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REVIEW: ANALYSIS AND COMPARISON OF SHELL AND HELICAL COIL HEAT EXCHANGER BY USING SILICA AND ALUMINA

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ABSTRACT

The recovery of waste heat has been a topic of concern for large-scale industrial companies for several decades. This recovery not only makes an operation more environment friendly, but it also helps to cut costs. In addition to this, it can reduce the amount of resources needed to power a facility. Many industries have implemented different methods of waste heat recovery. One popular choice is using a heat exchanger. This paper presents the study of silica and alumina nanofluid in shell and helical coil heat exchanger. In this present paper the efforts are made to understand that how the nanofluid will give pressure drop in hot and cold fluid and also what was the change in reynold's number, by reading the results/ researched by various authors.

Keywords: Shell and Helical Coil, Nano-fluid, Heat Exchanger, CFD, Pressure Drop, Temperature Distribution, Reynold's number.

1. INTRODUCTION

Shell and Helical coil heat exchangers are of great use in industrial applications such as power generation, nuclear industry, process plants, heat recovery systems, refrigeration, food industry, etc due to its compact structure and high heat transfer coefficient. Helical coils of circular cross section have been used in wide variety of applications due to simplicity in manufacturing. Flow in curved tube is different from the flow in straight tube because of the presence of the centrifugal forces. These centrifugal forces generate a secondary flow, normal to the primary direction of flow with circulatory effects that increases both the friction factor and rate of heat transfer. The intensity of secondary flow developed in the tube is the function of tube diameter (d) and coil diameter (D). Due to enhanced heat transfer in shell and helical coiled configuration the study of flow and heat transfer characteristics in the curved tube is of prime importance. Developing fluid-to-fluid helical heat exchangers (fluid is present on both sides of the tube wall) requires a firm understanding of the heat transfer mechanism on both sides of the tube wall. Though much investigation has been performed on heat transfer coefficients inside coiled tubes, little work has been reported on the outside heat transfer coefficients

Heat transfer fluid is one of the serious factors as it disturbs the size and cost of heat exchanger systems. Conventional fluids like oil and water have partial heat transfer potentialities. For reduce cost and meet the increasing demand of industry and commerce we have to develop different types of fluids it is our top priority. By chance, the growths in nanotechnology make it possible to get higher efficiency and cost saving in heat transfer methods. Nanoparticles are occupied as the fresh group of materials which having potential applications in the heat transfer area.

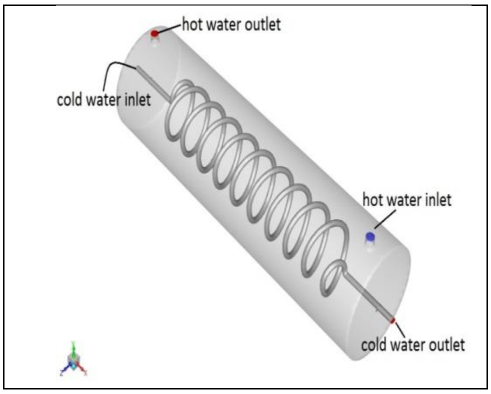

Figure 1 [12]

1.1 Nano Fluid

Nano fluid is nothing but it is a fluid particles which have less than even a micron (9-10 times) smaller in diameter and highly reactive and proficient material which can be used to increase feature like rate of reaction, thermal conductivity of any metal or material and they are that much reactive and strong.

The following benefits are expected when the nano fluid circulates the nano particles: [3]

i. Heat conduction is higher

ii. Stability
iii. Choking not occurs in Micro passage cooling
iv. Probabilities of erosion reduced
v. Pumping power is reducing

2. LITERATURE REVIEW

Shell and Helical coil is very compact in structure and it possess high heat transfer coefficient that why shell and helical coils heat exchangers are widely used. In literature it has been informed that heat transfer rate of shell and helical coil is larger than straight tube.

Lei et al. [1] accomplished a numerical investigation of numerous baffle inclination angles on fluid waft and warmth switch of non-stop helical shell and tube warmth exchangers by means of the use of periodic version. From the effects computed, it was determined that the high-quality-integrated overall performance occurs approximately 45° helix attitude overall performance of heat exchanger also depends on pressure drop. Leakage can reduce pressure drop and therefore in line with compartment average heat transfer coefficient.

R. Patil et.al. [2] suggested design methodology for helical coil heat exchanger. heat transfer coefficient based on the inside coil diameter hi, is obtained using method for a straight tube either one of Sieder –Tate relationships or plot of the Colburn factor ,JH vs Re. outside heat transfer coefficient is calculated using correlation for different range of Reynolds number. Helical coil heat exchanger is the better choice where space is limited and under the conditions of low flow rates or laminar flow.

N. Ghorbani et.al. [3] conducted experimental study of thermal performance shell and coil heat exchanger in the purpose of this article is to access the influence of tube diameter , coil pitch , shell side and tube side mass flow rate on the modified effectiveness and performance coefficient of vertical helical coiled tube heat exchanger. The calculation has been performed for the steady state and the experiment was conducted for both laminar and turbulent flow inside coil. It was found that the mass flow rate of tube side to shell ratio was effective on the axial temperature profiles of heat exchanger. He concluded that with increasing mass flow rate ratio the logarithmic mean temperature difference was decreased and the modified effective's decreases with increasing mass flow rate.

K. Abdul Hamid et. al. [4] has done work on pressure drop for Ethylene Glycol (EG) based nanofluid. The nanofluid is prepared by dilution technique of TiO_2 in based fluid of mixture water and EG in volume ratio of 60:40, at three volume concentrations of 0.5 %, 1.0 % and 1.5 %. The experiment was conducted under a flow loop with a horizontal tube test section at various values of flow rate for the range of Reynolds number less than 30,000. The experimental result of TiO_2 nanofluid pressure drop is compared with the Blasius equation for based fluid. It was observed that pressure drop increase with increasing of nanofluid volume concentration and decrease with increasing of nanofluid temperature insignificantly. He found that TiO_2 is not significantly increased compare to EG fluid. The working temperature of nanofluid will reduce the pressure drop due to the decreasing in nanofluid viscosity.

Saket A Patel et.al. [5] done CFD analysis of heat transfer enhancement in helical coil heat exchanger by varying helix angle. His attempts are made to enhance the overall heat transfer coefficient in HCHE by varying helix angle. Hot water flows in helical coil and cold water flows in shell side. Three different angles are analysing for that. Optimum helix angle is found out by CFD analysis. Results indicate that at 20 helix angle gives maximum overall heat transfer coefficient about 33% increases compared to 0^0 angle.

Jyachandraiah et.al.[6] focus his work on CFD analysis of HCHE by varying different volume flow rates at coil side with constant flow rate at shell side. various flow rate values are 40, 60, 80, 100 and 140 LPH. Result shows that dean number increase in coil side flow rate and the overall heat transfer coefficient increase with increase in flow rate at coil side. The greater effectiveness of 0.80 was obtained at 40 LPH.

Kannaadasan et.al.[7] compare Heat transfer and pressure drop in horizontal and vertical position was experimentally. In the experiment CuO/water based nanofluids used. The graph shows that value of friction factor decreases with increase in dean number. Finally, he concludes that heat transfer enhancement is more in vertical position than in horizontal one.

3. PROBLEM FORMULATION

There is less work has been done on heat transfer rate of shell and helical coil heat exchanger. In my work I am trying to showing the CFD analysis of Fe_2O_3 Nanofluid with water as its base fluid for hot and cold fluid in shell and helical coil heat exchanger by keeping in mind that Nano fluid should produce maximum heat transfer rate with minimum power consummation. Because some times in the process of improving the heat transfer coefficient we consume more power without knowing the economic cost. Consider a 3D design of CAD model of helical coil of tube outer diameter (d_o) 16 mm, inner diameter of helical coil (d_i) 12 mm, pitch of 26.3mm, pitch coil dia. 86 mm, tube length of 235 mm, shell diameter is 110 mm and shell length is 215 mm, is generated by using ANSYS fluent 18.2.In my research I am using Fe_2O_3 Nano fluid with water as its base fluid.

4. CONCLUSION

The different boundary conditions are taken for shell and helical coil heat exchanger for the numerical simulations. The numerical study considers the effect of Nano fluid alumina and silica and water as its base fluid on the flow and heat transfer characteristics of tube. The thermal properties of fluid are lesser as compared to Nano fluid. We will made a shell and helical coil in which, helical coil of tube outer diameter (d_o) 16 mm, inner diameter of helical coil (d_i) 12 mm, pitch of 26.3mm, pitch coil dia. 86 mm, tube length of 235 mm, shell diameter is 110 mm and shell length is 215 mm, is generated by using ANSYS fluent.

References

1. Y.G. Lei, Y.L. He, R. Li, Y.F. Gao, Effects of baffle inclination angle on flow and heat transfer of a heat exchanger with helical baffles, Chem. Eng. Process. 47 (12) (2008) 2336–2345.
2. R.K. Patil, R.W. Shende and P.K. Ghosh, "Designing a helical- coil heat exchanger," Chemical Engineering, pages 85-88, 1982.
3. N. Ghorbani, H. Taherian, M. Gorji and H. Mirgolbabaei , "Experimental study of mixed convection heat transfer in vertical helically coiled tube heat exchangers," Experimental Thermal and Fluid Science, volume 34, issue 7, Pages 900-905, oct 2010
4. K. Abdul Hamid, W. H. Azmi, RIzalman Mamat, N. A. Usri and Gohalamhassan Najafi 2015, "Effect of Titanium Oxide Nanofluid Concentration on Pressure drop" ARPN Journal of Engineering and Applied Sciences, Volume 10, Page 7815-7820.
5. Hemasunder Banka, Dr. V. Vikram Reddy, M. Radhika 2016, "CFD Analysis of Shell and Tube Heat Exchanger using Titanium Carbide, Titanium Nitride and Zinc Oxide Nanofluid" International Journal of Innovations in Engineering and Technology, Special Issue, Page 315-322. Vidula Vishnu Suryawanshi, Nikhil Ghodake, Onkar Patil, Sham Lomate, Shital.G.Nerkar, 2021, "Design and analysis of Helical coil Heat Exchanger", International Journal of Engineering Research in Mechanical and Civil Engineering volume 6 Issue 8.
6. Vishal Momale, Aditya Wankhade , Prajakta Kachare, 2019, " Performance analysis of conical helical tube heat exchanger with straight and conical shell using cfd", Journal of Emerging Technologies and Innovative Research, Volume 6, Issue 1.
7. M. Balachandaran 2015, "Experimental and CFD study of a Helical Coil Heat Exchanger using Water as Fluid" International Journal of Mechanical and Production Engineering, Volume 3, Page 87-91.
8. Ashkan Alimoradi, 2017, "Investigation of exergy efficiency in shell and helically coiled tube heat exchangers" Elsevier 2017 Page 1-8.
9. B. Chinna Ankanna, B. Sidda Reddy 2014, "Performance Analysis of Fabricated Helical Coil Heat Exchanger", International Journal of Engineering & Research, Volume 3, Page 33-39.
10. Karishma Jawalkar, Vijaykant Pandey, Poonam Wankhede 2018, "Comparison onComputational Fluid Dynamics Analysis of Zinc Oxide, Silicon Dioxide and Magnesium Oxide Nano-fluid using Oil as base fluid in Helical Coil Heat Exchanger", International Journal of Innovative Research in Science, Engineering & Technology, Volume 7, ,Page 2777-2786.
11. K. Palanisamy, P.C. Mukesh Kumar 2019, "Experimental investigation on convective heat transfer and pressure drop of cone helically coiled tube heat exchanger using carbon nanotubes/ water nanofluids", Elsevier – Heliyon 5.
12. T. Srinivas, A. Venu Vinod 2015, "Heat Transfer Enhancement using CuO/Water Nanofluid in a Shell and Helical Coil Heat Exchanger" Elsevier, Volume 127, Page 1271-1277.
13. Vinita Sisodiya, Dr. Ankur Geete 2016 "Heat Transfer analysis of Helical coil Heat Exchanger with Al_2O_3 Nanofluid" International Journal of Engineering and Technology, Volume 3, Page 366-370.
14. https://www.researchgate.net/figure/Physical-dimensions-of-tube-in-tube-helical-heat-exchanger_fig3_287510007http://engglearning.blogspot.in/2011/03/helical-spring.html
15. Sarit Kumar Das, Stephen U. S. Choi, Hrishikesh E Patel 2006, "Heat Transfer in Nano fluids -A Review" Heat Transfer Engineering, Volume 27.
16. Ram Kishn, Devendra Singh, 2020,"CFD Analysis of Heat Exchanger model using ansys fluent", International Journal of Mechanical Engineering & Technology, Volume 11 Issue 2, Page1-9.
17. Jaafar Albadr, Satinder Tayal, Mushtaq Alasadi 2013 ―Heat transfer through heat exchanger using Al_2O_3 nanofluid at different concentrations‖ Elsevier, Volume-1, Page 38-44.
18. Yamini Pawar, Ashutosh Zare, Ashish Sarode 2016, "Helically Coiled Tube with Different Geometry and

Curvature Ratio on Convective Heat Transfer: A Review" International Journal of Innovative Research in Advanced Engineering, Volume-3, Page 19-23.

19. Kevin Kunnassery, Rishabh Singh, Sameer Jackeray 2017 "Experimental analysis of helical coil heat exchanger by using different compositions of nano fluids" International Journal of Innovative and Emerging Research in Engineering, Volume-4, Page 219-229.
20. Onkar Lathkar, Dr P.J. Bansod 2019, "CFD Analysis of Heat Transfer Enhancement in Heat Exchanger using Nanofuids", International Research Journal of Engineering and Technology, Volume-6, Page 4478-4482.
21. Fakoor-Pakdaman, M.A. Akhavan- Behabadi,P. Razi 2013, "An empirical study on the pressure drop characteristics of Nanofluid flow inside helically coiled tubes" International Journal of Thermal Sciences, Volume 65, Page 206-213.