e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Conference:01/March-2023 Impact Factor- 7.868 www.irjmets.com
National Conference on Trending Technology for Achieving Sustainable Development Goals
NCTTASDG 2023 Organized by Shri Shankarprasad Agnihotri College of Engineering, Wardha

HEAT TRANSFER ANALYSIS OF A CONE SHAPED HELICAL COIL TUBE WITH ANNULAR FINS USE IN AIR PREHEATER A REVIEW

Jay Chhadi*1, Dr. C. B. Kothare*2

*1PG Student, Department of Mechanical Engineering, SSPACE, Wardha, Maharashtra, India.

*2Associate Professor, Department of Mechanical Engineering, SSPACE, Wardha, Maharashtra, India.

ABSTRACT

A helically coil-tube heat exchanger is generally applied in industry applications due to its compact structure, larger heat transfer area and higher heat transfer capability. Several studies from literature have also indicated that heat transfer rate in helically coiled tube are superior to straight tube due to complex flow pattern exist inside helical pipe. The concept behind compact heat exchanger is to decrease size and increase heat load which is the typical feature of modern helical tube heat exchanger. While the heat transfer characteristics of helical coil heat exchangers are available in the literature. The poor efficiency of an air preheater in the modern Oil and Gas fired heater of petrochemical plants is one of the main reasons for higher unit heat rate & is responsible for deterioration in heater efficiency. The main problem of air preheater is the leakage of air to the flue gas side & thereby resulting in poor thermal performance. The higher contaminant in flue gas adds to the problems associated with tubular air preheater. Air preheaters are designed to meet performance requirements with consideration of highly influencing parameters viz. heat transfer, leakage and pressure drop. In the present work the performance of tubular air preheater is evaluated and analysis for different tube arrangement for evaluating influence of various parameters viz. Gas flow rate, Gas temperature, tube pitch, etc. This work can also be used while selecting a new type of surface geometry for optimizing the design of air preheater.

Keywords: Air-Preheater, Cone shaped Helical Coil, Annular Fins coil, CAD Tool, CFD Analysis

I. INTRODUCTION

Helical tubes are universally used in chemical reactors, ocean engineering, heat exchangers, piping system and many other engineering applications. It has been long recognized that heat transfer characteristic of helical tubes are much better than that of straight ones because of the occurrence of secondary fluid flow in planes normal to the main flow inside the helical structure. In the present study an experimental investigation of heat transfers in cone shaped helical coil heat exchanger is reported for various Reynolds number. The purpose of this study is to design and fabricate a non-previously implemented shell and cone shaped helical coil and fitted with a twin cylinder diesel engine to recover waste heat from the exhaust gas to heat water. A "C" program was developed for the easiness of the design and an AutoCAD model of the design was made. For the fabrication of the coil, copper tubes were used. To evaluate the designed value various temperatures have taken for various mass flow rate of the water. The results show that the design value is having a good agreement with the experimentally obtained value. It was found that the heat transfer rates are 1.18 to 1.38 times more for the cone shaped helical coil than that of simple helical coil. Heating combustion air can raise Fired Heater efficiency about 1% for every 22°C in temperature increase in stack. The most common way to preheat the air is with a heat exchanger on the flue exhaust. Air-pre heaters are used to pre-heat the air before the commencement of any other process, for combustion in fired heater. These are heat exchangers which are widely used in fired heater in order to increase the overall efficiency of the heater. APH is broadly classified as recuperative and regenerative. Recuperative type exchanges heat between the hot and cold fluid in a continuous process. Under this, there exists tubular type air-pre heater (APH) and plate type air-pre heater. Regenerative type also exchange heat between the hot and cold fluid alternatively and it is not continuous. Under this, we have rotating-plate air-pre heater (RAPH) and stationary plate APH. Our focus will be on regenerative airpreheaters as these heat exchangers find a wide use in industries. Many limitations are also associated with an air-preheater. The difficulties which generally occur in this case is that the ducting system required. For cold air and hot air requires space and more supports which eventually enlarges the entire setup. The second problem is that the portion of the tubes, which is exposed to the flue gas, undergoes wear and tear, reason being the fact

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Conference:01/March-2023 Impact Factor- 7.868 www.irjmets.com
National Conference on Trending Technology for Achieving Sustainable Development Goals
NCTTASDG 2023 Organized by Shri Shankarprasad Agnihotri College of Engineering, Wardha

that flue gas coming out of the furnace is loaded with ash content and dust particles. Regenerative APH - In this, the heating elements are either rotary or stationary. The primary problem here is the wear and tear of the plates as the incoming flue gas is dust-laden having high ash and silica content. The second problem is the leakage of gases from gaps between the rotating and stationary structures, this leakage of gases affects the performance of APH to a great extent. Seals are provided in the APH to prevent the leakage. Another problem is the deposition of unburnt particles on the surface of APH. As the unburnt deposits meet flowing cold air and flue gas, the ignition temperature is reached along with sufficient amount of oxygen due to which the particles start burning. This also sometimes causes explosions inside the APH. Dew Point Corrosion is a problem generally seen in all kinds of air-pre heaters. The flue gas coming out of the furnace is dust-laden containing contaminants such as chlorides, sulphates etc. As the flue gas attains the acid saturation temperature, i.e., the temperature at which condensation of acids takes place, sulphates, chlorides etc. condensate in the form of acids such as sulphuric acid, hydro-chloric acid and other acids. The condensation takes place on steel tubes and plates, the portion of the tubes or plates which is surrounded by acids is less oxygenated, thus serving as anode while the portion which is not surrounded by acids is more oxygenated thus serving as cathode. This anode-cathode leads up to an electro-chemical cell, which in turn corrodes the base material. Amidst all such problems related to APH, the heating elements or Coils play a vital role in regulating the performance of the APH. The coil is also changed at regular intervals in order to ensure uninterrupted performance of the APH. The aim is to find and investigate the dependence of an air-preheater on coil profile. As the cast tube air-preheater operates at a relatively high temperature, the matrix wall will expand on coming in contact with the flue gas and shrink on contact with cold fluid. At the same time, the inlet gas temperature, flow rate, and thermodynamic properties are varied momentarily; this results in a typical mushroom type deformation This deformation causes leakage and also results in mechanical friction which seriously affects the thermal efficiency and security of the system. In order to analyses the system, we used Computational fluid dynamics (CFD) is a computer based tool for simulating the behavior of systems involving fluid flow, heat transfer and other related physical processes. It works by solving the equations of the fluid flow (in a special form) over a region of interest, with specified (know) conditions on the boundary of that region. Fluid (gas and liquid) flows are governed by partial differential equations which represent Conservation laws for the Mass, Momentum, and Energy. Computational Fluid Dynamics (CFD) is the art of replacing such PDE systems by a set of algebraic equations which can be solved using digital computers.

II. LITERATUTE REVIEW

[1] BagoutdinovaAlfiyaGizzetdinovna, "Engineering Calculation and Experimental Study of a Cone-Shaped Coil Heat Exchanger". In his paper, the calculation of a coil heat exchanger with a linearly varying bending radius of a helical spiral (cone-shaped coil heat exchanger) has been performed. They performed the experimental study of heat transfer in a cone-shaped coil heat exchanger of the "pipe-in-pipe" type. They obtained the empirical formulas for the Nusselt number and hydraulic resistance coefficient. It has been established and experimentally confirmed that cone-shaped coil heat exchangers are more compact and efficient in comparison with the known cylindrical coils. It is proposed to modernize the hot water preparation unit in one of the residential buildings in the city of Kazan (Russia) by replacing the outdated shell and-tube heat exchanger with a compact cone-shaped coil heat exchanger, which made it possible to reduce the duration of hot water preparation significantly, to reduce the costs of the heating medium and, thus, to reduce consumer costs.

[2] Hitesh Khurana, RudrodipMajumdar, and Sandip K Saha, "Numerical Investigation on the Performance of the Helical and Conical Coil Heat Exchanger Configurations in the Dynamic Mode of Heat Extraction". In this paper they have explained that, in solar heating systems, immersed heat exchangers of curved shape are used to charge and discharge sensible heat water storage tanks. Effect of arrangement and position of the tubes, geometry of coil, configuration, shape, flow rate, type of working fluid, Reynolds number associated with flow, and inlet temperature to coil, on the performance of storage systems have been studied in the literature. Rate of discharge, heat transfer coefficient, effectiveness of heat exchanger, heat transfer rate, discharging efficiency and increment in temperature of outlet fluid are the standard performance parameters to evaluate the heat

transfer and fluid flow phenomenon in the curved tubes. Heat transfer characteristics are investigated and analyzed for one helical and two conical coil (conical and inverted conical) configurations using a three-dimensional unsteady numerical model. The numerical model is validated against reported experimental result and a good agreement is found. For the same length of the coil, the inverted conical configuration presents more heat transfer surface area to the incoming hot fluid entering the thermal energy storage tank, as compared to conical coil and helical coil configurations, leading to higher extraction of thermal energy. Based on the performance parameters, inverted conical coil experiences enhanced heat transfer, high overall heat transfer coefficient and better effectiveness of heat exchanger as compared to helical and conical coil configurations.

[3] Mukesh Kumar1, Professor Manojkumar Singh, "Heat Transfer Analysis of Cone Shaped Helical Coil Heat Exchanger of Different Pitches and Diameter". The purpose of their article is to compare the heat transfer in cone shaped helical coil and simple helical coil. The pitch, height and length of both the coils are kept same for comparative analysis. The calculations have been performed for the steady state condition and experiments were conducted for different flow rates in laminar and turbulent flow regime. The coil side flow rate is kept varying while the coil side flow rate is kept constant. It was observed that the effectiveness of the heat exchanger for the cone shaped helical coil is more than that for the simple helical coil. Results show that the heat transfer rates for the cone shaped helical coil are comparatively higher than that of the simple helical coil.
[4] YaminiPawar, AshutoshZare, Ashish Sarode, "Helically Coiled Tube with Different Geometry and Curvature Ratio on Convective Heat Transfer: A Review". Their paper elaborates a brief review on different curvature ratio and geometry of tubes in heat transfer through heat exchangers. A helically coil-tube heat exchanger is generally applied in industry applications due to its compact structure, larger heat transfer area and higher heat transfer capability. Several studies from literature have also indicated that heat transfer rate in helically coiled tube are superior to straight tube due to complex flow pattern exist inside helical pipe. The concept behind compact heat exchanger is to decrease size and increase heat load which is the typical feature of modern helical tube heat exchanger. While the heat transfer characteristics of helical coil heat exchangers are available in the literature.

[5] Dr. B. Jayachandraiah, H.S.S.K. Praveen, "Heat Transfer Analysis of a Helical Coil Heat Exchanger by using CFD Analysis". An attempt is made in their paper to evaluate the thermal performance of HCHE through CFD analysis. The modeling is done by using CATIA V5 software. The model contains the Coiled tube and Shell having an inner diameter of 8.41 mm and 260 mm respectively. The height of the shell is 250 mm. The material of the Shell and Coil is made up of Steel and Copper respectively. Computational Fluid Dynamics (CFD) Analysis is performed for different flow rates of 40, 60, 80, 100, 140 LPH at Coil side and constant flow rate of 200 LPH at Shell side in both laminar and turbulent flow regimes under steady state conditions. It was found that the heat transfer characteristics were found better at the flow rate of 80 LPH and it is well desired to be maintained in the coil.

[6] Umang K Patel, Prof. Krunal Patel, "CFD Analysis Helical Coil Heat Exchanger". Their study aims to perform a numerical study of helical coil tube-in-tube heat exchanger with water as both hot and cold fluid. To improve the effectiveness, D/d geometrical parameter will be varied for different boundary conditions. The impact of this modification on Cold water temperature, Hot water temperature, Cold water velocity, Hot water velocity, Reynolds number, with respect to D/d will also be studied.

[7] SumedhHajare, P. N. Chaudhari, "Design and fabrication of conical helical coil heat exchanger for waste heat recovery from exhaust of diesel engine.". In their paper, the conical helical heat exchanger is proposed and designed to recover the loss of energy or heat available in the exhaust of diesel engine. Nearly, 30-40% energy is waste from exhaust. The heat available at the exhaust system of diesel engine is calculated for exhaust gas waste heat recovery. Exhaust gas properties will be needed to design the heat exchanger for waste heat recovery. It has been recognized that heat transfer characteristic of helical tubes are much better than that of straight ones because of the occurrence of secondary fluid flow in planes normal to the main flow inside the helical structure. Calculations are carried out to design of heat exchanger and then CFD simulation is carried

and results are obtained for conical helical heat exchanger. Main focus of design of heat exchanger is to be compact-shaped so that it gets retrofitted into vehicles. Fabrication of the heat exchanger is carried out according to modelling of designed heat exchanger. Water is used as working fluid as it will have important role in this research. This fabricated heat exchanger has coupled with exhaust system of diesel engine. CFD analysis is carried out for different load, at different speed of engine and for different mass flow rate of working fluid.

[8] ShindeDigvijay D., Dange H. M., "Heat Transfer Analysis of a Cone Shaped Helical Coil Heat Exchanger". In their study an experimental investigation of heat transfer in cone shaped helical coil heat exchanger is reported for various Reynolds number. The purpose of this article is to compare the heat transfer in cone shaped helical coil and simple helical coil. The pitch, height and length of both the coils are kept same for comparative analysis. The calculations have been performed for the steady state condition and experiments were conducted for different flow rates in laminar and turbulent flow regime. The coil side flow rate is kept varying while the coil side flow rate is kept constant. It was observed that the effectiveness of the heat exchanger for the cone shaped helical coil is more than that for the simple helical coil. Results show that the heat transfer rates for the cone shaped helical coil are comparatively higher than that of the simple helical coil. It was found that the heat transfer rates are 1.18 to 1.38 times more for the cone shaped helical coil than that of simple helical coil.

[9] Navneet Kumar1, Vijaykant Pandey, "CFD Analysis of Cone Shaped Coil Heat Exchanger by Using Copper Oxide Nanofluid with Ethylene Glycol and Water as Its Base Fluid in Aluminum Tube with Different Mass Flow Rate". In their study, the efforts are made to understand that how to compare the heat transfer rate in Cone shaped coiled tube heat exchanger using CuO Nano fluid with Water and Ethylene glycol as a base fluid in Cone shaped Heat Exchanger with the help of CFD on aluminium tube. Cone Shaped coil was fabricated by bending 500 mm length of aluminium tube having 10mm tube diameter, 50 mm pitch coil diameter, 25mm pitch and tapered angle 20. The comparison of pressure drop and temperature

variation between different mass flow rate with water and ethylene glycol as its base fluid in aluminium tube found in this analysis. The result indicates that the CuOnanofluid with ethylene glycol as a base fluid at 0.02m/s mass flow rate have maximum pressure drop and also have minimum temperature variation compare with other mass flow rate.

[10] H. N. Deshpande, S. Y. Bhosale, S. M. Magar, B. T. Tagad, "Comparative and numerical analysis of straight and conical coil heat exchanger". In their study, an attempt is made to change the curvature ratio continuously throughout the coil by using a conical shaped coil in order to decrease the critical Reynolds number. Numerical results of conical coil are compared with straight helical coil by using ANSYS fluent for mass flow rate through coil 0.07kg/s and 0.05 kg/s through shell. From Numerical analysis it is observed conical coil giving 8.71% more heat transfer than straight coil. The mass flow rate range through coil is taken 0.01 kg/s, 0.02 kg/s, 0.05 kg/s, 0.07 kg/s, 0.09 kg/s, 0.1 kg/s keeping mass flow rate through shell 0.05 kg/s constant also tube inlet and shell inlet temperatures maintained same 42ºC and 27ºC respectively and for same mass flow rate heat transfer rate calculated numerically.

[11] K. Palanisamy and P. C. Mukeshkumar, "Heat Transfer Enhancement and Pressure Drop Analysis of a Cone Helical Coiled Tube Heat Exchanger using MWCNT/Water Nanofluid". In their investigation, the heat transfers and pressure drop analysis of a cone helically coiled tube heat exchanger handling MWCNT(Multi Walled Carbon nanotube)/water nanofluid have been carried out experimentally. The MWCNT/water nanofluids of 0.1%, 0.3%, and 0.5% particle volume concentration have been synthesized with the addition of surfactant Sodium dodecyl benzenesulfonates by using two step method and characterized. The test runs conducted laminar flow in the Dean number range of 481 < De <2130. The thermo physical properties have been determined by using the existing mathematical models. It is found that the tube side experimental Nusselt numbers are 22%, 41% and 52% higher than water for the 0.1%,0.3% and 0.5% nanofluids volume concentration respectively. These are due to higher thermal conductivity of MWCNT nanofluid than water and better mixing of fluid and nanotube. This may also be due to very strong secondary flow formation in cone coiled tube. It is also found that the pressure drop of 0.1%, 0.3% and 0.5% were found to be 25%, 50% and 81% respectively higher than water. The increase in pressure drop is due to increase in nanofluid viscosity

while adding nanotubes. The measurement of nanofluid thermal performance factor is found to be greater than unity. It is concluded that the MWCNT nanofluid can be applied as a coolant in cone helically coiled tube heat exchanger to enhance heat transfer with considerable pressure drop.

[12] IraidaKrutova and YakovZolotonosov, "Solution of conjugate problem in a conical coil heat exchanger". The article investigates the influence of the geometric parameters of conical coil heat exchangers on their effectiveness. The object of study is a conical coil heat exchanger with different tube diameters of the inner coil (di = 13, 15, 17 mm) and various number of turns (N = 6, 10, 14). Modeling was carried out in the Ansys Fluent software package. For each combination of the parameters, data were obtained on the temperature and velocity of the coolant at the outlet. It was found that a change in the number of turns by a factor of 2.3 leads to an increase in the temperature of the heated fluid by an average of 9.7 ° C. The effect of changing the diameter of the inner coil is non-linear.

[13] Suraj R. Gurav, "Parametric Comparison of Heat Transfer in Helical and Straight Tube-In-Tube Heat Exchanger". The purpose of their work is to compare tube-in-tube helically coiled heat exchanger with a straight tube heat exchanger. In current work the fluid to fluid heat exchange is taken into consideration. The actual experimentation is carried out on tube-in-tube helical coil heat exchanger and tube-in-tube straight heat exchanger by keeping mass flow rate constant for both the fluids. The results were plotted graphically for comparison of heat transfer in both heat exchangers.

[14] Siddhartha Shankar Behera, "CFD Analysis of Heat Transfer in a Helical Coil Heat Exchanger Using Fluent". His study deals with the analysis of the helical coiled heat exchanger with various correlations given by different papers for specific conditions. Although various configurations are available, the basic and most common design consists of a series of stacked helically coiled tubes placed in a cylindrical outer cover. The inner tube ends are connected to manifolds, which act as fluid entry and exit locations. And the outer tube is also provided with inlet and outlet manifolds so that cooling fluid can be passed through it. The tube bundle is constructed of a number of tubes stacked atop each other, and the entire bundle is placed inside a helical casing, or shell. The complex fluid-dynamic inside curved pipe heat exchangers gives them important advantages over the performance of straight tubes in terms of area/volume ratio and enhancing of heat transfer and mass transfer coefficient. Convective heat transfers between a surface and the surrounding fluid in a heat exchanger has been a major issue and a topic of study for a long time.

Outcomes from Literature Survey

1) Annular fins can increase the heat transfer rate in heat exchangers.

2) Authors have focused on the efficiency improvement of the heat exchanger.

3) Cone shaped structure improves the fluid flow contact with surface.

4) There is large scope of study in case of cone shaped helical coiled heat exchangers with and without annular fins.

5) Mounting fins with specific velocity of fluid flow can give better heat transfer rate.

6) To study the effects that various inlet opening have on the flue-gas properties, a new numerical heat-transfer model was developed. The model enables three-dimensional flow and heat-transfer simulations within trisector regenerative heat exchanger.

ACKNOWLEDGEMENT

I would like to express my deep and sincere gratitude to my Guide Dr. C. B. Kothare, Department of Mechanical Engineering and Principal of Shri. ShankarprasadAgnihotri College of Engineering, Ramnagar, Bapujiwadi, Wardha, for guiding me to accomplish this project work.

III. REFERENCES

[1] BagoutdinovaAlfiyaGizzetdinovna, "Engineering Calculation and Experimental Study of a Cone-Shaped Coil Heat Exchanger". Department of General Mathematics of the Lobachevsky Institute of Mathematics and Mechanics, Kazan Federal University https://doi.org/10.29042/2020-10-5-163-173, Helix (2020) 10 (5): 163-173

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Conference:01/March-2023 Impact Factor- 7.868 www.irjmets.com
National Conference on Trending Technology for Achieving Sustainable Development Goals
NCTTASDG 2023 Organized by Shri Shankarprasad Agnihotri College of Engineering, Wardha

[2] Hitesh Khurana, RudrodipMajumdar, and Sandip K Saha, “Numerical Investigation on the Performance of the Helical and Conical Coil Heat Exchanger Configurations in the Dynamic Mode of Heat Extraction”. Department of Mechanical Engineering, Indian Institute of Technology Bombay, Mumbai- 400076, INDIA., EEP, School of Natural Sciences and Engineering, National Institute of Advanced Studies, Bengaluru-560012, INDIA

[3] Mukesh Kumar1, Professor Manojkumar Singh, “Heat Transfer Analysis of Cone Shaped Helical Coil Heat Exchanger of Different Pitches and Diameter”. International Journal of Advanced research in Science and engineering, Vol. No. 6, Issue No. 7, July 2017, www.ijarse.com

[4] YaminiPawar, AshutoshZare, Ashish Sarode, “Helically Coiled Tube with Different Geometry and Curvature Ratio on Convective Heat Transfer:A Review”. International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN: 2349-2763, Issue 10, Volume 3 (October 2016) www.ijirae.com

[5] Dr. B.Jayachandraiah, H.S.S.K.Praveen, “Heat Transfer Analysis of a Helical Coil Heat Exchanger by using CFD Analysis”. International Journal of Computational Science, Mathematics and Engineering, Volume. 3, Issue. 5, 2016, ISSN-2349-8439

[6] Umang K Patel, Prof. Krunal Patel, “CFD Analysis Helical Coil Heat Exchanger”. Vol-3 Issue-2 2017 IJARIIE-ISSN(O)-2395-4396

[7] SumedhHajare, P. N. Chaudhari, “Design and fabrication of conical helical coil heat exchanger for waste heat recovery from exhaust of diesel engine.”. International Engineering Research Journal, Special Edition PGCON-MECH-2017

[8] ShindeDigvijay D., Dange H. M., “Heat Transfer Analysis of a Cone Shaped Helical Coil Heat Exchanger”. International Journal of Innovations in Engineering and Technology (IJIET)

[9] Navneet Kumar1, Vijaykant Pandey, “CFD Analysis of Cone Shaped Coil Heat Exchanger by Using Copper Oxide Nanofluid with Ethylene Glycol and Water as Its Base Fluid in Aluminium Tube with Different Mass Flow Rate”. International Journal for Research in Applied Science & Engineering Technology (IJRASET), ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538, Volume 10 Issue X Oct 2022- Available at www.ijraset.com

[10] H. N. Deshpande, S. Y. Bhosale, S. M. Magar, B. T. Tagad, “Comparative and numerical analysis of straight and conical coil heat exchanger”. GRD Journal for Engineering, Volume 2, Issue 11, October 2017 ISSN: 2455-5703

[11] K. Palanisamy and P. C. Mukeshkumar, “Heat Transfer Enhancement and Pressure Drop Analysis of a Cone Helical Coiled Tube Heat Exchanger using MWCNT/Water Nanofluid”. Journal of Applied Fluid Mechanics, Vol. 10, Special Issue, pp. 7-13, 2017.,Selected papers from International Conference on Newer Engineering, Concepts and Technology, ICONNECT2K17, 2017, Available online at www.jafmonline.net, ISSN 1735-3572, EISSN 1735-3645., DOI: 10.36884/jafm.10.SI.28265

[12] IraidaKrutova and YakovZolotonosov, “Solution of conjugate problem in a conical coil heat exchanger”. STCCE-2020, IOP Conf. Series: Materials Science and Engineering 890 (2020) 012156, IOP Publishing, doi:10.1088/1757-899X/890/1/012156

[13] Suraj R. Gurav, “Parametric Comparison of Heat Transfer in Helical and Straight Tube-In-Tube Heat Exchanger”. International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064 Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

[14] Siddhartha Shankar Behera, “CFD Analysis of Heat Transfer in a Helical Coil Heat Exchanger Using Fluent”. A Thesis Submitted in Partial Fulfillment of The Requirements for the Degree of Bachelor in Technology in Mechanical Engineering, National Institute of Technology, Rourkela 769008

[15] “Steam Book”, 2006 The Babcock & Wilcox Company, pp.20-7.

[16] Donald Q.Kern, “Process Heat Transfer”,2004 Tata McGraw-Hill Publication, pp. 701. [16] Rodney R. Gay, “Power Plant Performance Monitoring”,2004, pp. 433.

[17] TeodorSkiepko, Ramesh K. Shah , “A comparison of rotary regenerator theory and experimental results for an air preheater for a thermal power plant”, Rochester Institute of Technology, Rochester,USA.

[18] T. Skiepko, "Effect of reduction in seal clearances on leakages in a rotary heat exchanger", Heat recovery system CHP 9 (6) (1989) 553-559.

[19] Rakesh Kumar &Sanjeev Jain , "Performance Evaluation of air pre heater at off design condition",Dept of MechEngg, IIT,New Delhi

[20] Rao, J.B.B.; and Raju, V.R. (2016). Numerical and heat transfer analysis of shell and tube heat exchanger with circular and elliptical tubes. International Journal of Mechanical and Materials Engineering, 11, 1-18. 8 | P a g e

[21] Dizaji, H.S.; Jafarmadar, S.; and Asaadi, S. (2017). Experimental exergy analysis for shell and tube heat exchanger made of corrugated shell and corrugated tube. Experimental Thermal and Fluid Science, 81, 475-481.

[22] Naidu, S.B.P.; and Kishore, P.S. (2017). Heat transfer enhancement using circumferential finned twisted tape heat exchanger. International Journal of Research - Granthaalayah, 5(9), 152-163.

[23] Pathade, P.; and Singh, A. (2017). Twisted type shell and tube heat exchangers. International Journal of Engineering Development and Research, 5(2), 296-299.

[24] Ahmed, A.; Bhattacharjee, A.; and Saha, S. (2017). Comparison of performance of shell-and-tube heat exchangers with plain and annular-finned tube bundle. Proceedings of the 1st International Conference on Mechanical Engineering and Applied Science. Dhaka, Bangladesh, 1-9.

[25] Labbadlia, O.; Laribi, B.; Chetti, B.; and Hendrick, P. (2017). Numerical study of the influence of tube arrangement on the flow distribution in the header of shell and tube heat exchangers. Applied Thermal Engineering, 126, 315-321.

[26] Shirvan, K.M.; Mamourian, M.; and Esfahani, J.A. (2018). Experimental investigation on thermal performance and economic analysis of cosine wave tube structure in a shell and tube heat exchanger. Energy Conversion and Management, 175, 86-98.

[27] Ayub, Z.H.; Yang, D.; Khan, T.S.; Al-Hajri, E.; and Ayub, A.H. (2018). Performance characteristics of a novel shell and tube heat exchanger with shell side interstitial twisted tapes for viscous fluids application. Applied Thermal Engineering, 134, 248-255.

[28] Saffarian, M.R.; Fazelpour, F.; and Sham, M. (2019). Numerical study of shell and tube heat exchanger with different cross-section tubes and combined tubes. International Journal of Energy and Environmental Engineering, 10(1), 33-46.

[29] Radojković, N.; Ilić, G.; Stevanović, Z.; Vukić, M.; Mitrović, D.; and Vučković, G. (2003). Experimental study on thermal and flow processes in shell and tube heat exchangers: Influence of baffle cut on heat exchange efficiency. Mechanical Engineering, 1(10), 1377-1384.

[30] Akpabio, E.; Oboh, I.; and Aluyor, E.O. (2009). The effect of baffles in shell and tube heat exchangers. Advanced Materials Research, 62-64, 694-699.

[31] Singh, A.; and Sehgal, S.S. (2013). Thermohydraulic analysis of shell-andtube heat exchanger with segmental baffles. ISRN Chemical Engineering, 2013, 1-5.

[32] Kirubadurai, B.; Rajasekaran, R.; Kanagaraj, K.; and Selvan, P. (2014). Heat transfer enhancement of shell and tube heat exchanger. International Journal for Research in Applied Science and Engineering Technology (IJRASET), 2, 309-318.

[33] Wen, J.; Yang, H.; Wang, S.; Xu, S.; Xue, Y.; and Tuo, H. (2015). Numerical investigation on baffle configuration improvement of the heat exchanger with helical baffles. Energy Conversion and Management, 89, 438-448.

[34] Leoni, G.P.; Klein, T.S.; and Medronho, R.D.A. (2016). Assessment with computational fluid dynamics of the effects of baffle clearances on the shell.

[35] Rana A. Hussein, Adil A. Alwin, Isam M. Abed" Experimental Investigation and Analysis of Heat Transfer Rate in Conical Tube heat Exchanger: A Novel Enhancement Approach" April 30, 2021

[36] Akash Kumar Modi, AzharulHaque , BhanuPratap, Ish Kumar Bansal , Prasoon Kumar, S. Saravanan, M. Senthil Kumar, C. Ramesh Kumar "A Review on Air Preheater Elements Design and Testing" April 30, 2021

[37] P.N. Sapkal, P.R. Baviskar, M.J. Sable, S.B. Barve. To optimise air-preheater design for better performance, new aspects of fluid mechanics, Heat Transfer and Environment.

[38] AvinashMaharaj ,Walter Schmitz, Reshendren Naidoo "A numerical study of air preheater leakage" 16 July 2015 [5] T. PIHU, H. ARRO, A. PRIKK, R. ROOTAMM, A. KONIST "Corrosion of Air Preheater Tubes of Oil Shale CFB Boiler. Part I. Dew Point of Flue Gas and Low-Temperature Corrosion" 01 Jan, 2009

[39] Waugh. Analysis on Thermal stress deformation of Rotary Air-preheater in a thermal power plant. Korean J. Chem. Eng., Vol. 26, 833-839, 2009.

[40] Wang HY, Zhao LL, Xu ZG, Chun WG, Kim HT. The study on heat transfer model of tri-sectional rotary air preheater based on the semi-analytical method. ApplTherma Eng. 2008;28:1882–8. DOI10.1016/j.applthermaleng.2007.11.023.

[41] I. Warren. Ljungstrom heat exchangers for waste heat recovery. Heat Recovery Syst. CHE 2 (3) (1982) 257-271.

[42] Heidari-Kaydan A, Hajidavalloo E. Three-dimensional simulation of rotary air preheater in steam power plant. ApplThermEng 2014;73:397–405. DOI10.1016/j.applthermaleng.2014.08.013.

[43] Chen H, Pan P, Shao H, Wang Y, Zhao Q. Corrosion and viscous ash deposition of a rotary air preheater in a coal-fired power plant. ApplThermEng 2017;113:373–85. DOI 10.1016/j.applthermaleng.2016.10.160.

[44] Rakesh Kumar, Sanjeev Jain; Performance evaluation of air-preheater at off design condition.

[45] SreedharVulloju, E.Manoj Kumar, M.Suresh Kumar, K.Krishna Reddy; Analysis of performance of Ljungstrom air preheater Elements; International Journal of current engineering and technology.

[46] G.Shruti, RavinarayanBhat, Gangadhar Sheri; Performance evaluation and optimization of air preheater in thermal power plant; International Journal of Mechanical Engineering and Technology (IJMET)