Design And Optimization of Heat Exchanger To Enhance Its Efficiency.

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Abstract - . A heat exchanger is a piece of equipment built for efficient heat transfer from one medium to another. The media may be separated by solid wall, so that they never mix, or they may be in direct contact. In this studies we are making geometrical changes in a heat exchanger which can be improve its efficiency and effectiveness. In which we change the tubes nature from straight to curvy.

Index Terms - Mounting, Industrial Development, Efficiency enhancement, Heat Exchanger, minimization human efforts

I. INTRODUCTION (HEADING 1)

The heat exchanger is an equipment that allows heat transference between two fluids at different temperatures. Heat exchangers are extensively used in industry due to their wide variety of construction and applications in heat transference processes for producing conventional energy such as condensers, heaters, boilers or steam generators. They provide an adequate surface for heat transference to occur and their mechanical and thermal characteristics allow high pressure and high temperature processes. Heat exchangers are important, their optimization rises the competitiveness and allows energy saving. The necessity of saving and recovering energy for different processes in industry makes essential the develop of new manufacturing technology for heat exchangers in order to cover a wide range of operation conditions.

In recent years, new software for design heat exchangers has been focus in adapting the equipment to the required process and new solutions have been found that make the design. Double pipe heat exchangers are the simplest exchangers used in industries. On one hand, these heat exchangers are cheap for both design and maintenance, making them a good choice for small industries. On the other hand, their low efficiency coupled with the high space occupied in large scales, has led modern industries to use more efficient heat exchangers like shell and tube or plate. However, since double pipe heat exchangers are simple, they are used to teach heat exchanger design basics to students as the fundamental rules for all heat exchangers are the same. Optimizing the operational parameters play a key role in the enhancement of heat transfer rate after the design of heat exchanger. The transfer of heat to and from process fluids is an essential part of most chemical processes. The most commonly used type of heat-transfer equipment is the ubiquitous shell and tube heat exchanger.

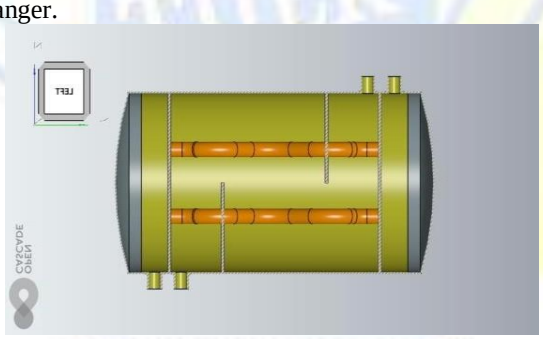

Fig.1 3D Model of the Heat Exchanger

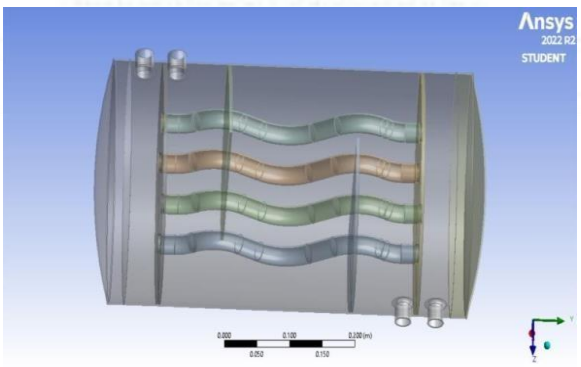

Fig.2 3D Model of Heat Exchanger with inside Curvy Tubes.

II. LITERATURE SURVEY

A heat exchanger is a device designed to efficiently transfer or "exchange" heat from one matter to another. When a fluid is used to transfer heat, the fluid could be a liquid, such as water or oil, or could be moving air. The most well known type of heat exchanger is a car radiator. In a radiator, a solution of water and ethylene glycol, also known as antifreeze, transfers heat from the engine to the radiator and then from the radiator to the ambient air flowing through it. A heat exchanger is a piece of equipment built for efficient heat transfer from one medium to another. The media may be separated by solid wall, so that they never mix, or they may be in direct contact. In this studies we are making geometrical changes in a heat exchanger which can be improve its efficiency and effectiveness. In which we change the tubesnature from straight to curvy.

V.K. Patel and R.V. Rao explores the use of a non-traditional optimization technique; called particle swarm optimization (PSO), for design optimization of shell-and-tube heat exchangers from economic view point. Minimization of total annual cost is considered as an objective function. Three design variables such as shell internal diameter, outer tube diameter and baffle spacing are considered for optimization. Two tube layouts viz. triangle and Square are also considered for optimization. Four different case studies are presented to demonstrate the effectiveness and accuracy of proposed algorithm. The results of optimization using PSO technique are compared with those obtained by using genetic algorithm (GA).

SiminWangJianWenYanzhong Li in his paper shows that the configuration of a shell-andtube heat exchanger was improved through the installation of sealers in the shell-side. The gaps between the baffle plates and shell is blocked by the sealers, which effectively decreases the short-circuit flow in the shell-side. The results of heat transfer experiments show that the shell-side heat transfer coefficient of the improved heat exchanger increased by 18.2–25.5%, the overall coefficient of heat transfer increased by 15.6–19.7%, and the efficiency increased by 12.9–14.1%. Pressure losses increased by 44.6–48.8% with the sealer installation, but the increment of required pump power can be neglected compared with the increment of heat flux. The heat transfer performance of the improved heat exchanger is intensified, which is an obvious benefit to the optimizing of heat exchanger design for energy conservation.

HEAT EXCHANGER DESIGN AND CALCULATIONS

Dimension of Heat Exchanger to manufacturing

- Tube bend radius =60mm
- Tube Diameter =25mm
- Tube Material =SS304
- Shell Material =M.S
- Shell diameter =300mm
- Overall length =600mm
- Bended Tubes length =Shell length
- Thickness of shell = 2mm
- Tube thickness =1mm
- Overall thickness = 2mm
- Shell length =460mm
- Pipe length overall =520mm
- Shell Inner Diameter =296mm
- Dom length =140mm

CALCULATIONS

- Thi = Inlet Temperature of Hot Fluid = 97°C
- Tho = Outlet Temperature of Hot Fluid = 75°C
- Tci = Inlet Temperature of Cold Fluid = 26°C
- Tco = Outlet Temperature of Cold Fluid = 62°C
- ΔTA = Temperature Difference Between Hot Fluid = 22°C
- ΔTB = Temperature Difference Between Cold Fluid = 36°C

$$\epsilon \text{ (Effectiveness)} = \frac{Tco - Tci}{Thi - Tci}$$

$$= \frac{62 - 26}{97 - 26}$$

$$= 0.507$$

$$\epsilon = 50.7\%$$

$$\text{(Efficiency)} = \frac{Tco - Tci}{Tho - Tci}$$

$$= \frac{62 - 26}{75 - 26}$$

$$= 0.7346$$

$$= 73.46\%$$

LMTD = Logarithmic Mean Temperature Difference :

$$\Delta Tm = \frac{(\Delta TA - \Delta TB)}{\ln(\Delta TA / \Delta TB)}$$

$$= \frac{(22 - 36)}{\ln(22/36)}$$

$$= 5.304°C$$

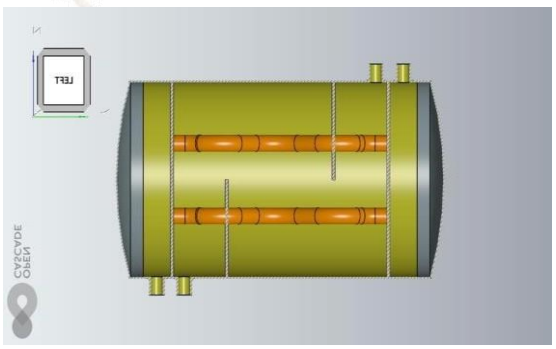

Fig. 3-D model of heat exchanger

Fig.4 Manufactured Prototype of heat exchanger

III. IMPORTANCE OF HEAT EXCHANGER

There is a wide application of heat exchanger in the field of cryogenics and other industrial applications for its enhanced heat transfer characteristics and compact structure**.** Lots of researches are going on to improve the heat transfer rate of the heat exchanger. Here, in this work, an analysis has been done for heat exchangers with constant heat transfer coefficient with turbulent flow. There are various factors present that may affect the heat transfer characteristics of the heat exchanger. A heat exchanger is a system used to transfer heat between a source and a working fluid. Heat exchangers are used in both cooling and heating processes. The fluids may be separated by a solid wall to prevent mixing or they may be in direct contact. They are widely used in space heating, refrigeration, air conditioning, power stations, chemical plants, petrochemical plants, petroleum refineries, natural-gas processing, and sewage treatment. Heat exchangers are the essential accessories designed to provide highest heat transfer inside the minimal area feasible. Heat exchangers are always regarded important for research in the field of thermal engineering. A heat exchanger is a piece of equipment built for efficient heat transfer from one medium to another. The media may be separated by solid wall, so that they never mix, or they may be in direct contact. In this studies we are making geometrical changes in a heat exchanger which can be improve its efficiency and effectiveness. In which we change the tubes nature from straight to curvy.

We began our project's work by conducting a market and literature survey. We gathered several research papers that were relevant to our issue and reviewed them in order to better understand the heat exchanger. Collected the raw data on previous heat exchangers. We have chosen our standard and necessary pieces for this heat exchanger after comprehending the results of the market study, Analyse the problem statement that needs to solve, which ended up with enhancement of efficiency. Designed the geometrical changes required. Manufactured the Heat Exchanger prototype and calculated the improved efficiency.

IV. CONCLUSIONS

- In conclusion, the proposed solution offers an effective and efficient way of enhancing efficiency of heat exchanger, this prototype can be a way for improvement in the heat exchanger industries.
- Due to this prototype the change in efficiency takes place at rate of 10-15% more efficient than the regular tube and shell heat exchanger.
- From the above prototype model we can enhance efficiency of heat exchanger.
- It will really beneficial as looking toward the future scope for oil refineries, sugar factories, chemical industries.

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