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REVIEW ON SHELL AND TUBE HEAT EXCHANGER USING NANOFLUIDS

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ABSTRACT

Different types of heat exchangers are extensively used in various industries to transfer the heat between cold and hot fluids. The key role of the heat exchanger is to transfer heat at maximum rate .Shell and Tube heat exchangers are having special importance in boilers, oil coolers, condensers, pre-heaters. Shell and Tube heat exchanger is one such heat exchanger, provides more area for heat transfer between two fluids in comparison with other type of heat exchanger. To intensify heat transfer with minimum pumping power innovative heat transfer fluids called Nano fluids have become the major area of research now a days. This Review paper summarizes the important articles published on the effect of the heat transfer characteristics in shell and tube heat exchangers using Nano fluids. The review of previous works by researchers suggests that Nano fluids have great potential in augmentation of heat transfer of a heat exchanger. Nano fluid is advanced heat transfer fluid for next generation.

KEYWORDS: Shell and Tube heat exchanger, Nano fluids, Heat transfer

INTRODUCTION

Heat exchanger is a device which transfers heat from hot fluid to cold fluid. Heat exchangers facilitate the exchange of heat between the fluids that are different temperature while keeping them from mixing with each other. Heat exchangers find widespread use in power generation, chemical processing, electronics cooling, air-conditioning, refrigeration, and automotive applications. There are different types of heat exchangers with different designs, materials and have been customized to meet specific needs. Out of this Shell and Tube heat exchanger without doubt, one of the most widely used heat exchanger. The robustness and medium weighted shape of Shell and Tube heat exchangers make them well suited for high pressure operations. A Nano fluid is a fluid contain nanometer size metal particle, called nanoparticles. These fluids are engineering colloidal suspension of nanoparticle in base fluid. Nanoparticle used in Nano fluids are typically made of metals, oxides, carbides or carbon Nano tube. Common base fluids include water, ethylene glycol and oil. They exhibit high thermal conductivity and convective heat transfer coefficient compared to the base fluid. Nano fluid is used as a cold fluid in heat exchanger which considered as a three phase fluid i.e. solid phase (nanoparticles), liquid phase (base fluid), and interfacial phase therefore it increases the rate of heat transfer and efficiency of heat exchanger as well. In many field like Automobiles, boilers, cooling towers, and cogeneration systems use of Nano fluid has become one of the emerging topics discussed due to its favorable characteristics in thermal and electrical conductivity. Nano fluids are supplied by two methods called the one-step and two-step methods. One step technique, the first step is production of nanoparticle and second step is the dispersion of the nanoparticle in a base fluid. Second technique is a mass production method of Nano fluids by utilizing the inert gas condensation technique. The main disadvantage of two step method is form cluster during preparation of Nanoparticle. Nano fluid can be used to cool automobile engine and welding equipment and cool high heat flux device such as high power microwave tube, and high power laser diode array. Nano fluid could flow through the tiny passage in MEMS to improve the efficiency.

LITERATURE REVIEW

S.G.h. Etemad,B.Farajollahi[1] "Heat Transfer of Nano-fluid in a shell and tube heat exchanger "The objective of this paper is An experimental system was designed and constructed to investigate heat transfer behavior of γ-

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Al_2O_3 Nano-fluid in a shell and tube heat exchanger. Heat transfer characteristics were measured under the turbulent flow condition. The experiments were done for wide ranges of Peclet numbers, and volume concentrations of suspended nanoparticles. Based on the results, the heat transfer characteristics of nanofluids improve with Peclet number significantly. Addition of nanoparticles to the base fluid causes the significant enhancement of heat transfer characteristics and results in larger heat transfer coefficient than that of the base fluid at the same Peclet number. The nanofluid has an optimum volume concentration in which the heat transfer characteristics show the maximum enhancement.

Albadr et al. [2] experimentally studied horizontal shell and tube heat exchanger for forced convective heat transfer and flow characteristics of a counter flow under turbulent flow conditions for water as base fluid and different volume concentrations of Al_2O_3 nanofluid. They found that nanoparticles dissolved in distilled water not only increases thermal conductivity but also viscosity of the nanofluid. Friction factor increases with the increase in volume concentration of nanoparticle. Particle volume concentration of 2% the use of Aluminum oxide nanofluid gives significantly higher heat transfer characteristics

V.SanthoshCibi, et al., [3] studied on Convective of heat transfer increment with graphite nanofluids by the use of Shell and tube heat exchanger. They mainly focus during their research study the graphite nanofluids performed great in Shell and tube heat exchanger for laminar. They used Graphite nanopowders for the experimentation and stirrer with the base water by varying its concentration in the range of 0.025, 0.05, and 0.075 (in percent) by volume. During the experimentation they observed that when the concentration of the graphite was rises with different concentrations, the heat-transfer-co-efficient rises gradually with the concentrations. They also concluded that the performance of graphite on K value of nanofluids was much best than heat transfer-coefficient of nanofluids, and also with graphite rise concentration and flow performance of the coldest fluid.

B.Kirubadurai,and K.Ramesh, [4] they did the research on heat-transfer behavior of Shell-Tube heat Exchanger Using Silicon Nitride- Water Nano Fluid. They did the work on new nanofluid system which they emerge by silicon nitride to synthesize Nano fluid for shell-tube heat exchanger. During the study the results show that the nanofluid provides proper thermal property. They also concluded that the most of these parameter of heat-transfer was not taken for study in past time, hence they performed on it and it require the simultaneously study of nanofluid for heat transfer provide valuable information for the optimization of heat-transfer improvement. And they find the efficiency raises up to eleven percent with nano-particle with water.

Khoddamrezaee et al. [5] investigated heat transfer characteristics of an Al2O3/ethylene glycol nanofluid and ethylene glycol fluid in a cross rectangular arrangement of tubes in a shell and tubes heat exchanger. The variables like stagnation point, separation point, heat transfer coefficient and shear stress for nanofluid and pure fluid were determined and compared. From the results it is found that by using of nanofluids, the stagnation and separation points of flow were delayed and the heat transfer coefficient and shear stress increased.

L.B. Mapa et al.[6] Measured enhanced thermal conductivity of Cu-water Nano fluid using shell and tube heat exchanger. Where the dimension of heat exchanger is 240x24x0.25mm, using 37 tubes. The outcome of this analysis is rate of heat transfer is increases with increasing flow rate and also its concentration. By nanoparticle dispersed into de-ionized base fluid a better enhancement is achieved.

Arun KumarTiwari[7] "Thermal Performance of Shell and Tube Heat Exchanger using Nano fluids "in this paper, an attempt is made to experimentally investigate the thermal performance of a shell and tube heat exchanger using nanofluids. The cold water based nanofluids flow in tube side and water as hot fluid flows on shell side. Use of nanoparticles in water based nanofluid as coolant in shell and tube heat exchanger improves the effectiveness by a considerable amount, while the convective and overall heat transfer coefficient increases even further with the addition of 3% Al_2O_3 nanoparticles in water based fluid.

Lotfi et al.[8] conducted an experimental investigation on heat transfer enhancement of multi-walled carbon nanotube (MWNT)/water nanofluid) in a horizontal shell and tube heat exchanger. The test section of the heat exchanger has 14 tubes with 7mm inside diameter and lenght580mm. The coolant flows in shell with 101mm diameter. The carbon Nanotubes were prepared by the use of catalytic chemical vapor deposition (CCVD) method over Co–Mo/Mg On a catalyst. From the results it is seen that the presence of multi-walled Nanotubes enhanced the heat transfer rate the heat exchanger.

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R. M. Arunachalam and S. Suresh M. Raja, [9] studied heat transfer character of Alumina/water nanofluid in a shell and tube heat exchanger with the aid of coil insert. They studied behavior of Peclet no, or Alumina/water nanofluid concentration on the heat transfer and pumping power. The concentration was taken as 0.5, 1 and 1.5 (in percent) was prepared and made solution with base water. An increase in the volume concentration of the nanoparticles in the base fluid caused a significant improvement in the all over heat transfer coefficient compared with water, they used wire coil insert raises the all over heat-transfer-coefficient for the give Peclet number and it was raised by 12.6, 20 25 (all in percent) for Alumina/water nanofluid when the percentage of volume concentrations was 0.5, 1, 1.5 at Pe of three thousand, compared to those of distilled water. There was similar rise of thirteen percent in the pumping work for wire coil insert, when compared to that of the pumping power find with distilled water

Ramesh R, Dr.R.Vivekananthan [10] "Application of Al_2O_3 Nanofluid for Enhance Heat Transfer Rate in Shell and Tube Heat Exchanger" This project is to enhance the heat transfer rate of shell and tube heat exchanger in temperature process station by using Al_2O_3 nanofluid and Ethylene glycol. Al_2O_3 and copper nanoparticles are found to have good thermal conductivity for the heat transfer in shell and tube heat exchanger in Temperature process station. The presence of nanoparticles changes the flow structure so that besides of thermal conductivity increment in a temperature process station of heat exchanger. Al_2O_3 has been mixed with water as a base fluid to increase the heat transfer rate. The experimental and numerical investigation has to be performed and the results have been compared to validate the performance of the heat exchanger.

Leong et al. [11] investigated the application of nanofluids as working fluids for a biomass heating plant with shell and tube heat recovery exchangers. The results showed that the overall and convective heat transfer coefficient increased with the application of nanofluids compared to ethylene glycol or water based fluids.

Vinodkumar, Kiran Voonna, T.K.Tharakeshwar [12] "Improvement of Heat Transfer Coefficients in a Shell and Helical Tube Heat Exchanger Using Water/$A_{l2}O_3$ Nanofluid"In this research paper improving heat transfer in helical tube heat exchanger is studied, experimented and analyzed by many research peoples, it's because the fluid passing through the helical tube offers certain better advantages then straight tubes. in this paper we are concentrating on improving shell side heat transfer coefficients and net heat transfer in given experimented model, without much pressure loss is our main aim of project. So we are referring some journals for correlations of Al_2O_3 nanofluids properties and designing the model in ANSYS WORKBENCH 15 then it is meshed and solved in STARCCM+ solver for various concentrations of nanofluids. The hot fluid passes through the helical coil and cold fluid passes through the shell in a counter flow manner, water is used as a base fluid in both cases. The copper is chosen as a material of tube, whereas the physics monitoring equations like mass momentum and energy are solved using turbulence of k-e two equation models. The results of temperatures are validated for experimented values that are referred and heat transfer values are plotted.

CONCLUSION

In this paper investigation of different researchers from previous work on heat transfer enhancement of Shell and Tube heat exchangers by using different nanofluid has been reviewed. The heat transfer enhancement capability of nanofluids makes them suitable in heat exchangers an interesting option, which leads better system performance and the resulting advantage in energy efficiency. Heat transfer rate increases with increasing concentration of nanoparticle. Nanofluids are more efficient as compare to other base fluids. Efficiency of heat exchanger is varies by factors like temperature flow rate, concentration of nanofluid, size of heat exchanger. Nano fluid is advanced heat transfer fluid for next generation.

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