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Review Over The Effects Of Baffle Orientation And Shape Factor Over Pressure Drop And Heat Transfer Coefficient In Tube Heat Exchange

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Abstract - *A heat exchanger is a mechanical system that exchanges heat between two or more fluids Any heat exchange intensification technique or device consists in modifying or improving the performance of the energy carrier. In this review, we have tried to identify the techniques to perform the energy vector between the cold source and the hot source. There are two different techniques, one called passive and the other is active. Thus, we have cited some correlations that describe the heat exchange as a function of the Nusselt number. This review is closed by the scientific work which aims to demonstrate the interest of using the passive technique.*

Bibliographic study:

The various sizes, positions, and orientations of obstructions inside exchanger tubes have been the focus of several scientific works, according to the literature. In order to better comprehend convective flow in a rectangular pipe.

Pethkool et al. **[1],** For a Reynolds number ranging from 5500 to 60000, it was examined how blocking factor (e/D) a corrugated helical tube with monophasic turbulent water flow that was influenced convective heat transfer. The findings demonstrate that the performance factor significantly rises with an increase in blocking factor and reaches a value of about 232 percent when compared to a smooth tube.[10], the evaluation of the Nusselt number is carried out by the following formula:

$$Nu = 1{,}579 Re^{0.639} Pr^{0.3} (e|D_H)^{0.46} (P|D_H)^{0.35} \quad (I.1)$$

Fig -1 Tube corrugated

Promvonge's experimental work. **[2],** undertaken to assess the forced convection heat transfer for turbulent airflow in a channel with a 60°-V multiple deflector turbulator., the Reynolds number is between 5000 and 25000, and the blocking factor varies between 0.1 and 0.3. The Nusselt number is evaluated by the following empirical formula:

$$No = 0.147 Re^{0.763} Pr^{0.4} (1 - e|H)^{-1,793} (PR + 1)^{-0.42} \quad (I.2)$$

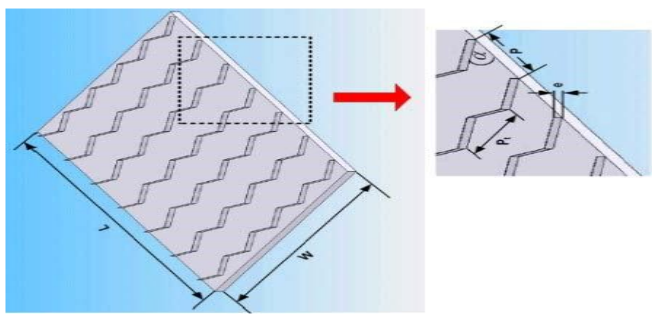


Fig -2 Twisted bands

DeMartini et al. [19], We undertaken an intriguing computational and experimental analysis of flat transverse baffles for a turbulent airflow regime in a two-dimensional heat exchange channel. Additionally, they discovered that this issue is crucial in the area of heat exchangers since it affects flow characterisation, pressure distribution, and the potential existence and growth of recirculation's. A reasonably dense recirculation zone is visible above each chicane's facets and is moving in the direction of swallow on the profiles and axial velocity distribution. The impact of the flow field's distortion increases as the flow approaches the first chicane. The biggest disruption is seen upstream of the second chicane, they also demonstrated.

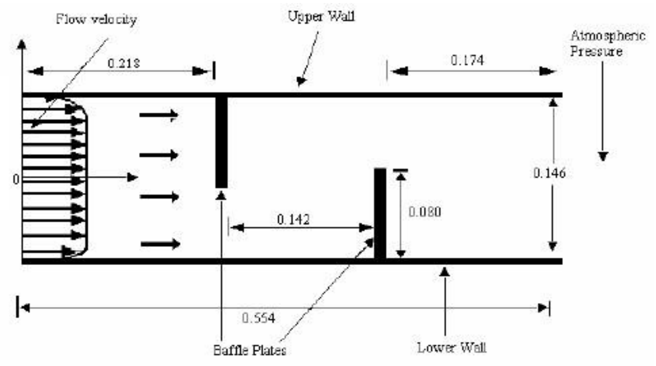


Fig -3 Channel configuration studied by DeMartini et al, **[3]**

Bensenouci et al. **[4],** Forced convection heat transfer in a rectangular pipe with baffles was investigated by numerical modelling. Convective heat exchange is promoted by the requirement to insert rows of fins and baffles in the vein of the emolument in heat exchangers. Research has revealed that the vertical portions nearest to the baffles are better heated than the distant vertical parts. The distribution of the temperature field in the channel further supports this observation.

Menni et al. **[5],** numerically studied the comparison between two different forms of fins and transverse baffles. The first is rectangular with a sharp tip, and the second rectangular is with a rounded tip. In a horizontal, two-dimensional pipe with a rectangular cross-section, they are placed in overlap. The fluid (air) is of the Newtonian type, incompressible with constant thermo-physical properties. The flow regime is considered permanent and purely turbulent. For a Reynolds number of between 5000 and 20000, calculations are conducted. The examination of the data showed that the addition of rectangular type baffles without rounding provides a significant increase in speed and improves the intensity of heat transmission when used with rectangular chianes.

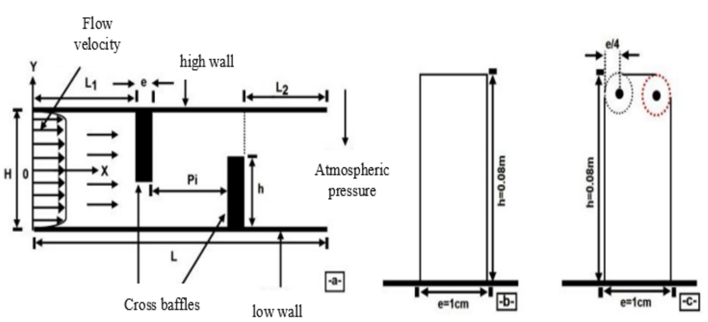


Fig -4 Rectangular wing with a rounded tip: Test section

Tsay et al. **[6]**, The improvement of heat transmission of a flow in a channel with a vertical chicane was quantitatively examined. In the 100–500 Reynolds number range, the impact of chicane size and back coatings on the flow structure is thoroughly investigated. They observed that by adding a baffle to the flow, the typical Nusselt number could be increased by 190%. They also noticed that the chicane's position affects the thermal and dynamic properties of the flow.

Bilen et al. **[7],** conducted an experimental study on the thermal and hydraulic characteristics of turbulent airflow in tubes with different groove forms (circular, trapezoidal, and rectangular), with Reynolds numbers ranging from 10000 to 30000. When comparing the findings to a smooth tube, the circular groove configuration increases heat transmission by 63%, the trapezoidal groove configuration by 58%, and the rectangular grooved tube by 47%. The authors attributed the relatively poor thermal performance of rectangular grooves to the appearance of stagnation or recirculation zones in this configuration. The relatively similar thermal performance of trapezoidal and circular grooves, despite a lower number of trapezoidal grooves, is explained by greater flow disturbance in this configuration.

Siddiqui et al. **[8],** The impact of placing baffles in a rectangular channel at various heights and inclination degrees on the increase in heat transmission was investigated experimentally and computationally. The findings demonstrate that the average Nusselt number is 120 percent more than in the case without a chicane for a Reynolds number range between 500 and 20000. They also discovered that the least amount of pressure loss occurs when the baffles are turned to face the channel's downstream side.

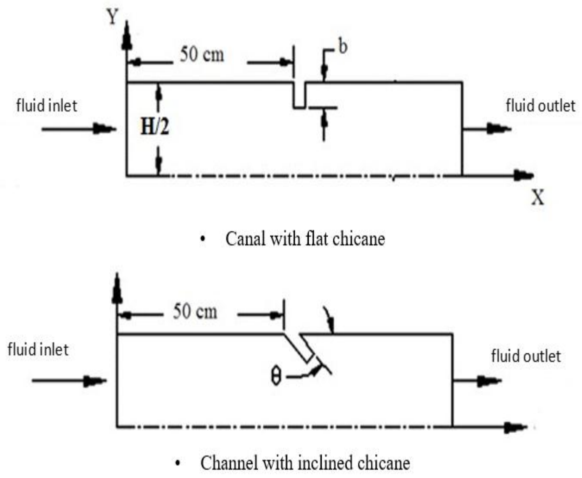


Fig -5 Chicane device in the canal

The work of Li et al. **[9],** a finned and flat tube heat exchanger with longitudinal vortex generators to provide a 3D numerical assessment of heat transfer and airflow characteristics. The line of rectangular fins had a downstream direction and was set out in pairs. Impact occurs at 20°, 30°, and 40° angles. Between 500 and 5000 is the Reynolds number. The numerical results show that these parameters may be changed to enhance heat transfer and friction coefficient in the Reynolds number range. They found that when fluid flows in the same direction as the fins' angle of inclination, the Nu number increases by 23-42 %, from 23 to 46 %, and increases by 23-31 %, 23-43 %, and 23-47 %, respectively and from 23 to 52 %, with equivalent inclination degrees of (20°, 30°, and 40°) in the opposite direction.

Wang et al. **[10],** Experimental testing of two unique heat exchanger layouts using a novel type of baffles is done. The results of this investigation, which concentrated on the heat transfer characteristics of FB-STHX and SB-STHX, suggest that heat exchange has improved. According to the experimental findings, the Nusselt number for FB-STHX is almost 50% that of SB-STHX at the same Reynolds number and tube grille circumstances, while the pressure drop of the first arrangement is roughly 30% that of the second. However, the first chicane's total Nu/p performance is 60% better than the second chicanes.

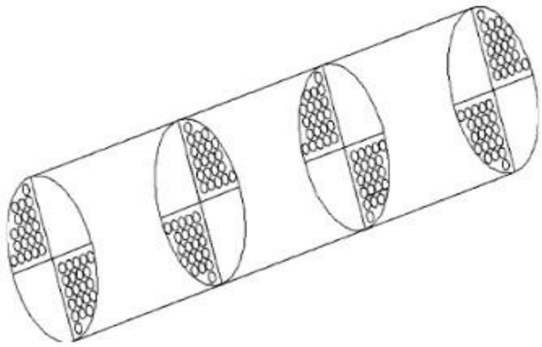
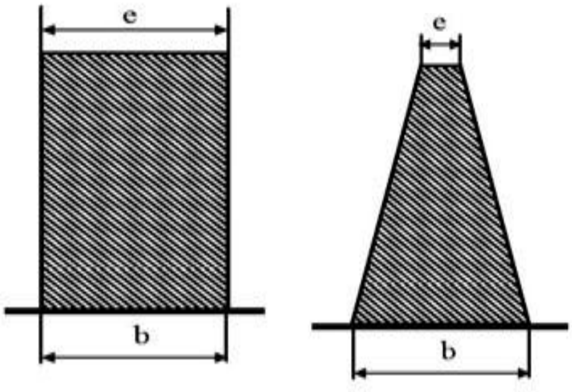


Fig -6 New chicanes device

Benzenine et al. **[11],** numerical research on turbulent airflow using transverse baffles. In a rectangular section pipe, two distinct types of flat, trapezoidal rectangular baffles are positioned in overlap. The findings demonstrate how baffles affect heat exchange intensification as a function of Reynolds number, which is between 1.87 103 and 1.87 105. They also demonstrate how locations with rapid fluid acceleration lead to an increase in friction coefficient.

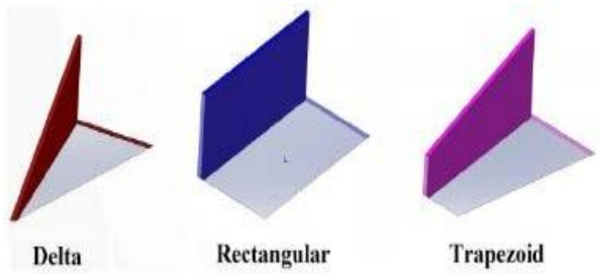


a- Flat rectangular chicane b- Trapezoidal chicane

Fig -7 Geometric shape of the chicanes studied

Through the use of three different inserts, Selva Kumar et al experiential's investigation **[12]** sought to enhance heat transmission in a circular copper tube with an internal diameter of 10 mm. The three inserts are either 15 mm, 20 mm, or 25 mm in pitch, with a rectangular form. Using inserts increases the rate of heat transmission, according to the results, which are supported by experimental pressure measurements and excellent fluid particle mixes inside the tube. Improved heat transmission is also related to a reduced pressure drop. They also discovered that the 20 mm pitch inserts had the highest thermal performance factor.

Xuedong et al. **[13],** 304 to 2130 Reynolds numbers were used to study the performance of air-side heat transfer using numerical simulation. Analysis is also done on the mechanism causing enhanced heat transfer. Fins of the delta, rectangular, and trapezoidal forms were installed on the heat exchanger's surface. The results of the calculations reveal that some eddies have formed behind the fins, which disturbs the fluid flow and enhances heat transmission. When comparing delta-shaped fins to rectangular and trapezoidal fins, the Nusselt number rose by 77.16 percent and 90.21 percent, respectively. A delta-shaped fin's Nusselt number outperforms a flat surface channel by 176%.



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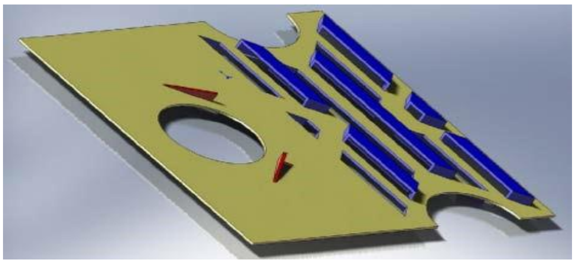

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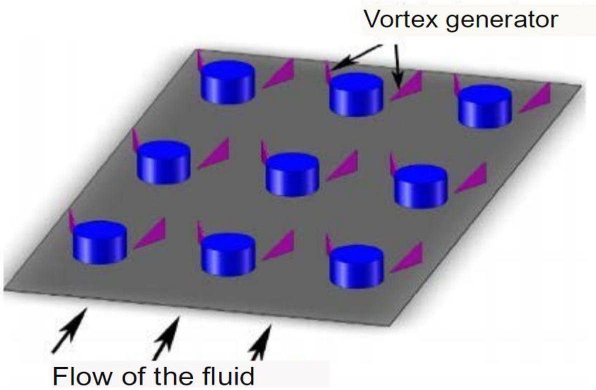

-c-

a- Shape of the fins, b- Compound fins and c-Arrangement of the fins

Fig -8 Different forms of fins

Wu et al. **[14],** The impact of a pair of delta-shaped fins positioned longitudinally as a vortex generator in a rectangular tube of heat exchanger with various degrees of inclination changing between 15°, 30°, 45°, and 60° was conceptually and numerically evaluated; the fluid employed was air. The outcomes demonstrate that, in comparison to a level surface, the Nusselt number of a surface with a pair of delta fins rises when the angle of inclination is elevated. The average Nusselt number increases by 8 to 11 percent for angles 15°, 30°, 45°, and 60°, respectively, and by 15 to 20 percent, 21 to 29 percent, and between 21 and 34 percent. They also discovered that the 60° angle of inclination has a bigger impact than the other angles.

Khoshvaght et al. **[15],** compared and evaluated seven typical channel layouts utilised in finned plate heat exchangers through experimental study. Experimental testing was done on all channels, including smooth, perforated, offset, louvres, corrugated, vortex generators, and pins. The fluid used is water with a Reynolds number range of 480 to 3770. Three energy performance evaluation criteria were used to determine the optimal channel. The results show that the vortex generator channel considerably improves the heat transfer coefficient and properly reduces the heat exchange surface. Thus, fin plate heat exchangers chose it as a premium surface. Additionally, low Reynolds values are where the corrugated channel operates the best.

Saha et al **[16],** To understand the relationship between local flow behaviour and the mechanism of improved heat transfer, the performance of a plate heat exchanger was quantitatively examined. The numerical simulation was performed in a rectangular channel with longitudinal vortex generators embedded in the bottom wall and spaced regularly in both flow directions. They used two different types of fluid flow with two different types of vortex generators, namely the pair of rectangle fins (RWP) and the pair of delta fins, to gauge the improvement in heat transfer (DWP). The performance of vortex generators was compared using integral (integer) measurements such the Nusselt number, pressure loss, and performance evaluation factor. The results showed that RWP enhanced heat transfer more than DWP did.

Du et al **[17],** two oval tube heat exchangers with fins were experimentally tested for their heat transfer and pressure drop properties (HE1: double rows of tubes, HE2: three rows of tubes). The fins are angled in the airflow direction. To achieve the best heat transfer and pressure performance, four air intake angles (30°, 45°, 60°, and 90°) were individually evaluated with Reynolds numbers ranging from 1300 to 13000. On the air side, experimental correlations between the Nusselt number and the coefficient of friction were found, and overall evaluations of heat transfer efficiency were performed. The findings demonstrate that for heat exchangers that are positioned obliquely, the improvement in heat transfer performance is dependent on the degree of inclination of the air intake.

Wongcharee et al. **[18],** compared the effects of two distinct twisted band configurations (TA) and (TT), Figure 9. Experimental evaluations of the heat transfer and pressure drop characteristics of two oval tube heat exchangers with fins were performed (HE1: double rows of tubes, HE2: three rows of tubes). The fins are directed toward the direction of airflow. Four air intake angles (30°, 45°, 60°, and 90°) were independently investigated with Reynolds numbers ranging from 1300 to 13000 to get the greatest heat transfer and pressure performance. On the air side, assessments of the total effectiveness of heat transmission were made, and experimental correlations between the Nusselt number and the coefficient of friction were discovered. The results show that the improvement in heat transfer performance for heat exchangers that are positioned obliquely depends on the angle of the air intake.

- Alternating axis twisted strip tubes (TA):

$$No = 0.032Re^{0.985}Pr^{0.4}(Y|W)^{-0.594} \quad (I.3)$$

- Typical twisted strip tubes (TT):

$$NNNN = 0.005RRRR^{1.139}PPPP^{0.4}(YY|WW)^{-0.521} \quad (I.4)$$

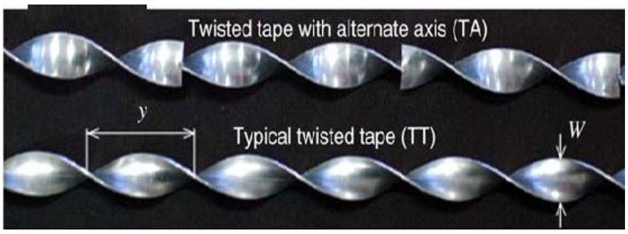

Figure 9: Twisted band

The experimental results obtained show that the V-deflector provides an increase in the Nusselt number with the increase in the blocking factor (e/H) of about 187% at low Reynolds number compared to a channel without a deflector.

CONCLUSION

Review shows that the thermal performance at the level of this device depends essentially on the geometric parameters of the channel (thickness, length and width, blocking factor, etc.). Given the scientific interest, it was thought useful to begin a study in this direction, with the aim of demonstrating the impact of inserting the elements inside the channel as obstacles in the opposite direction of the flow of the fluid on the intensification of heat exchanges. The shape, orientation, arrangement, and arrangement of the baffles by contribution to the flow of the fluid, the thermo-physical parameters of the fluid, the flow regime.

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