ABSTRACT:
The challenges posed to the effort of enhancing the rate of heat transfer includes drop in pressure at the delivery end of the tube. Generating higher turbulence improves the rate of heat transfer but at the cost of the drop in pressure in the system. This leads to higher power consumption for the same amount of heat transfer. The study undertaken for this dissertation work aims to introduce aero-dynamics in the construction of the heat exchanger that would streamline the flow of air through the channel and eventually reduce the pressure drop in the system. For deployment of CFD methodology, ANSYS Fluent is proposed as a software tool while validation shall be pursued using physical experimentation either for the benchmark geometry or the proposed solution based on feasibility of development of prototype for this work.

INTRODUCTION:
The science and engineering of heat transfer plays a critical role in the design of compact heat exchangers. Typically, air-side thermal resistance constitutes about 80% of the total thermal resistance to heat flow. Commonly, densely packed fins are used to increase the air-side surface area and also play the dual role of increasing the heat transfer coefficient. This is accomplished by using various topologies such that the thermal boundary layer is constantly regenerated either by interrupted surfaces and/or inducing self-sustained flow oscillations. Fins can be broadly categorized into continuous surfaces, e.g. wavy fins and ribbed channels, and interrupted fins, e.g. strip fins and louvered fins. An additional aspect which any design has to be sensitive to is the friction penalty of achieving enhanced heat transfer. Hence, surface topologies which maximize heat transfer augmentation with minimal friction penalty are sought. This research investigates new fin topologies with heat transfer characteristics that will surpass conventional fin, where the main goals are to increase the heat transfer rate of the fin surface while keeping an acceptable pressure drop penalty. Surface roughness is usually applied to smooth surfaces to promote flow mixing and initiate turbulence in the flow. Since spherical indentations or dimples have shown good heat transfer characteristics when used as surface roughness, in this work the employment and modification of dimples/protrusions shape for different heat enhancement applications will be investigated.

Artificially roughened surfaces, extended surfaces, inlet vortex generators, vibration of the surface or fluid, application of electrostatic fields, and the insertion in tubes of objects such as twisted tapes, coiled wire or spinners are a few examples of such augmentative techniques. Existing systems can often be improved by using an augmentative method, while in other applications, such as the design of heat exchangers for use in space vehicles, an augmentative scheme may be mandatory in order for the system to function properly in a zero gee environment, and meet the size limitations imposed. Increases in cost, weight, and pumping power are frequently associated with a given augmentative method, and the designer must, therefore, make a careful study in order to determine the net improvement available from such a method.

Enhanced surfaces

Since there are so many different types of heat exchanger enhancements, it is highly unlikely that a commercial simulator could support them all. Furthermore, some propriety data from the manufacturers of the heat transfer enhancement might never be released. However, that does not mean that process and project engineers can not perform some of the preliminary calculations for new technologies. The following provides background information on many different types of heat exchanger enhancements. Heat exchanger enhancement must always satisfy the primary goal of providing a cost advantage relative to the use of a conventional heat exchanger. Other factors that should be addressed include fouling potential, reliability and safety. Heat exchanger enhancement can be divided into both passive and active methods. Passive methods include extended surfaces, inserts, coiled or twisted tubes, surface treatments, and additives. Active techniques include surface vibration, electrostatic fields, injection, and suction. The majority of the current discussion is related to the passive methods involving mechanical modifications to the tubes and baffles. Figure 1 shows several different schematics of enhancements to heat exchanger tubes including finning, inserts, and twisting.

Finning

Tubes can be finned on both the interior and exterior. This is probably the oldest form of heat transfer enhancement. Finning is usually desirable when the fluid has a relatively low heat transfer film coefficient as does a gas. The fin not only increases the film coefficient with added turbulence but also increases the heat transfer surface area. This added performance results in higher pressure drop. However, as with any additional surface area, the fin area must be adjusted by an efficiency. This fin efficiency leads to an optimum fin height with respect to heat transfer. Most of the heat transfer and film coefficients for finned tubes are available in the open literature and supported in most commercial heat exchanger rating packages. Recent papers also describe predicting finned tube performance.

Tube Inserts or Protrusions

Inserts, turbulators, or static mixers are inserted into the tube to promote turbulence. These devices are most effective with high viscosity fluids in a laminar flow. Increases in the heat transfer film coefficients can be as high as five times. Inserts are used most
often with liquid heat transfer and to promote boiling. Inserts are not usually effective for condensing in the tube and almost always increase pressure drop. Because of the complex relationships between the geometry of the insert and the resulting increase in heat transfer and pressure drop, there are no general correlations to predict enhancements. However, through the modification of the number of passes, a resulting heat transfer coefficient gain can be achieved at lower pressure drop in some situations. Aerodynamic bead shape insert shall be the proposed solution for this problem.

**Problem Definition:**
Conductive method of heat transfer through a metal conductor i.e. plain metallic tube with a heating element on the exterior is used as a reference / benchmark for this work. The metallic tube housed in a heating coil allows air to pass through from one end to the other while picking up heat on its way to the exit. The problem area identified for this work is to maximize and consequently result in a higher temperature differential for the passing air. The same should be evident at the points being examined using thermocouples for recording temperature. The pressure recorded over a conventional tube should not drop more than 15% for the tube with the aeroshaped beads. The heat enhancement is aimed to reach a target value of at least 5% over the conventional method of heat transfer.

**LITERATURE REVIEW**

1. Bodius Salam, Sumana Biswas, Shuvra Saha, Muhammad Mostafa K Bhuiya [2013] were conducted an experimental investigation was carried out for measuring tube-side heat transfer coefficient, friction factor, heat transfer enhancement efficiency of water for turbulent flow in a circular tube fitted with rectangular-cut twisted tape insert. The results can be summarized as, The Nusselt number increased with the increase of Re & the experimental values were enhanced by 2.3 to 2.9 times compared to Nusselt number with smooth tube values. Also an average of 68% enhancement of heat flux was observed for tube with rectangular-cut twisted tape insert than that of smooth tube & the experimental friction factor with inserts values were found to be 39% to 80% higher than friction factor with smooth tube values.

2. Munish Gupta, Neeti Arora, Rajesh Kumar, Sandeep Kumar and Neeraj Dilbaghi [2011] indicate that, a comprehensive review on forced convection heat transfer characteristics with different nanofluids based on experimental investigations with constant heat flux, constant wall temperature boundary conditions and in heat exchangers is presented in this review paper. Most of the experimental studies showed that nanofluids demonstrate an improved heat transfer coefficient compared to its base fluid. Further it increases significantly with increasing concentration of nanoparticles as well as Reynolds number.

3. V. V. Olimpiev [2010] have shows the Enhancement of Heat Transfer and the Potential for Energy Conservation in Industrial Oil Coolers. They shows the results from a calculation study on analyzing the efficiency of a few most advanced intensifiers of heat transfer are presented & the most efficient intensifiers are determined, and their considerable possibilities for energy conservation and saving of structural materials are estimated & also Industrial recommendations for improving the design of coolers and using preferable intensifiers are proposed and substantiated.

4. Mazen M. Abu-Khader [2006] explain this present work aims at presenting an overview of the up to date research on the applications of tube inserts and introducing a clearer picture on their thermal and hydraulic performance. The effect of twisted tape will be examined closely through the use of an industrial case study to give a better understanding on the effect of twisted tapes on various laminar, transition and turbulent flow regions. Outline general themes when considering twisted tapes as tube inserts during the design of new shell and tube heat exchangers. Finally, verifying the power exponents of Re and Pr in both laminar and turbulent flow regions.

5. P. C. Mukesh Kumar, J. Kumar, R. Tamilarasan, S. Sendhil Nathan and S. Suresh [2014] have undertaken detailed experimental investigation of turbulent heat transfer and experimental pressure drop of a helically coiled tube with Al2O3/water nanofluid at 0.1%, 0.4% and 0.8% particle volume concentration were tested. It is studied that the heat transfer coefficients increase with increasing the particle volume concentration. The maximum enhancement of overall heat transfer coefficient, inner heat transfer coefficient and inner Nusselt number were found to be 30%, 15% and 56%, respectively higher than water at 0.8% volume concentration. These enhancements are due to higher thermal conductivity of nanofluid, better mixing of fluid, and random movement of nanoparticles which carry more heat energy. Further, it is observed that the presence of nanoparticles shows positive effect on the formation of secondary flow in coiled tube. It is also noted and the pressure drop increases while increasing particle volume concentration. The pressure drop is 9% higher than water at 0.8% concentration. This pressure drop increase is due to increased of viscosity when particle volume concentration is increased. Therefore, the conventional heat transfer fluids can be replaced with Al2O3/water nanofluid in helically coiled tube heat exchanger for enhancing more heat transfer with negligible pressure drop penalty.
6. I. Mamaliga, D. Sidor, C. Condurat, E. T. Iacob [2014] explain the hydrodynamics and the mass transfer coefficients for a packing material consisting of modified Raschig rings used in absorption columns were investigated. Significant differences in the mass transfer coefficients were obtained for the 25 mm regular and modified ceramic Raschig ring packing’s. The experimental values for the liquid holdup and the pressure drop for random modified packing are in good agreement with those obtained for the 25 mm ceramic Raschig rings. The liquid holdup and the pressure drop are significantly lower for the arranged packing. The liquid film mass transfer coefficients were determined for the arranged and the random packings in the range of the liquid and the gas velocities common to the absorption column operation conditions.

7. Gang Lin, Karsten Kusterer, Dieter Bohn, Takao Sugimoto, Ryozo Tanaka, Masahide Kazari [2013], investigation on the Double Swirl Chambers cooling configuration has been focused on the influence of geometry parameters e.g. merging ratio of chambers and aspect ratio of inlet duct on the cooling performance. The results show a very large influence of these geometry parameters in heat transfer enhancement and pressure drop ratio. Compared with the basic configuration of Double Swirl Chambers cooling, the improved configuration with 20% to 23% merging ratio shows the highest globally averaged thermal performance parameter.

OBJECTIVE:
The following are the objectives of this work:
- To enhance the heat transfer augmentation with minimum pressure drop
- To enhance the heat transfer coefficient with increasing thermal performance.
- To get numerical results for align and staggered arrangement of dimples comparing with plain tube.
- To build test rig set up for testing the performance.
- Manufacture the tube with align or staggered array of dimple, which gives best performance numerically.
- To test the tube under varying mass flow rate for different Reynolds number.
- To compare the results with plain tube.

METHODOLOGY:

Experimental Set up:
The apparatus consists of a centrifugal blower unit fitted with a circular tube, which is connected to the test tube located in horizontal orientation. Flexi glass heater encloses the test section to a whole length. Input to heater is given through rheostat. Four thermo-couples at equal distances from the origin of the heating zone are embedded on the walls of the tube and one thermocouple is placed in the air stream at the exit of the test section to measure the temperature of flowing air. The digital device multimeter is used to display the temperature measured by thermocouple at various position. The temperature measured by instrument is in °C. The test tube of about 1 to 2mm thickness is used for experimentation. A U tube manometer or electronic multi-meter measures the pressure drop across the test section. Typically, the pipe system consists of a valve, which controls the airflow rate through it and an orifice meter to find the volume flow rate of air through the system. The two pressure tapings of the orifice meter are connected to a water U-tube manometer to indicate the pressure difference between them. Display unit is a digital multimeter used to indicate temperature indicator. Difference in the levels of manometer fluid represents the variations in the flow rate of air. The velocity of airflow in the tube is measured with the help of orifice plate and the water manometer fitted on board.

REFERENCES

1. Bodius Salam, Sumana Biswas, Shuvra Saha, Muhammad Mostafa K Bhuiya[2013],Heat transfer enhancement in a tube using rectangular-cut twisted tape insert,5th BSME International Conference on Thermal Engineering, Department of Mechanical Engineering, Chittagong University of Engineering & Technology, Chittagong 4349, Bangladesh.