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CFD ANALYSIS OF DOUBLE PIPE HEAT EXCHANGER WITH AND WITH OUT DIMPLES

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Abstract - *Double pipe heat exchangers are widely used in various heat transfer applications starting from oil refineries to automobile radiators because of simplicity in design. The rate of heat transfer in a double pipe heat exchanger can be increased by using various heat transfer augmentation techniques out of which dimples is identified as a passive method with least value of pressure drop in comparison with other techniques. In the present work, the performance of double pipe heat exchanger with and without dimples are investigated using the CFD package ANSYS FLUENT 18.2 and the arrangement providing efficient heat transfer is identified through CFD results*

Key Words: Heat Transfer, Dimples, CFD, Double pipe Heat Exchanger.

1. INTRODUCTION

Effective utilization of available energy becomes need of hour today. This obviously requires effective devising. When it concerns with heat energy the devices are heat exchangers. Heat exchanger may be defined as equipment which transfers the energy from a hot fluid to a cold fluid, with maximum rate and minimum investment and running cost. There are numerous types of heat exchanger which varies in structure and function according to the need. Waste heat is heat, which is generated in a process by way of fuel combustion or chemical reaction, and then "dumped" into the environment even though it could still be reused for some useful and economic purpose. The essential quality of heat is not the amount but rather its "value". The strategy of how to recover this heat depends in part on the temperature of the waste heat and the economics involved.

The development of high-performance thermal systems has stimulated interest in methods to improve heat transfer. The study of improved heat transfer performance is referred to as heat transfer augmentation, enhancement, or intensification. A great deal of research has focused on various augmentation techniques with emphasis on rough surfaces, transverse or spiral ribs, transverse grooves, knurling, corrugated and spirally corrugated tubes, straight , and spiral and annular fins.

In this investigation, augmented surface has been achieved with dimples strategically located in a pattern along the tube of a double-pipe heat exchanger with the increased area on the tube side. A wide variety of industrial processes involve the transfer of heat energy and they provide a source for energy recovery.

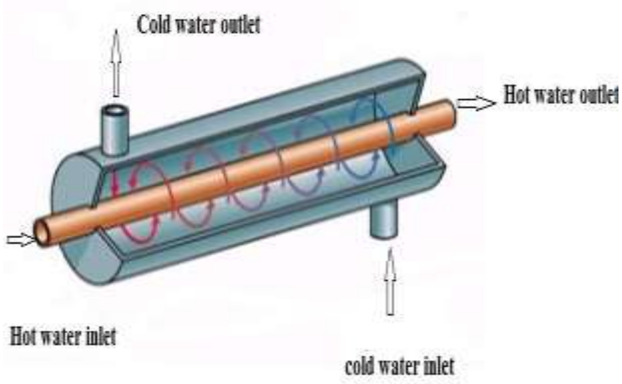

Fig 1.1 Double Pipe Heat Exchanger

2. LITERATURE REVIEW

It is the only quest to increase the efficiency which has encouraged the people to take up the study in this direction. Study has been conducted to analyze the varies types of dimple tube heat exchanger varying the shape of the dimple may it be hemispherical, almond shape or square shape dimples also varying the conditions to analyze the performance of the system and comparing the result with the usual system. Idario. P. Nascimento and Ezio. C. Garcia performed experiments to enhance the heat transfer rate in compact heat exchangers by using shallow square dimples in flat plate tubes. By using dimple flat tubes it enhanced the heat transfer augmentation factor. A good correlation was found among the experimental and the predicted internal coefficient of friction. The method is a passive way of heat transfer enhancement technique. It was noticed that the setup provided a heat transfer augmentation factor between 1.37 and 2.28. Chi-Chuan Wang, Kuan-Yu Chen, Yur-Tsai Lin investigated the semi dimple vortex generator. The setup is applicable to fin and tube heat exchanger. The study examines the air side performance of the fin and tube heat exchangers having simple dimple vortex generator.

Many samples were been taken, out of the many conclusions one of the conclusions is that the experimental setup is 10% more efficient than the plain fin geometry. Ming Li, Tariq. S. Khan, Ebrahim

H. Ayub worked on the geometric optimization for thermal hydraulic performance of dimpled tubes for single phase flow.

Enhanced surfaces have larger heat transfer surface area and offer increased turbulence level hence allowing higher heat exchange performance. In this study, numerical simulations are conducted to simulate geometric design optimization of enhanced tubes for optimal thermal–hydraulic performance. The simulations are validated with experimental data. Al Hajri and Zahid.

3. CAD MODELLING

The geometry of double pipe heat exchanger with and without dimples has been modeled on AUTO CAD 3D modelling.

Table 3.1 Dimensions of the Double Pipe Heat Exchanger

SL. NO.	PARAMETER		DIMENSION
1	Hot pipe	Inner diameter	16.5mm
		Outer diameter	21.5mm
2	Cold pipe	Inner diameter	42mm
		Outer diameter	48.5mm
3	cold pipe inlet	Inner diameter	11mm
		Outer diameter	12mm
4	Cold pipe outle t	Inner diameter	11mm
		Outer diameter	12mm
5	Hot pipe length		750mm
6	Cold pipe length		450mm

4. CFD ANALYSIS

Computational Fluid Dynamics (CFD) has been performed based on a 3-D finite volume method. K-epsilon (kε) turbulence model was used for the purpose of flow analysis of all the CAD models. K-epsilon (k-ε) turbulence model is the most common model used in Computational Fluid Dynamics (CFD) to simulate mean flow characteristics for turbulent flow conditions. It is a two equation model which gives a general description of turbulence by means of two transport equations (PDEs). The original impetus for the K-epsilon model was to improve the mixing-length model, as well as to find an alternative to algebraically prescribing turbulent length scales in moderate to high complexity flows. For a much more practical approach, the standard k-ε turbulence model is used which is based on our best understanding of the relevant processes, thus minimizing unknowns and presenting a set of equations which can be applied to a large number of turbulent applications.

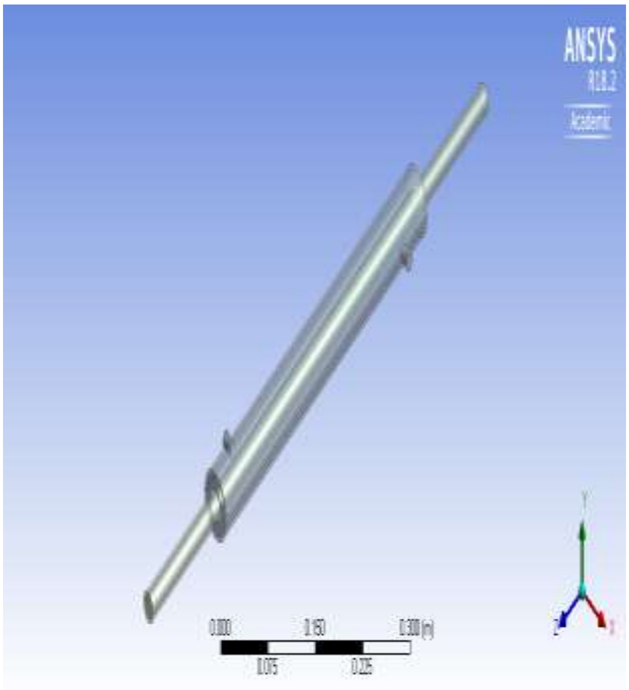

Fig 4.1 Geometry Modal of Double Pipe Heat Exchanger with Out Dimples

Fig 4.2 Geometry Modal of Double Pipe Heat Exchanger with Dimples

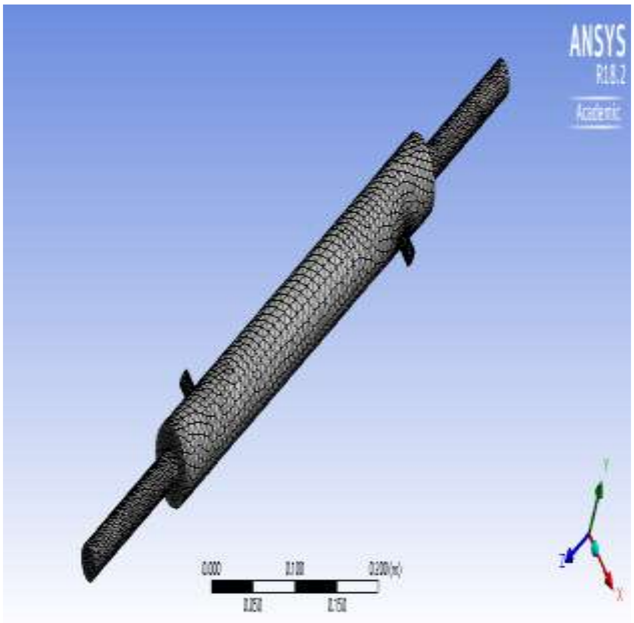

Fig 4.3 Mesh Modal of Double Pipe Heat Exchanger with Out Dimples

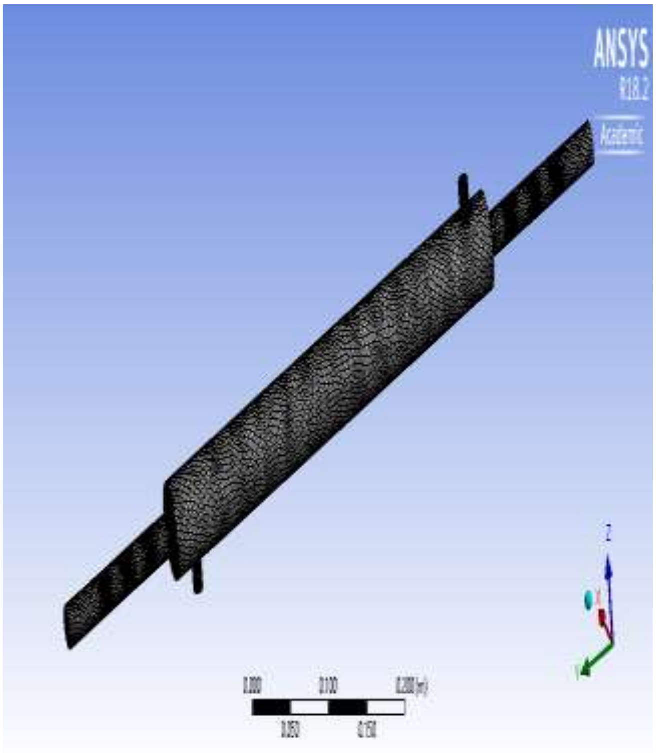

Fig 4.4 Mesh Modal of Double Pipe Heat Exchanger with Dimples

Boundary conditions are used according to the need of the model. The inlet and outlet conditions are defined as mass flow rate inlet and pressure outlet. As this is counter flow with two tubes so there are two inlets and two outlets. The walls are separately specified with respective boundary conditions

Table 4.1 Boundary Condition

QUANTITIES	BOUNDARY CONDITION
Working fluid	Water
Inner pipe (hot fluid)	Hot inlet Mass flow rate = 0.125 kg/s Temperature = 82.22 c
Outer pipe (cold fluid)	Cold inlet Mass flow rate =0.215kg/s Temperature = 32.22 c

5. RESULT AND DISCUSSION

After the exporting the model into analysis has done in two steps. In first step water is taken into consideration. All the analysis has been done at three different fluid velocities to both with and without dimples.

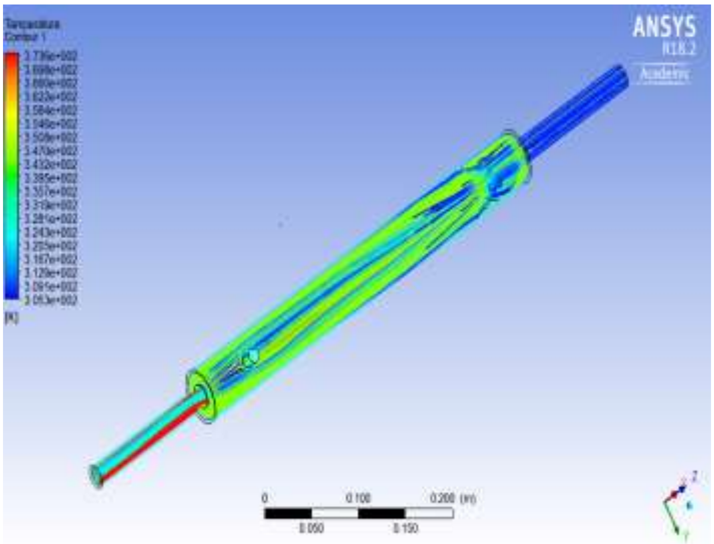

Fig 5.1 Temperature Distribution of Double Pipe Heat Exchanger with Out Dimples

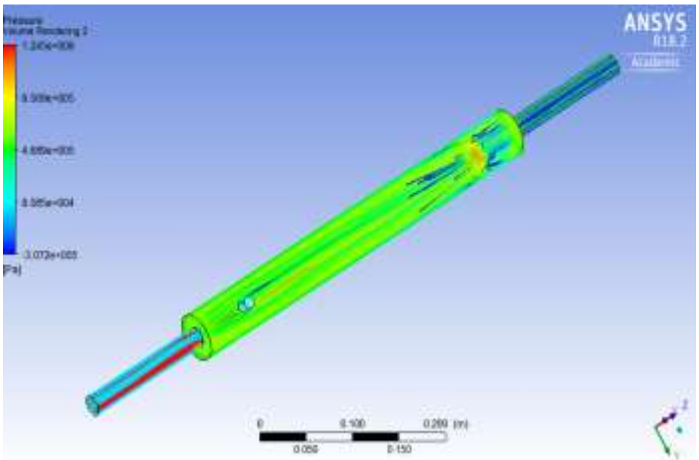

Fig 5.2 Pressure Distribution of Double Pipe Heat Exchanger with Out Dimples

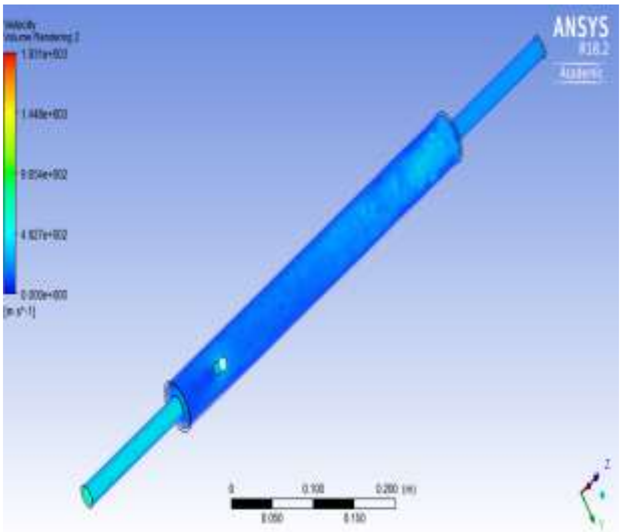

Fig 5.3 Velocity Distribution of Double Pipe Heat Exchanger with Out Dimples

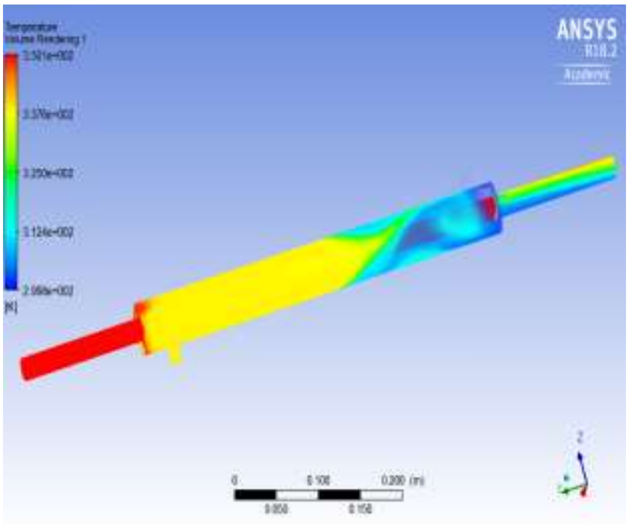

Fig 5.4 Temperature Distribution of Double Pipe Heat Exchanger with Dimples

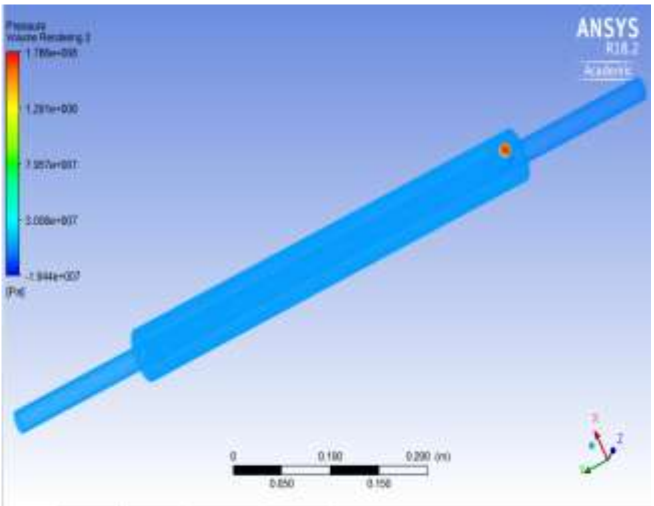

Fig 5.5 Pressure Distribution of Double Pipe Heat Exchanger with Dimples

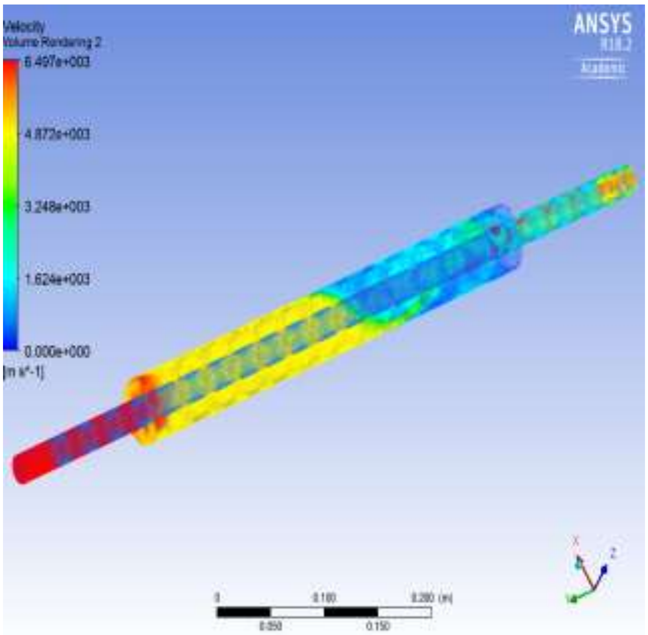

Fig 5.6 Velocity Distribution of Double Pipe Heat Exchanger with Out Dimples

Table 5.1 Temperature result of results Of Double Pipe Heat Exchanger with Out Dimples

WITHOUT DIMPLE		TEMPERATURE (K)
Hot fluid	inlet	360
	outlet	316
Cold fluid	inlet	305
	outlet	332

Table 5.2 Temperature result of results Of Double Pipe Heat Exchanger with Dimples

WITHOUT DIMPLE		TEMPERATURE (K)
Hot fluid	inlet	360
	outlet	310
Cold fluid	inlet	305
	outlet	340

6. CONCLUSION

Thus the performance of double pipe heat exchanger with and without dimples shapes and configurations are investigated using the CFD package ANSYS FLUENT 18.2 The simulation was carried out for water to water heat transfer characteristics and different shapes were studied. We are absorbed temperature and pressure, velocity in double pipe heat exchanger with and without dimples. And we concluded that the heat transfer rate of double pipe heat exchanger with dimple is better than the double pipe heat exchanger without dimples.

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