ISSN: 2583-3286(Online)

IPEC Journal of Science & Technology
Vol. 01 (01), Feb. 2022, pp. 21-25

Performance Analysis of Shell and Tube Heat Exchangers Using Al_2 O_3 Nano-Fluid A Review

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Accepted on 21 February 2022

Abstract: Nano fluid has more application due to its effective thermo-physical properties. Thermal aspect of STHE could be enhancement by applying Nano fluid. In this analysis we have to consider the different parameters like effectiveness, flow rate, heat transfer by using a nano fluid. MATLAB programming was apply to calculate the STHE performance. The present paper try to find out the effect aspect of process parameter like diameter , length of tube and drop of pressure in shell side for different configuration like triangular & square pitches. Heat transfer coefficient & drop of pressure is also determined by changing the spacing of baffle. Nano fluid has better thermal characteristic than other fluids. Under several different flows through STHE, the HTC was calculated by applying Nano fluid. For various discharge of Nano fluid through STHE with volume fraction of water and Al_2 O_3 with 0.02%,0.04%,0.06% and 0.08% are considered to calculate the HTC.

***Keywords* — Nano fluid, Shell and tube Heat Exchangers, Heat transfer rate**

I. INTRODUCTION

Heat exchanger is a devices in which heat transfer take place at various temperature of different type of fluid. STHE are used with different shape in the industrial application. On every day, the requirement of energy is gradually increased. Due to population growth, modern life, industrial application, much of cost is invested for energy utilization. With increase of energy consumption, more greenhouse gases emission has been takes place therefore serious issues like environmental pollution will occurs for all counties. Most of the researchers has said that it is very necessary to save the energy for survival of modern life. Energy saving is also achieved by Nano fluid for function of industrial device including mention heat exchanger Process diagram of STHE is as shown in Fig. 1.

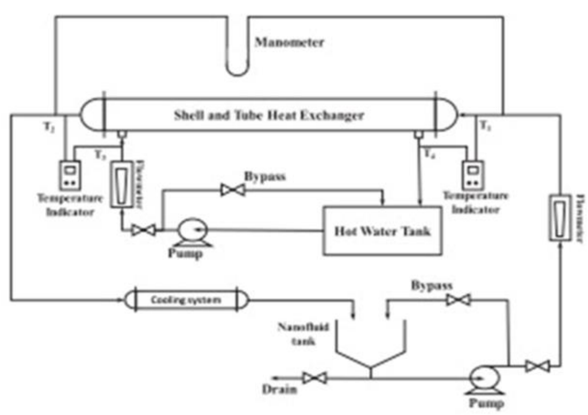

Figure 1 Shell and tube heat exchanger

II. LITERATURE REVIEW

D. Raghulnath, et. Al (2021) has evaluated the effect analysis of different parameter like non dimensional number (Reynolds number, Nusselt number), HTC, temperature and pressure variation throughout the length on effectiveness of STHE. For design aspect of heat exchanger, process parameters are optimized. For improving heat transfer, helical coil are used which crate more turbulence during the fluid flow. Turbulators may be apply in annular space to create more turbulence of fluid flow. In present work, after using circumferential turbulators, HTR is improved. For various value of dischare, the temperature variation distribution is plotted throughout the length of STHE. Effectiveness of STHE will improved when discharge rate of hot fluid is higher than cold fluid[1]. F. Ceglia et. Al (2021) discussed thermoelectric application area with high temperature sources, geothermal energy is widely used. In general. Organic Rankine cycles technology is implement for power production by using geothermal sources. Power generation by power plant can be enhanced by applying either low or medium enthalpy geothermal sources. In power generation process, The pentration cost is expensive and more corrosion occurs in different expensive component so that high corrosion resistant material are apply for cost analysis of power generation. The smart cheaper material was used for exchanging heat between fluid and geothermal brine for

Date of Submission: 05 Jan 2022
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Published online : 25 February 2022

heat exchanger. Author used the polymer evaporator in Organic based Rankine Cycle system. Due to application of polymer based evaporator, the corrosion problem will be minimized for geothermal fluid. The capacity of Organic based Rankine Cycle is 10 KW. The given analysis have conducted by considering four working fluid and three polymer material used in evaporator. In this analysis, the various layout of STHE used in power production unit is constructed. The author had design the organic based system to analyses the cost aspect of STHE. Result indicate that if the fluid is taken through the tube, then more better result had been obtained. For cost saving upto 70% , it is beneficial to select the Nano fluid, ORC system and polymer evaporator for same time duration of life cycle.[2]. M.Ravikumar et al (2021) has determined the STHE effectiveness by knowing its performance. Effectiveness of STHE depend on area of tube, coefficient of heat transfer and temperature of different fluid. HTR is also depends upon temperature of entity and the atmosphere. Three cases are considered to analyze the STHE performance. In present study , a base model (without fins) and two different profiles of fins added to hot fluid pipe. It is common to enhance the HTR by using the fins to the entity with reference to increasing the HTC. The same projected area of fins is attached to hot fluid side to find heat transfer. When profile of fins is changed than different HTR was obtained. The author achieved the optimum profile of fin with suitable orientation to obtain best heat exchanger effectiveness. [3]. Babak Masoumpour, et. al (2021) was observed the performance aspect of heat exchanger, when inlet steam is mixed with steam return from outlet. Such type of mixing of stream is considered during working of heat exchanger. Focus of author is to determination of HTE and cost calculation yearly. Result show that optimum value of HTE is achieved by recovery of discharge rate. For improving the result, at different value of discharge rate, the effect on recovery of discharge rate on tube side is considered [4]. **Mohammad Fares, et. al (2020)** had calculated the HTR for vertical heat exchanger after

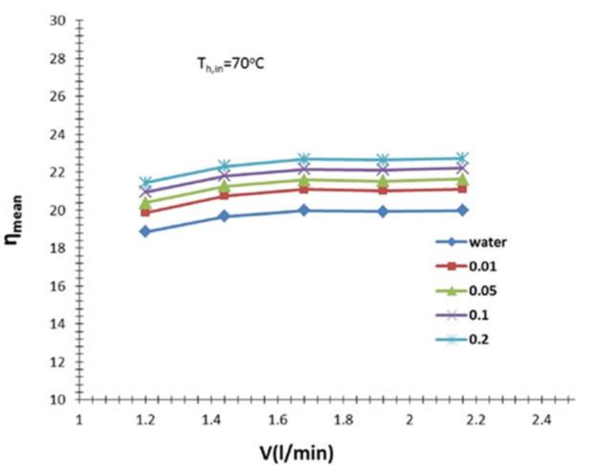

Figure 2 Mean thermal efficiency

implementing graphene nano fluid. In general, Graphene nanofluid is obtain from sugar in the graphite foam. For improving HTR through heat exchanger, the nanofluid(graphene) had been apply on heat exchanger across tube side. As the result, the performance in term of effectiveness have enhanced on using grahene nanofluid or water nano fluid. When 0.2% graphene nanofluid is used then 29% more HTR will achieved. When Graphene nanofluid was used, then HTE is increased by 13.7%. Therefore the author concluded that HTR through heat exchanger will increases after increasing the discharge of grapheme nanofluid[5]**.**

H.Panahi, et al (2020) investigates the failure condition of STHE by using material in tube sheet. During the observation, the author selects LPG treatment plant. In general, A516 carbon grade is apply for manufacturing of tube sheet. And this tube sheet is cladded with 304 grade stainless steel on inner surface for reduce the corrosion. Stainless steel (Austenitic phase) is used for manufacture tube sheet of STHE. The tube of STHE has been failure after the operation of six years due to increase in internal pressure .After the failure, leakage of gas will be take place. Corrosion formed on the gap between both surfaces of tube sheet. Therefore primary reason of failure is cracking and corrosion. A various methods is used for reduce the failure. One of the method, which discussed by author to minimized the failure condition was Mitigation strategies. [6]. Zekun Yang, et al (2020) had discussed a various method to improve performance aspect of heat exchanger(STHE).. One of methods discussed by author is Heat transfer transmission (HTT). For designing and performance aspect STHE, optimization methodology is discussed. Author also discussed the GDP model. STHE design was done by GDP model. This optimization technique is based on non-linear programming. This mention optimization technique involved the 12 parameter like four tube-side techniques, three shell side techniques and remaining discrete decisions techniques. Total cost is minimize by applying the GDP model technique. Both BARON and DICOPT problem solver are used to test the performance aspect of heat exchanger(shell and tube). Result analysis for performance checking of STHE, BARON and DICOPT is more advantages with reference to conventional method[7]. Hao-Zhe Jin, et al(2020) had studies the heat exchanger(shell and tube) in petrochemical industry. Author also studies waste material in hydro-generation reaction of petrochemical industry. In different phases of gas and water, the corrosive phenomenon is also analyses. Aspen software is utilized for simulate the hydro processing reactor for liquid waste. The corrosion is main factor for risk determination of heat exchanger. During analysis, ammonium salt crystal is able to say for corrosion. For finding HTR through STHE, Dynamic mathematical model is used. Design aspect of STHE is mainly determined by proportional integral derivative (PID) system for temperature control. Fuzzy logic is implementing for design parameter for PID. Exit temperature of STHE can be control by MATLAB simulation[8]. Mohammad hojjat (2020) had used artificial neural network to calculate effectiveness of STHE. In STHE, Newtonian Nano fluid is act as a coolent. Thermal characteristic of newtonian fluid is predicted by ANN software. Thermal conductivity properties and nano particle concentration is taken to input parameter for ANN method. For higher accuracy of processes measurement , non dimensional number like Reynolds number and prandtl is also taken ato input of ANN method. In this method , the special importance on minimizing nusselt number & drop of pressure due to nano fluid application is consider. The main parameter on STHE performance is depend upon volume proportion of nano fluid and Reynolds number. Result analysis show that

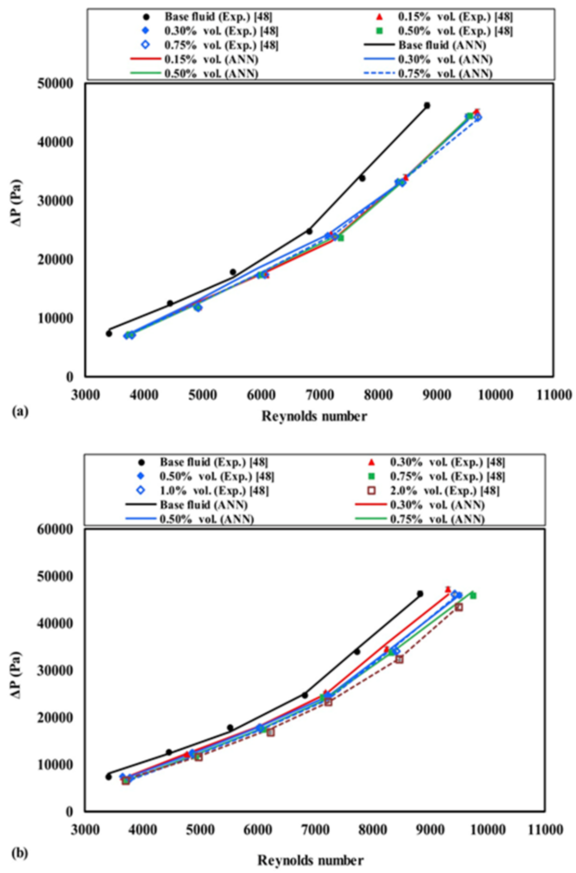

Figure 3 Pressre drop of nanofluid vs Reynolds number (a) Tio_2 (b) Al_2o_3

when the nano fluid is apply , then pressure drop by 10 percentage and nusselt number is increase by 30 percentage[9]

Jean Li , et al(2019) had describe the Rankine cycle system in which STHE is implement. Due to flow of organic fluid on either side of tube , the energy loss will be decrease. Therefore thermo physical performance had been improved. Influence degree implemented by STHE kept in form type for thermo-physical parameter of RC system is same. Author analyzed a construction of STHE form. The arrangement of HE form also influenced the various properties of different parameter which is used in RC system. The author studies three different type of arrangement form of HE. During the analysis, five different fluids are considered and fluid hydrocarbon based. The working temperature of fluid lies between 100 to 200 °C. Running cost of RC system is affected by arrangement of HE. Almost 15% of investment cost had been decreased by using the different arrangement of HE forms. The parameter which is optimized for improving the RC system are mainly depends upon source and fluid temperature. This study emphasis the economical heat exchanger position for different hydrocarbons at source temperatures of 100 to 200 °C[10]. S. Anitha , et. al (2019) had analysed the single pass STHE. During the analysis, nano particle (Al2O3) had been consider. In this analysis 31 proportion of Al2O3 is considered for knowing the STHE performance. During the flow of Nano fluid through tube of heat exchanger, 32 Multiphase mixture model was consider. In this analysis , finite volume method was consider .3-D equations and 33 constrain is used for FVM. The result is also validated by stand data of journal. After considering concentration of nano(Al2O3)fluid, better result had been achieved. Nano fluid concentration depends upon Nusselt number(NN) and HTC. When Nusselt number had been increased at certain value of Reynolds number, then number of transfer unit is also increase. Therefore STHE performance increases. For hybrid nanofluid application, the overall effectiveness of HE has been improved. So it is benefical to use nano fluid for industrial application. In many industry, Al2O3-Cu/water system had been apply for better result. The author emphasis on using the hybrid type nano fluid application. In this analysis, unsteady three-dimensional nano fluid flow is consider.it is consider that the discharge of hybrid type nano fluid through the tube of HE is incompressible. When the hybrid type nanofluid is flow through, it is assume that there is no slip across surface of HE tube. At flowing condition of fluid through the tube of HE, the author considers the adiabatic process across the surface. The experiment is performed by changing the proportion of Al2O3. This experimental investigation indicate that the utility of nanofluids in STHE increases the performance. On changing the nano fluid concentration from 1 to 20 % , the thermo physical like thermal conductivity properties and heat transfer had been improved[11]. Ammar Ali Abd, et. al (2018) was analyzed Performance aspect of STHE. In this paper , the author consider HTC & shell diameter effect on performance aspect of heat exchanger. When baffle space is increased by 0.2 , then HTR is deceased by 15 % . When pressure is decreased by 41% then the baffle space is increased by 0.2. When cutting space had been increased then pressure and HT will be decreased. Pressure will by decreased by 26 % , when cutting space will be increased by 10 %. HTR is also

Published online : 25 February 2022

decreased by 5.5 % , when space cutting has been decreased by 10 %. With increase with tube length, HTC will increase and pressure will be drop. After Increasing length of tube by 0.61 m then the HTC will increased by 32 % and pressure drop by 14 % for tube side. On shell side of heat exchanger, when tube length will increased by 0.61 m , then HTC is increase by 2.2% and 22% increase in pressure . The important parameter for maintaining the pressure and

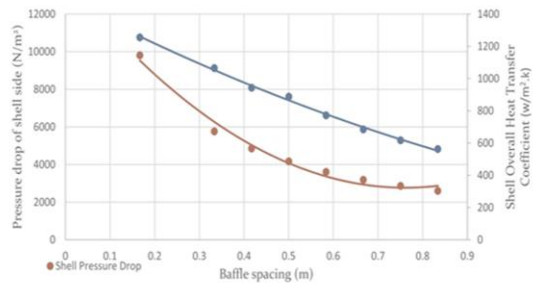

Figure 5 Baffle spacing against shell heat transfer coefficient and shell pressure drop

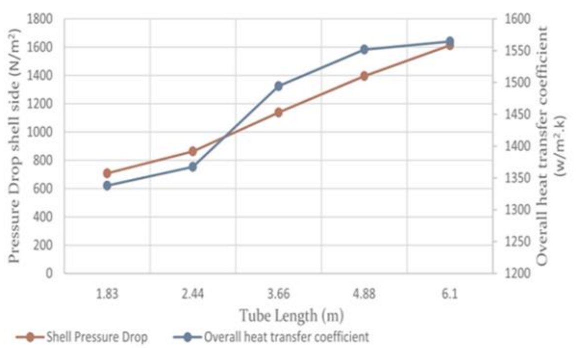

Figure 4 Tube length against heat transfer coefficient and pressure drop for shell drop

HTC is to change the tube length. For simulating the variation of length of tube on basis of HT and pressure drop, the tube length had been taken as 1.82 m, 2.42 m, 3.65 m , 4.84 m and 6.1 m respectively on both side of tube [12].

K.Somasekhar, et. al (2016) was analyzed the STHE by CATIA software. The author also investigates the multi pass tube effect on performance of STHE. CATIA is used to modeling of three tube STHE. Meshing of similar type of parameter is done by ICEM CFD software. The pressure & HTR had been calculated for both nano fluid(Al2O3-water) and water (distilled) by using CFD software for turbulent type of flow. In general there is requirement of cooling medium. During the operation of STHE, Nanofluid (Al2O3-water) is apply as cooling purpose . After the observation, the result is compared with CFD simulated. In this analysis, HTR is determined by considering non-dimensional number effect like Peclet number and volume of Al2O3 nanoparticles content. During the observation, the author observed that Al2O3 nanofluid is effective medium w.r.t Distilled water. Drop of pressure will more increased when Al2O3 nanofluid is used [13].

Nishant Kumar, et. al (2016) had investigate HTC of Fe2O3/water and Fe2O3/EG nanofluids on determining the performance of STHE under different condition of flow(laminar / turbulent flow). After varying concentration of ethylene glycol-based Fe2O3 nanofluid , the flow rate was measured. When nanoparticles is mixed with main fluid and this mixure of fluid is apply as a working fluid, then heat transfer charactestice and thermal conductivity will increased. This improvement in thermal properties is take place due to increase of nano- particles concentration & temperature of fluids. when concentration of nano fluid particles increased, then there is increase in thermal conductivity and HTR due to much involvement particles. Therefore with increase in temperature, thermal conductivity is also increased. For turbulent flow, there is significant decrease in pressure when nano fluid is used. But pressure is not changed for laminar flow.[14]. I.M. Shahrul , et. al (2016) was analyzed performance of STHE by applying Al2O3–W, SiO2–W, and ZnO–W nanofluid. When ZnO–W nanofluid is used, then POHE will increased by 10 %. After using the 0.3 vol of ZnO–W, then thermal performance of STHE will improved by 35 %. Author observed that with use of SiO2–W nanofluid , the less performance will improved. So author suggest that after using ZnO–W fluid particle, the POHE will more improved[15].

III. CONCLUSIONS

The empirical analysis of multifaceted data with the help of correlation tests contemplates it with vagueness, emphasizing the application of more broadly applicable and robust statistical techniques. It is supported by the fact that the non-linear rank correlation tests conducted for temperature/humidity and COVID-19 cases considering five Indian regions for four different time durations had come out with different results. These differences may be attributed to the fact that the other factors in coherence with the climatic factors are also to be considered responsible for the transmission of the disease. It is therefore concluded that the results of the rank correlation tests seem to be inadequate for deriving any conclusion for the effect of temperature or humidity on the transmission of the COVID-19 disease.

For more accurate results, the authors therefore suggest the application of other more suitable statistical methods such as regression analysis - a procedure equipped with the inclusion of many factors at a time in order to attain a more reliable, decisive and worthwhile conclusion.

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Published online : 25 February 2022