (2021) [1]** In this paper, helical barrier heat transfer are numerically simulated and experimentally measured, and a number of co configuration steps based on the evolutionary algorithm is created at the same time, taking into consideration thermodynamics and economic interests. The effects of key helical baffle layout factors, such as helical gear and axial overlapping ratio, on heat and flow distribution and characteristics have been identified. Variations of the optimization methods of updated viscous dissipation quantity and overall cost are examined using five design factors. The Pareto efficient solutions can be obtained, and the outcomes of the solitary optimisation problem are contrasted.

(2) **Cai et al., (2021) [2]** This research provides a new mathematical model for segments and sub heat exchangers (MSTEs) used for supercritical CO₂ cooling that uses less computation while maintaining excellent precision. The characteristics of heat transport in the shell and tube passes, as well as the interaction between them, are investigated. In

the shells passage, barriers lead to several zones with varying follow characteristics and heat transfer properties. Furthermore, due to the CO₂ located close critical properties, higher heat transmission performance in the shells passage leads to increased temperature distribution in the tubes passage. The optimal solution method was based on the van een function of $P_i = F(A_i)$, which characterises the impact of bewilders on the performance of MSTEs, highlights the difference between heat flux barter and stress loss in numerous segments and guidance to start reducing pressure drops while maintaining the heat transport load as well as area. The numerical findings and the optimization approach are used to find the optimal baffles layout. The optimisation method is very effective for heat transfer with varying local heat - transfer characteristics and pressure drops performance, as shown by a comparing of the simulated data of the conventional and improved MSTEs.

(3) **Thondiyil & Kodakkattu, (2021) [3]** In this paper, computational fluid dynamics (CFD) was used to study a shell and tube heat exchangers with asymmetrical baffles, and the Taguchi method was used to optimise it. The effectiveness parameters determined using CFD analysis are heat exchange rate and pressure losses. Using five heat exchanger design specifications, an experimentations were built as orthogonal arrays according to Taguchi experimental setup. The design requirements optimised are the shell interior diameter, tube outer diameter, baffles cut, baffles spacing, and baffle angular position. For each permutation in the test table, CFD simulations were run, and the appropriate rate of heat transfer, pressure losses, and S/N ratio data were determined. The mean S/N ratio for each variable is examined during optimization. Finally, two sets of optimal parameter combinations for maximal heat transmission and minimal pressure loss were discovered.

(4) **Menni et al., (2021) [4]** The air flow in a HE with three S-obstacles is investigated using the CFD technique in this study. Three longitudinal, solid-type, S-upstream form baffles with varied stations were installed in the channels and fixed to their top and bottom walls in a zigzag manner in the targeted HE, with the goal of forcing recirculation cells to increase mixing and thus convective heat transfer. In addition, the experimental results k-epsilon is created with the goal of mimicking turbulent effects. Verification and comparisons with various literatures are also carried out.

(5) **Pushpa et al., (2021) [5]** Simulation studies of buoyant transferring heat inside a finite porosity cylinder circumferential area with a circular barrier attached to the inner cylinder are shown in this study. Because of the direct significance of this topic to the construction of heating systems, the major goal of this inquiry is to offer a detailed

influence of baffle on forced convection heat transport rates. For the mathematical model, the Brinkman-extended Reynolds model is used, and the ADI and SLOR algorithms are used to simulate the governing PDEs. According to the results of the current calculations, the size and position of the baffle has a significant impact on the buoyant heat transfer and flow transport properties. It has been discovered that putting the baffle at the top border increases thermally absorption rates, whilst extending the barrier length reduces thermal transfer. For just about any baffle height and position, a rise in Richardson and Laughlin number improves the amplitude of flow recirculation.

The current project's goals are as follows:

- The major goal of this research is to run computer simulation calculations to see how the architecture and temperature hydraulic efficiency of a rectangular duct with baffles exchanger are affected.
- To analyse different models based on effective heat transfer and measure the findings using computer simulation assessment.
- To establish a new prototype of rectangular duct with baffle heating element with distinct baffle wickets and altitude for heat dissipation.

III. METHODOLOGY

Steps Methodology

1. From the foundation paper, calculate the construction parameters of a triangular duct with a baffle heating element.
2. Creating various CAD models of rectangle shaped channel heat exchangers with baffles.
3. In ANSYS fluent, assign the hydraulic fluid for rectangular duct with baffle heating systems.
4. Use the equilibrium equations.
5. A CFD analysis of the baseline model and model parameters of rectangular duct with baffle heating systems will be performed.

Volume Flow Rate Calculations: Calculation of Mass flow rate: mass flow rate is the mass of a substance which passes per unit of time shown by equation 1.

$$m = \rho AV \tag{eq:1}$$

Where:

ρ : Compactness (density) of a moving liquids in km per cubic metre

V: Velocity of fluid in m/s

A: Flowing region, in m²

m: Mass flowing rate, in kg/sec

Calculation of Reynolds No.: The Reynolds number is the ratio of inertial forces to viscous forces within a fluid which is subjected to relative internal movement due to different fluid velocities as shown by equation 2.

$$R_e = \frac{1}{\mu} (\rho V D) \tag{eq:2}$$

Where:

R_e = Reynolds Number

μ = kinematic viscosity

Calculation of Nusselt No.: It is the ratio of convection heat transfer to fluid conduction heat transfer under the same conditions as shown by equation 3.

$$Nu = \frac{1}{k} (h D_h) = 0.023 Re^{0.8} Pr^{0.4} \tag{eq:3}$$

Where

Nu = Nusselt Number

h = Coefficient of heat exchange

D_h = Diameter of the hydraulic system

K = The network's heat transfer coefficient

Pr = Prandtl number

Thermal Conductivity Calculation: It is the proportionality constant between the heat flux and the thermodynamic driving force for the flow of heat as shown by equation 4.

$$h = \frac{k.Nu}{D_h} W/m^2.k \tag{eq:4}$$

Calculation of Heat transfer rate: It is the amount of heat that is transferred per unit of time in some material as shown by equation 5

$$Q = m c_p (T_{max} - T_{min}) \tag{eq:5}$$

Where:

Q = Heat transferring rate [W]

M = Mass flowing rate [kg/sec]

C_p = Specific Heat of fluid [J/kg-K]

T_{max} = Max temperature of fluid [K]

T_{min} = Minimum temperature of fluid [K]

With the help of the design module of the ANSYS workbench, a three-dimensional CAD model of a circular cylinder with baffles separation 80 mm and height 12.5 mm was built in the current work. The rectangle channel's length (L) is 500 mm, its height (h1) is 20 mm, and it has barriers spaced by an $e = 80$ mm spacing. The first barrier is positioned 15 mm away from the input portion.

Table 1: Geometrical parameters of rectangle shaped channel with baffles [36]:

S no.	Geometrical parameters	Value with units
1	Length of rectangle shaped channel (L)	500 mm
2	Height of rectangle shaped channel (h ₁)	20 mm
3	The height of baffle (h ₂)	12.5 mm
4	Channel comprised of two baffles detached by a distance (e)	80 mm

5	Initial baffle is located at a distance	15 mm from the inlet section
6	Working fluid	Cu-water nanofluid
7	Temperature of fluid at the intake segment is engaged	300 K
8	Velocity	4.2 mm/sec
9	Constant Heat flux at upper wall of channel	1000 W/m ²
10	Outlet pressure	Atmospheric pressure
11	bottom wall of channel and also the baffles	Adiabatic
12	The right side and left side facades	periodic

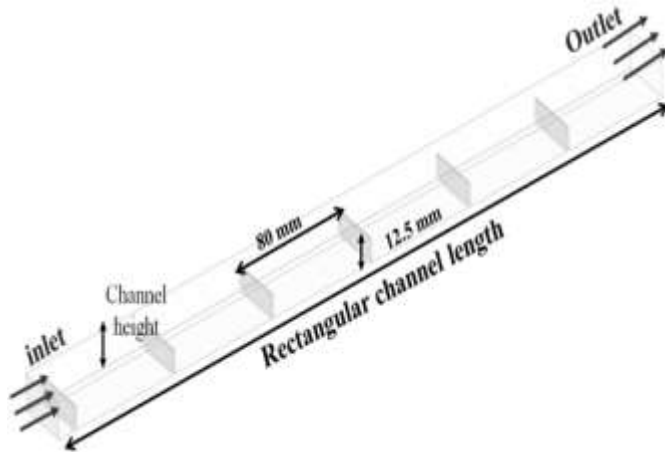


Figure 2: Computational domain of rectangle shaped channel 80 mm baffle spacing & 12.5 mm height. As shown in Figure 2, the total number of nodes is 177460, and the total number of elements is 145940. Tetrahedral components, which are rectangular and have 20 nodes on each side, are used. Figure 3 depicts the meshing.



Figure3: Mesh of circular cylinder with 80 millimetre baffle separation and 12.5 millimetre height

3.1 CAD geometry of circular cylinder with 40 millimetre opposite barrier separation and 10 millimetre height:

A two half Modelling of a triangle duct having baffle separation 40 mm and height 10 mm is produced at the bottom and top of the water with the help of both the design module and the ANSYS workstation, as shown in figure 4. The square show's length (L) is 500 mm, its height is 20 mm, and its baffles are spaced by a distance of approximately mm. The first baffle is positioned 15 mm

away from the input portion. Figure shows a two half image of the circular cylinder with barrier.

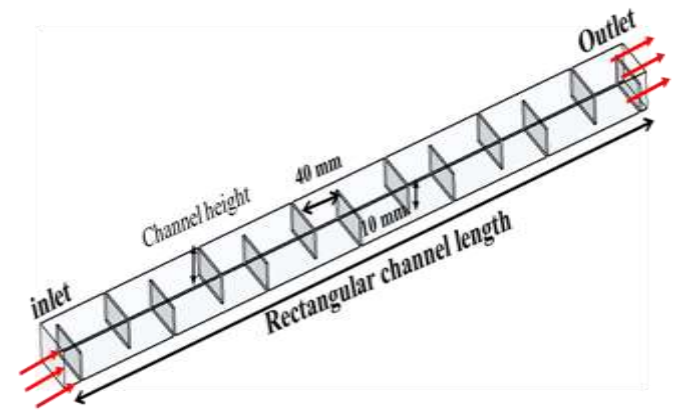


Figure4: CAD Geometry of rectangle shaped channel with The distance between opposite baffles is 40 mm, and the height is 10 mm.

The overall number of nodes in this work is 379368, and the total number of elements is 345800, as illustrated in figure 5 for meshing. Polyhedral components, which are triangular in shape and have 20 nodes on each side, are used.



Figure5: Cylindrical channels linking up with opposite flap separation of 40 millimetre and a height of 10 millimetre

3.2 CAD Geometry rectangle channel, 40 mm opposing barrier separation, 12.5 millimetre height:

A two half Modelling of a rectangular shaped with barriers spaced 40 mm and height 12.5 millimetre is created at the bottom and top sides of the channel using the behavior has been defined of the Solidworks software, as shown in figure 6. The rectangle network's length (L) is 500 mm, its height is 20 mm, and its baffles are spaced by a distance of approximately mm. The first baffle is positioned 15 mm

away from the input portion. Figure shows a three-dimensional image of the triangular duct with barrier.

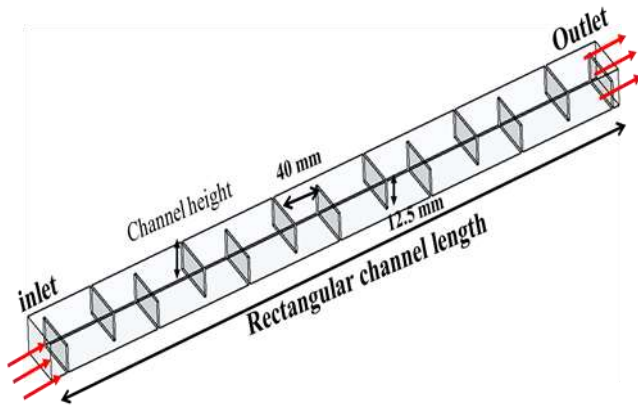


Figure6: Computational domain of rectangular shaped with opposite stump space 40 milimetre & height 12.5 milimetre. As indicated in figure 7, the overall number of nodes in this work is 377964, and the total number of elements is 343070. Hexahedral components, which are square in shape and have 20 nodes on each side, are used.



Figure7: Meshing of rectangular shaped opposite stump space 40 milimetre & height 12.5 milimetre

3.3 CAD Geometry of rectangle shaped channel with opposite baffle spacing 40 mm & height 15 mm:

A two half Cad design of a corrugated channel with baffle separation 40 mm and height 15 mm is inserted at the bottom and upper sides of the river using the construction phase of the Solidworks software, as shown in figure 8. The rectangle network's length (L) is 500 mm, its height is 20 mm, and its baffles are spaced by a distance of approximately mm. The first baffle is positioned 15 mm away from the input portion. Figure shows a three-dimensional image of the rectangular duct with barrier.

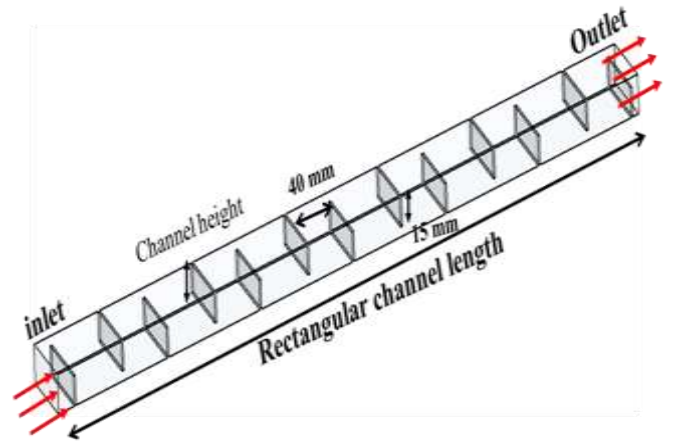


Figure8: Computational domain of rectangular shaped with opposite flumox spacing 40 milimetre & height 15 milimetre

As indicated in Figure 9, the overall number of nodes in this work is 377028, and the total number of elements is 341250. Hexahedral components, which are square in shape and have 20 nodes on each side, are used.



Figure9: Meshing of rectangular shaped among opposite flumox spacing 40 milimetre & height 15 milimetre

3.4 CAD Geometry of rectangle shaped channel with opposite baffle spacing 80 mm & height 10 mm:

A two half Modelling of a corrugated channel with baffles separated by 80 milimetre and a height of 10 milimetre is constructed at the bottom and upper sides of the channel using the construction stage of the Ansys software, as shown in figure 10. The rectangle show's length (L) is 500 mm, its height is 20 mm, and its baffles are spaced by a distance of approximately mm. The first baffle is positioned 15 mm away from the input portion. Figure shows a three-dimensional image of the triangular duct with baffle.

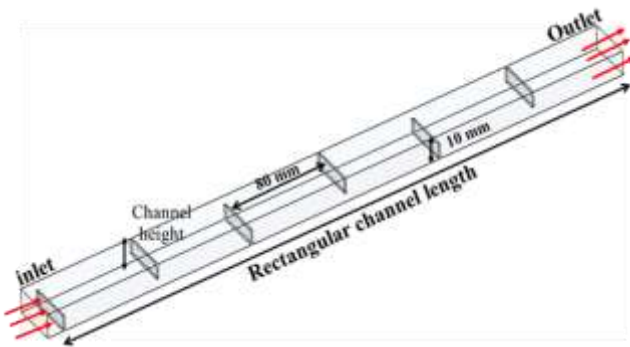


Figure10: Computational domain of rectangular shaped with opposite distance between baffles 80 milimetre & height 10 milimetre

As indicated in Figure 11, the overall number of nodes in this work is 378864, and the total number of elements is 347900. Hexahedral elements, which are rectangular in shape and have 20 nodes on each side, are used.



Figure11: Meshing of rectangular shaped among opposite distance between baffles 80 milimetre & height 10 milimetre

3.5 CAD Geometry rectangle shaped, 80 mm opposing barrier separation, 12.5 milimetre height:

With the help of the Parametric workbench's designing process, a two half CAD modeling of the a triangular duct with baffles separation 80 mm and height 12.5 mm is constructed at the bottom and upper side of the water, as illustrated in figure 12. The rectangle network's length (L) is 500 mm, its height is 20 mm, and its baffles are spaced by a distance of 40 mm. The first baffle is positioned 15 mm away from the input portion. Figure shows a three-dimensional image of the triangular duct with barrier.

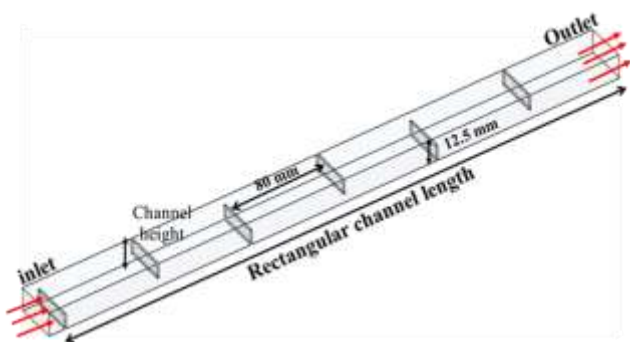


Figure12: Computational domain of rectangular shaped among opposite baffle spacing 80 milimetre & height 12.5 milimetre



Figure13: Meshing of rectangular shaped with opposite stump spacing 80 milimetre & height 12.5 milimetre
As indicated in Figure 13, the overall number of nodes in this work is 378216, and the total number of elements is 346640. Hexahedral elements, which are square in shape and have 20 nodes on each side, are used.

3.6 CAD Geometry of rectangular shaped with opposite stump spacing 80 milimetre & height 15 milimetre:

A two half Modelling of a corrugated channel with baffles separated by 80 mm and height 15 milimetre is constructed at the bottom and higher side of the water using the architectural phase of the Solidworks software, as shown in figure 14. The rectangle shaped channel's length (L) is 500 mm, its height is 20 mm, and its baffles are spaced by a distance of 40 mm. The first baffle is positioned 15 mm away from the input portion. Figure shows a three-dimensional image of the circular cylinder with baffle.

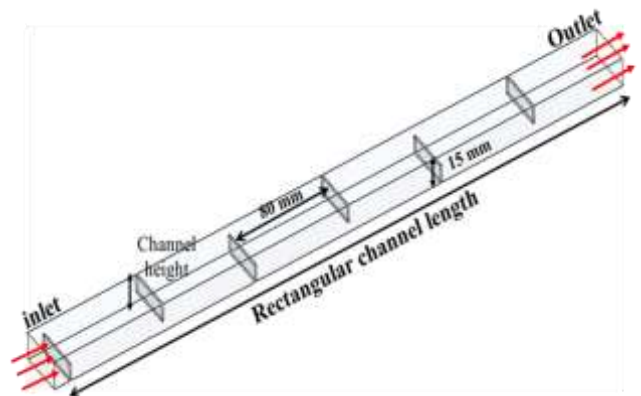


Figure14: Computational domain of rectangular shaped through opposite flummox spacing 80 mm & height 15 milimetre

As indicated in figure 15, the overall number of nodes in this work is 377784, and the total number of elements is 345800. Hexahedral elements, which are rectangular in

shape and have 20 nodes on each side, are used.



Figure15: Meshing of rectangular shaped among opposite baffle spacing 80 milimetre & height 15 milimetre

3.7 CAD Geometry of rectangle shaped channel with opposite baffle spacing 120 mm & height 10 mm:

A two half Modelling of a circular tube with obstructions interval 120 mm and height 10 mm is placed at the bottom and top of the water at a concentration of the ANSYS workbench's engineering phase, as shown in figure 16. The rectangle shaped channel's length (L) is 500 mm, its height is 20 mm, and its baffles are spaced by a distance of approximately mm. The first baffle is positioned 15 mm away from the input portion. Figure shows a three-dimensional image of the circular cylinder with barrier.

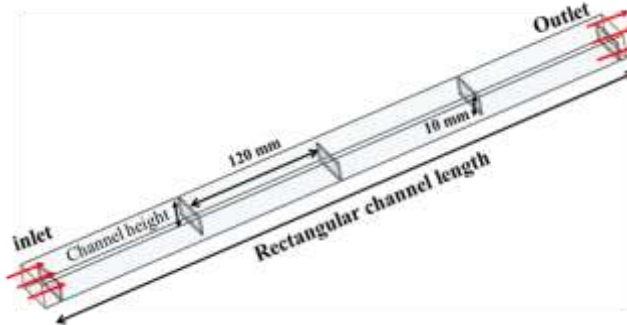


Figure16: Computational domain of rectangular shaped with opposite flummox spacing 120 milimetre & height 10 milimetre

As indicated in figure 17, the overall number of nodes in this work is 379224, and the total number of elements is 348600. Hexahedral elements, which are rectangular in shape and have 20 nodes on each side, are used.



Figure17: Meshing of rectangular shaped among opposite nonplus spacing 120 milimetre & height 10 milimetre
3.8 CAD Geometry of rectangle shaped channel with opposite baffle spacing 120 mm & height 12.5 mm:

At the bottom and upper sides of the water, a muti CAD version of a circular pipe with obstructions spacing 120 mm and height 12.5 mm is built with the help of the ANSYS workbench's engineering phase, as shown in figure 18.. The rectangle show's length (L) is 500 mm, its height is 20 mm, and its baffles are spaced by a distance of approximately mm. The first baffle is positioned 15 mm away from the input portion. Figure shows a three-dimensional image of the circular cylinder with barrier.

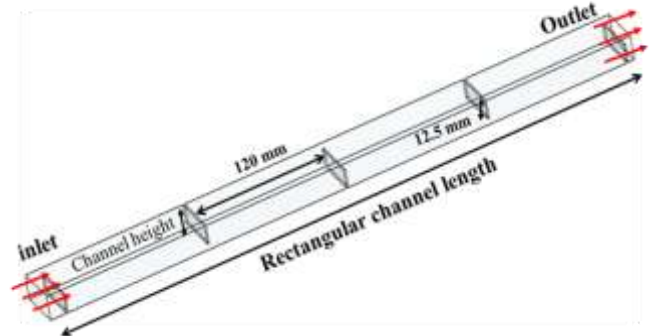


Figure18: Computational domain of rectangular shaped among opposite nonplus spacing 120 milimetre & height 12.5 milimetre

As indicated in figure 19, the overall number of nodes in this work is 378684, and the total number of elements is 347550. Hexahedral elements, which are rectangular in shape and have 20 nodes on each side, are used.



Figure19: Meshing of rectangular shaped with opposite confound spacing 120 milimetre & height 12.5 milimetre
3.9 CAD Geometry of rectangular shaped with opposite mystify spacing 120 milimetre & height 15 milimetre:

A muti CAD modeling of a rectangle shaped channel with barriers width 120 mm and height 15 mm is generated at the bottom and top sides of the river using the construction stage of the Ansys software, as shown in figure 20. The

rectangle channel's length (L) is 500 mm, its height is 20 mm, and its baffles are spaced by a distance of approximately mm. The first baffle is positioned 15 mm away from the input portion. Figure shows The rectangle duct without baffles in three dimensions.

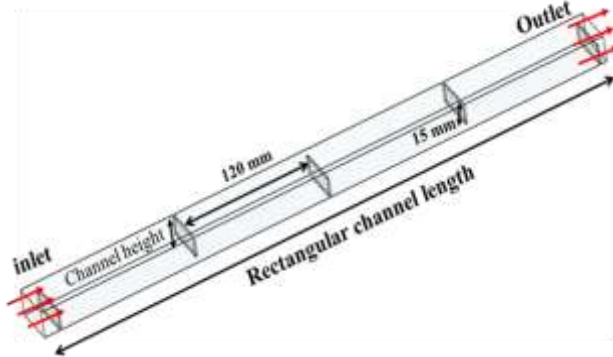


Figure20: Computational domain of rectangular shaped through opposite flummo spacing 120 milimetre & height 15 milimetre

As indicated in Figure 21, the overall number of nodes in this work is 378324, and the total number of elements is 346850. Hexahedral elements, which are rectangular in shape and have 20 nodes on each side, are used.



Figure21: Meshing of rectangular shapedamong opposite baffle spacing 120 milimetre& height 15 milimetre
 Mesh quality: The mesh quality has a significant impact on the calculation's accuracy and stability. Quadrilateral elements were created during discretization in the current study. The accuracy of the answer is influenced by the

quality of the cell, including its perpendicular quality, anamorphic widescreen, and standard deviation and variance.

3.10 Orthogonal mesh quality:The construct vectors, the vector from the division site to each of its sides, and the parameter from the cell core to cluster centers of each of the surrounding cells are used to determine diagonal grade for cells, as illustrated in figure 22. The orthogonal quality of the very worst squares will be closer to 0, while the omnidirectional quality of the greatest cells will be closer to 1. The mesh quality is satisfactory and very good in this example, with a 0.99823 is the least value, 1 is the largest value, and 0.99984 is the average value..

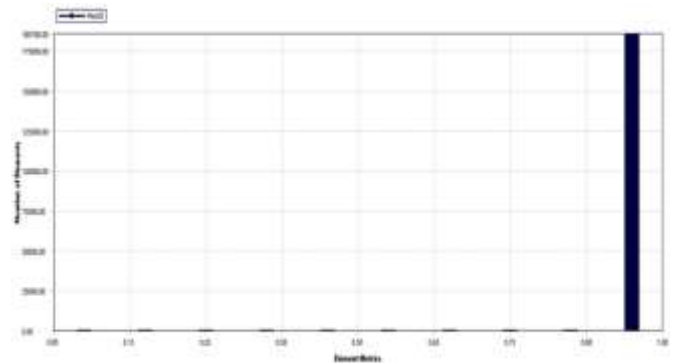


Figure 22:Rectangle conduit with baffles heating systems with perpendicular mesh refinement

IV. RESULTS AND DISCUSSION

The major goal of this research is to use a computational fluid approach to examine the best design of a rectangular duct with straighter correct angle baffle heat transfer with varying spacing and baffles height in order to maximise thermal efficiency. In this study, ten distinct 3D CAD models of rectangle shaped channels with baffle spacing of 40 mm, 80 mm, and 120 mm and baffle heights of 10 mm, 12.5 mm, and 15 mm were employed, and CFD analysis was performed to obtain maximal heat transmission. Various CFD study results have been explained in this chapter utilising contours diagrams, quantitative questions, and visual presentation.

Table 2: Calculation of Nano Fluid

Sno.	Parameters	Outcomes
1	Density	1069.535 kg/m ³
2	specific heat	3890.97 J/(kg.K)
3	thermal conductivity	0.6161 W/(m.K)

4	Dynamic viscosity	0.000873 kg(m.sec)
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Table 3: Heat transfer analysis for different Baffle spacing & height of rectangle shaped channel

Sno	Baffle spacing & height of rectangle shaped channel	Mass flow rate [kg/sec]	Specific heat $C_{p,nf}$ kJ/kg-K	T_{max} [°C]	T_{min} [°C]	ΔT [°C]	Heat transfer (Q) [kW]
1	Rectangle shaped channel having baffle arrangement at a distance of 80 mm & height 12.5 mm	0.1340	3.891	31.876	26.85	5.026	2.620
2	Rectangle shaped channel having opposite baffle arranged at a distance 40 mm & height 10 mm	0.1001	3.891	35.726	26.85	8.876	3.457
3	Rectangle shaped channel having opposite baffle arrangement at a distance of 40 mm & height 12.5 mm	0.1341	3.891	36.272	26.85	9.422	4.918
4	Rectangle shaped channel having opposite baffle arranged at a distance 40 mm & height 15 mm	0.1718	3.891	36.681	26.85	9.831	6.571
5	Rectangle shaped channel having opposite baffle arranged at distance of 80 mm & height 10 mm	0.0960	3.891	34.613	26.85	7.763	2.901
6	Rectangle shaped channel having opposite baffle distancing 80 mm & height 12.5 mm	0.1211	3.891	35.039	26.85	8.189	3.858
7	Rectangle shaped channel having opposite baffle distancing 80 mm & height 15 mm	0.1476	3.891	36.055	26.85	9.205	5.286
8	Rectangle shaped channel having opposite baffle distancing 120 mm & height 10 mm	0.0982	3.891	33.802	26.85	6.952	2.655
9	Rectangle shaped channel having opposite baffle distancing 120 mm & height 12.5 mm	0.1238	3.891	34.164	26.85	7.314	3.522
10	Rectangle shaped channel having opposite baffle arranged at distance of 120 mm & height 15 mm	0.1643	3.891	34.491	26.85	7.641	4.884

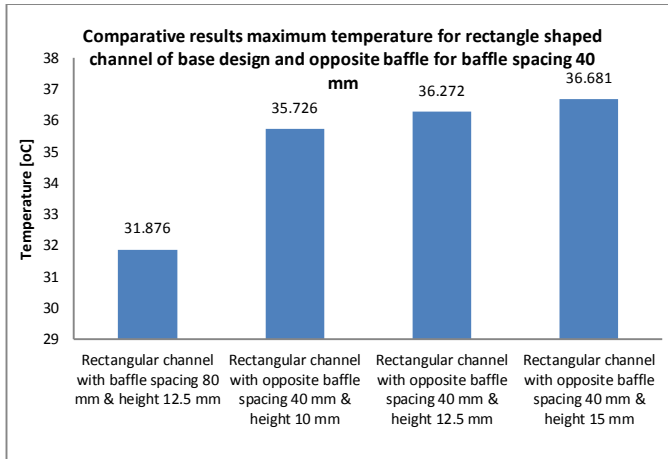


Figure23: Comparative results maximum temperature for rectangle shaped channel of base design and opposite baffle for baffle spacing 40 mm

The highest temperature of 36.681 oC was obtained for rectangular duct with opposing baffle with a baffle spacing of 40 mm and a height of 15 mm, as illustrated in figure 23.

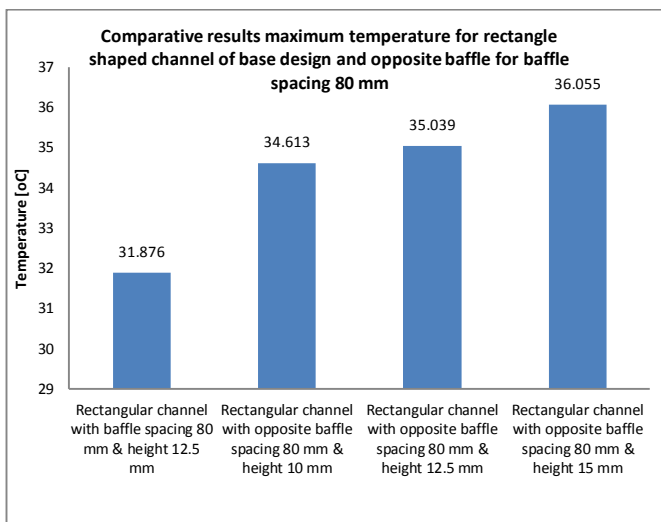


Figure24: Comparative results maximum temperature for rectangle shaped channel of base design and opposite baffle for baffle spacing 80 mm

According to the data available presented in figure 24, the maximum temperature for a circular cylinder with opposing baffle and a barrier gap of 80 mm and a height of 15 mm is 36.055 oC.

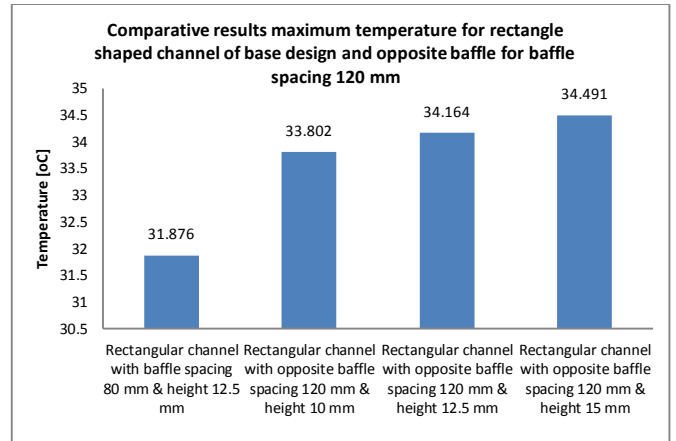


Figure25: Comparative results maximum temperature for rectangle shaped channel of base design and opposite baffle for baffle spacing 120 mm

According to the comparative data presented in figure 25, the highest temperature for a triangular duct with opposing baffle and a barrier spacing of 120 mm and a height of 15 mm is 34.491 oC.

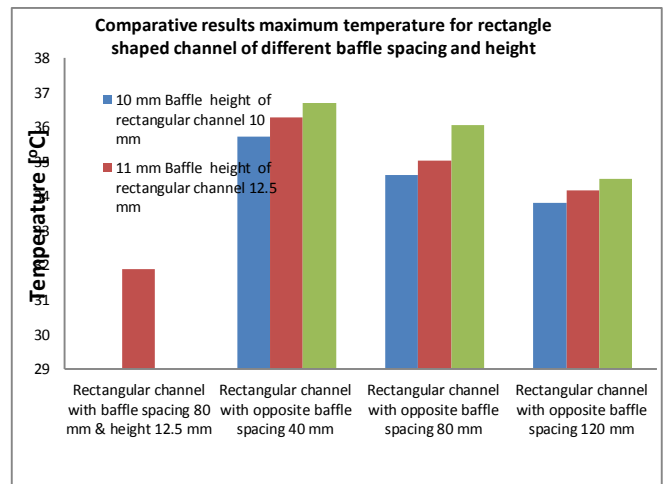


Figure26: Comparative results of maximum temperature for rectangular shaped of varied baffle heights and distance

The highest temperature of 36.681 oC was found for rectangular duct with opposite baffles having baffle spacing 40 mm and height 15 mm, as illustrated in figure 26 showing highest temperature for triangular duct of varying baffle separation and height.

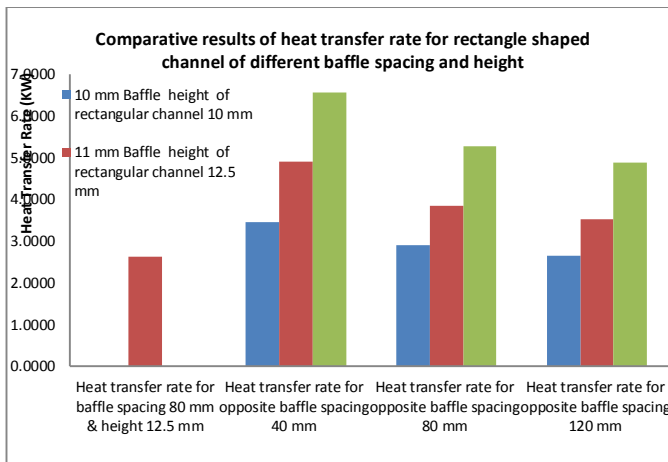


Figure 27: Thermal efficiency comparisons for rectangle shaped amid various perplex intervals and heights

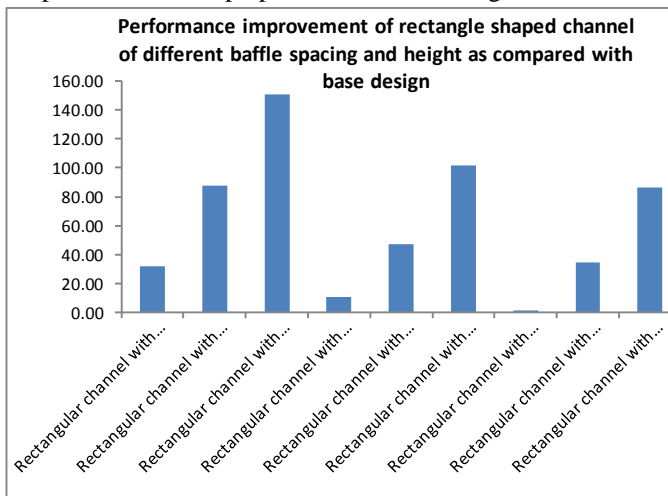


Figure 28: Performance improvement of rectangle shaped channel of different baffle spacing and height as compared with base design

Figures 27 and 28 show heat transfer rate and achievement improved performance of rectangle connection heat exchangers. It can be seen that the maximum rate of heat transfer of 6.571 KW has a performance of 1.5 times that of the frame structure for rectangular duct with contrary bewilders padding 40 mm and height 15 mm.

V. CONCLUSION

To improve heat transfer, a computer simulation analysis for a rectangle shaped channel with correct angle confounds exchanger with small displacements and baffle height was carried out. A total of ten distinct multiple computer-aided design models of vertical duct with bewilders spacing 40 mm, 80 milimetre, and 120 milimetre and baffle heights of 10 mm, 12.5 milimetre, and 15 milimetre were created. The major goal of this study is to run computer simulation simulations to see how Cu water nanoparticles affect the architecture and thermal hydrodynamic characteristics of a circular cylinder with baffles exchanger. The lower wall of the

channel, as well as the baffles, are regarded adiabatic zones, whereas the sides are termed periodic zones. This approach employs a second derivative upwind mass and energy equation. After completing computer simulation analysis on several designs of rectangle channels heat exchangers with variable baffle spacing and height heat exchangers, the following conclusions were reached

- After running a computer simulation simulation on a rectangular duct with baffle spacing of 80 mm and a height of 12.5 mm, the highest temperature was observed to be 31.876 oC, with a 5.026 oC variation from intake to outlet and a heat transfer of 2.620 KW.
- A highest temperature of 35.726 oC was reported after completing computer simulation analysis on a rectangular duct with opposing barrier spacing of 40 mm and height of 10 mm, with an 8.876 oC variation from intake to exit and a heat transfer of 3.457 KW.
- A maximum temperature of 36.272 oC was reported with a 9.422 oC variation from intake to outlet and a heat transfer of 4.918 KW after completing computer simulation analysis on a rectangular duct with opposed baffle separation 40 mm and height 12.5 mm.
- A highest temperature of 36.681 oC was reported with a 9.831 oC variation from intake to outflow and a thermal expansion of 6.571 KW after completing computer simulation simulation on a circular cylinder with opposing baffle spacing 40 mm and height 15 mm.
- A maximum temperature of 34.613 oC was reported after completing computer simulation analysis on a triangular duct with opposing baffle separation of 80 mm and a height of 10 mm, with a 7.763 oC variation from intake to exit and a heat transfer of 2.901 KW.
- A highest temperature of 35.039 oC was reported after completing computer simulation analysis on a rectangular duct with opposite barrier separation of 80 mm and a height of 12.5 mm, with an 8.189 oC fluctuation from intake to exit and a thermal expansion of 3.858 KW.
- A maximum temperature of 36.055 oC was reported after completing computer simulation analysis on a circular cylinder with opposed baffle spacing of 80 mm and height of 15 mm, with a 9.205 oC variation from intake to outlet and a heat transfer of 5.286 KW.
- A maximum temperature of 33.802 oC was reported with a 6.952 oC change from intake to outflow and a heat exchange of 2.655 KW after

completing computer simulation simulation on a circular cylinder with opposing barrier spacing 120 mm and height 10 mm.

- A highest temperature of 34.164 oC was reported with 7.314 oC variation from intake to outlet and a heat transfer of 3.522 KW after completing computer simulation analysis on a triangular duct with opposing baffle separation 120 mm and height 12.5 mm.
- A maximum temperature of 34.491 oC was reported with a 7.641 oC change from intake to outlet and a heat transfer of 4.844 KW after completing computer simulation analysis on a rectangle shaped channel with opposing baffle spacing 120 mm and height 15 mm.

The baffle pitch and height have a significant influence on the temperature distribution from the rectangle connection exchanger, with an optimum temperature differences of 9.831oC and a maximum heat transfer of 6.571 KW observed for baffle spacing 40 mm and height 15 mm for rectangle shaped channel with exact reverse baffles. In comparison to the base form of rectangle channels exchanger, the temperature difference increases nearly 1.5 times as the distance is reduced.

Future Scope:

There are several probable future works that could be investigated further;

- The heat exchanger's representative sample is rectangle shaped channel in this study; however, alternative designs may be available in the future.
- The current study examined eight alternative rectangle shaped channel with baffle heat exchanger designs; in the hereafter, it may be possible to predict thermal performance using other designs.
- While Cu water nano particles are being used as a working medium, another nano fluid can also be used in the hereafter.

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