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Review on Performance Analysis of Shell and Tube Heat Exchanger by using Al_2O_3 & CuO Nanofluid

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Abstract: Recent techniques have made creation of metal particles in nanometre scale called as nanoparticles, which when dispersed in a base fluid, enhances the thermal conductivity of the base fluid. Nanofluids were found to have higher thermal conductivity as compared to the base fluids. Nanoparticles overcome the previously stated issues such as clogging, erosion & instability, in light of the fact that the particles are ultra-fine and are typically utilized at low molecular forces. This and their other distinctive features offer unprecedented hidden for many applications in various fields including bio, energy, pharmaceutical industry, chemical, environmental, electronic, material, thermal and medical engineering. The term Nanofluid means the stable colloidal suspension of nano-sized solid particles in the common base fluids such as ethylene glycol and water. Nanofluids are prepared by adding nanoparticles into traditional heat transfer fluids are the next generation heat transfer fluids as they offers the exciting new possibilities to increase the heat transfer performance as compared to traditional fluids.
Keyword: base fluid, nanofluid, thermal conductivity.

I. INTRODUCTION

The most versatile shell and tube heat exchangers are used in process industries. They are also used as condensers in conventional and nuclear power stations, and steam generators in pressurized water reactor power plants. The major components in them are tubes, shell, and frontend head, rear-end head, baffles, and tube sheets. They are built of round tubes mounted in a cylindrical shell with the tubes parallel to the shell. One fluid flows inside tubes, while the other fluid flows across and along the axis of the exchanger. The shell-and-tube heat exchangers provide relatively large ratios of heat transfer area to volume and weight, which can be designed for high-pressures relative to the environment and high-pressure differences between the fluid streams.

Traditional heat transfer fluids such as Water, Ethylene Glycol and engine oil are used as coolants in many industrial applications and in process industries, such as transport vehicles, engine cooling, condensers and electronic devices. These type of fluids have poor thermal conductivities. This can be overcome by dispersing the micro particles which are having higher thermal conductivity. But, the dispersion of micro particles posses some problems. the micro particles suspended because some problems in heat transfer equipment. The micro particles tend to settle down quickly and cause clogging by passing through micro channels, which leads to a considerable increase in pressure drop requiring more pumping power. The particles also cause erosion of pipelines.

II. NANOPARTICLES AND NANOPARTICLES NEED

Nanoparticles are characterized as particulate scattering or strong particles with a size in the scope of 10-100 nm as At these length scales, materials start to show unmistakable properties that influence natural, compound and physical conduct. A wide assortment of nanoparticles exists with natural or inorganic organization, most being metals. Cases include: silica, silver, iron nanoparticles, carbon dark, aluminum, zinc oxides, titanium dioxide, polystyrene and nanoclays and so forth. Generally utilized heat exchange liquids, for example, ethylene glycol, water, and motor oils have moderately low thermal conductivities, when compeared with thermal conductivity of the solids. Higher thermal conductivity of the solids can be utilized to build the thermal conductivity of a liquid by adding little strong fragments to that liquid. Das and Choi [3] examined the use of suspensions of microparticles and the huge drawback were observed which are listed below, The particles settle down rapidly, forming a film on the surface and decreasing the heat transfer efficiency of the fluid. If the transmission rate of the flowing fluid is increased, sedimentation is decreased, but the corrosion of the transport devices and pipelines increases rapidly.T he big size of the particles contributes in clogging of the flow channels, particularly when the cooling channel is narrow. The pressure drop in the fluid increases rapidly. Finally, enhancement of conductivity based on the particle concentrations is obtained. The emergence of the recent materials technology had provided the opportunity to synthesize nano-particles which are completely different from the originating material in thermal, electrical, mechanical, and optical properties. Comparison of nanoparticles and microparticles characteristics is shown in Table 1.1. Nanoparticles stay suspended much longer as compared to micro particles; therefore, these rare properties of nanoparticles lead to flourish Nano fluids by combining the two most highly desired features for heat transfer systems: ultrahigh thermal conductivity and extreme stability

TABLE I Comparison between micro particles and nanoparticles characteristics

Sr No.	Description	Micro-particle	Nano-particle
1.	Stability	Settle	Stable (remain suspended for long time)
2.	Surface to volume Ratio	1	1000 times larger than micro particles
3.	Thermal conductivity	Low	High

III. VARIOUS AUTHORS RESEARCH ON NANOPARTICLES IN HEAT EXCHANGERS

C. Selvan, D. Mohan Lal, Sivasankaran Harish. et.al. [1] had studied the thermo physical properties of ethylene glycol-water mixture containing silver nanoparticles at different concentration also obtained correlation to predict the thermo physical properties of Ag/EG- water nanofluid. The suspension of silver nanoparticle in the base fluid enhances the density by 2.16% for 0.15 volume concentration at 70^0c. The maximum enhancement of thermal conductivity observes, is 12% for 0.15 % volume at 50^0C.

P. J. Fule. et.al. [2] performed the experimentation on heat transfer enhancement in the helical coil heat exchanger using CuO2 water nanofluid the nanofluid is prepared by using the two step method and use 0to 0.5 %volume concentration at a flow rate of 30 to 80LPH, the investigation carry out to study the effect of particle concentration on heat transfer enhancement. The density mixture is calculated by using Lee al correlation, specific heat is calculated by using pack and chew correlation, Maxwell static model determine the thermal conductivity. Arun KumarTiwari. et.al. [3] work on the thermal performance of shell and tube heat exchanger using$Al_2O_{3,}$ -water Nano fluid and conclude that the convective heat transfer coefficient and the overall heat transfer coefficient for nanofluid is higher than that of water base fluid.

Rahin Hassani. et.al. [4] performed the experimental Analysis aluminium oxide with the water volume fraction 0.1–0.3% nanofluid in the thermally developing region of a circular tube from his research, It is concludes that suspension of $Al_2O_{3,}$nano particle in pure water enhances the thermal conductivity due to increases of the thermal boundary layer. Also by decreasing the particle size the rate of Brownian motion increases in thermally developed region and with increasing particle Brownian motion increases. Maximum 22.63% heat enhances using 25 nm at Re=1400.

Rashmi. R. Sahoo. et.al. [5] performed the experiment on the performance of hybrid nanofluid as a coolant in louvered fin automotive radiator in. 1 % volume concentration of Ag, SIC CUOP&Tio2 in 0 to 1 % volume fraction of $Al_2O_{3,}$ nanofluid coolant. Among all studied, 1 % hybrid nanofluid of 0.5% Ag and 0.5% $Al_2O_{3,}$ gives highest effectiveness and heat transfer coefficient

RezaAghayari et.al. [6] Studied the effect of nanoparticle on heat transfer in mini double pipe heat exchanger in turbulent flow and obtain the relation of thermal conductivity correlation by using the Maxwell model. The results shows use of $Al_2O_{3,/}$water nanofluid gives a higher heat transfer coefficient than those of water. The nanofluid with suspended nanoparticles increases the thermal conductivity of the mixture and a large energy exchange process resulting from the chaotic movement of the nanoparticle. The enhancement of convective heat transfer coefficient depends on increasing the fluid thermal and decreasing the thermal boundary layer thickness. The thermal conductivity of the nanofluid increases with increasing the volume concentration and decrease of thermal boundary layer thickness due to the mobility of particles near the wall.

Lu Zheng. et.al. [7], studied the Numerical investigation on heat transfer performance and flow characteristics in circular tubes with dimpled twisted tapes using $Al_2O_{3,/}$water nanofluid heat transfer and flow in circular tubes fitted with dimpled twisted tape inserts, and $Al_2O_{3,/}$water nanofluid is employed. Considering the effects of dimples, protrusions, nanofluid volume fraction a and nanoparticle diameter deep, The results show that dimple side and protrusion side, both realize great heat transfer enhancement, and dimple side behave better compared with protrusion side. Utilization of dimples leads to an increase by 25.53% in convective heat transfer coefficient at most compared to smooth tape. Heat transfer performance is greatly improved on both tape wall and tube wallowing to disturbance to flow structures.

Ningbo Zhao. et.al. [8] analyzed the heat transfer performance of AL2O3 Water nanofluid of flat tubeunder different flow, the results shows that the heat transfer rate for flat tube much higher than the circular tube also with increase in length and particle volume concentration, heat transfer rate increases. Also it is found that significant reduction of thermal entropy generation with the increase of inlet velocity of fluid flow

P.C. Mukeshkumar. et.al. [9] examined the convective heat transfer coefficient and friction factor in a helically coiled tube with Al2O3 / water nanofluid. M. M. Sarfaraz. et.al. [10] measured the thermal performance of double pipe heat exchanger using COOH-CNT/Water nanofluifd. The diameter of the inner and outer tube was taken of 6.35 mm and 12.7 mm, respectively. The nanofluid was prepared using two step method with 0.1 to 0.3% volume concentration, the thermal conductivity of nanofluid measured using KD2 Decagon instrument. The result shows that thermal conductivity of nanofluid enhances up to 56% also the carbon nanotube nanofluids enhance the thermal performance of heat exchanger in comparison with water up to 44% of maximum mass concentration of 0.3 %

S.M. Peyghambarzadeh. et.al. [11] improved the cooling performance of automobile radiator with Al_2O_3, /water nanofluidat five different concentration range of 0.1 to 1%. And flow rate of range 2-5 l/min. The result shows that at 1% volume concentration the heat transfer performance enhances up to 45%.

Omid Mahian. et.al. [12] studied the entropy generation in nanofluid for proper thermal engineering application and concluded that addition of nanoparticle helps to decrease the entropy generation by uniform temperature. The study goes under limited volume fraction.

Sundar and Sharma. et.al. [13] studied the heat transfer enhancement of Al_2O_3, /water nanofluids at lower concentrations flowing thr ough a tube by inserting a long strip. The main aim of this study was to analyse the convective heat transfer coefficient and friction factor at different aspect ratios. The Reynolds number varied between 3000 to 22000. the volume fraction varied between 0 to 0.5 % and aspect ratio of the strip was ranged in between 0 to 18. At AS (aspect ratio) = 1 and Re = 3000, the friction factor of nanofluids with volume fraction, 0.5 % is 5.5 times more than that of water and at Re = 22000, it is 3.6 times more. At AR (aspect ratio) = 1, the HTC of 0.5% volume fraction Al_2O_3, /water nanofluid with strip insert is 50.12 % more at Re = 3000 and 55.73 % at Re = 22000 as compared to that of distilled water.

Wang and Mujumdar. et.al. [14] provided a summary of those numerical studies and also review some theoretical studies regarding the convective heat transfer of nanofluids. And clustering of nanoparticles which results in dramatic changes of thermal conductivity of nanofluids with temperature. The thermal conductivity of water-based nanofluids containing Al_2O_3, SiO2, and TiO2 nanoparticles at different temperatures. The thermal conductivity ratio decreased with increasing temperature, which is contradictory to many findings in the literature. The temperature dependence of the thermal conductivity of Al_2O_3 /water and CuO /water nano fluids was studied. Thermal diffusivity was measured by the using a temperature oscillation technique and then thermal conductivity was calculated. Several measurements were madeat different temperatures varying between 21 and 51°C. It was seen that for 1% Al2O3/water nanofluid, thermal conductivity enhancement, increased from 2% at21°C to10. 8% at 51°C. Temperature dependence of 4 % volume Al2O3 nanofluid was much more significant. From 21 to51°C, enhancement, increased from 9.4 to 24.3%. A linear relationship between thermal conductivity ratio and temperature was observed at both 1 and 4 vol.% Cases.

Li and Peterson. et.al. [15] investigated the effect of temperature on thermal conductivity of CuO(29 nm)/water and Al_2O_3,/water nanofluids. For both nanofluid types, it was observed that ata constant particle volume fraction, thermal conductivity ratio increased with temperature. In addition, it was noted that for Al_2O_3,/water nanofluid, the dependence of the thermal conductivity ratio on particle volume fraction became more pronounced with increasing temperature. A regression analysis based on the experimental data showed that the particle volume fraction dependence of thermal conductivity is much higher than the temperature dependence. For the Al_2O_3,/water nanofluid and CuO/water nanofluid, two correlations were proposed for the determination of the thermal conductivity.

There are also some studies which propose that Brownian motion is not very effective in the thermal conductivity enhancement.

Evans et al.[16] theoretically showed that the thermal conductivity enhancement due to Brownian motion is a very small fraction of the thermal conductivity of the base fluid. This fact was also verified by molecular dynamics simulations. As a result, it was concluded that Brownian motion of nanoparticles could not be the main cause of anomalous thermal conductivity enhancement with nanofluids

Another study that proposes the clustering effect as the main reason of thermal conductivity enhancement was made by Keblinski et al.[17] They analyzed the experimental data for thermal conductivity of nanofluids and examined the potential mechanisms of anomalous enhancement. Enhancement mechanisms such as micro convection created by the Brownian motion of being the particle volume fraction of the clusters, which are defined in the study and the related expressions also give the rein to calculate effective thermal conductivity theoretically

B. Farajollahi. et.al. [18] worked on heat transfer enhancement of shell and tube heat exchanger using Al_2O_3,/water and TiO2 between concentration of 0.3-2% and 0.15-0.75%, respectively under turbulent flow. Test size of Al_2O_3,/water and Tio2 is 25 nm and 10nm respectively, and water is used as base fluid.. The result shows that at optimum particle concentration TiO2 gives higher heat transfer characteristics than Al_2O_3,/water due to size of particle. While ɣ - Al_2O_3,/water gives a better heat transfer coefficient at higher particle concentration. Alhassan Salami Tijani. et.al. [19] measured the thermophysical properties of nanofluid and obtain different relations to calculate the Pradit number, renoluts number and Nusselt number of Al2O3nanofluid.

S.Suresh. et.al. [20] worked on effect of $Al_2O_{3,}$-CuO/water hybrid nanofluid in heat exchanger under Laminar flow. The convective heat transfer experimental result shows that uo to 13.56% enhancement in nussult number at Re=1730 when compeer with nussult number with water .the experimental result also shows that 0.1% $Al_2O_{3,}$-CuO/water hybrid nanofluid have slightly higher friction factor when compeer to 0.1 % $Al_2O_{3,}$/water nanofluid.

Mohamed M Tawtik. et.al. [21] Revieved the experimental studies of nanofluid thermal conductivity enhancement and its application. he also sujjes the parameter required to enhance the thermal conductivity of nanoflui. thepracticle applications are electronic cooling applications, solar thermal applications, medical applications etc.

M D Shende et.al [22] Reviewed thermal performance of heat pipe using alumina Nanofluid and concluded that aluminum oxide nanoparticle are best for heat pipe.

Mehrdad Karimza dehkhoai. et.al. [23], did the interesting study of the effect of nanoparticle type and nanoparticle mass fraction on heat transfer enhancement in pool boiling. this study presents an experimental investigation on mucleat pool boiling heat trandfer of TiO2 nanoparticle and CuO nanoparticle on flate heater for mass fraction range of 0.001% to 0.2% .the experimental result shows that around 15% enhancement in heat transfer performance by adding 0.001% TiO2 partyicle also by adding 0.001% CuO enhances heat transfer of 18%. With increasing fraction up to 0.2% it is enhances up to 35% Which shows that mass fractionindicates the performance of heat transfer.

Gaurav Deshpande et.al [24] performed experimentation on Heat Transfer Enhancement by Nanofluid in a Spiral Tube Heat Exchanger using Al2O3 /water nanopartical and concluded that heat transfer rate increases with increasing volume fraction of nanoparticle.

Table.2.1 Summery of literature.

Sr.no	Author	Study	Material	volume fraction	Re/flow rate	Enhancement
1	Ahmed A. Hussien		MWCNT and GNPS Hybrid nanofluid	0.1-0.35%	Re =200-500	43.4% enhancement in heattransfer
2	JavadGhaderion	evacuated tube solar collector	AL2O3 /Distilled water	0.06%	20L/H	57.63% Enhancement in solar collector efficiency
3	Adnan Sozen	parallel and cross-flow concentric tube heat exchangers	COOH-CNT/Water	0.30%		44% inhancement in thermal performance
4	M.M.Sarfaraz	double pipe heat exchanger	AL2O3 / water	0.1 to 1%	2-5 l/min	heat transfer performance enhances up to 45%.
5	Sundar and Sharma	tube by inserting a long strip	$Al_2O_{3,}$/water	0 to 0.5 %	Re =3000 to 22000,	50.12% enhancement in heat transfer peformance with strip insert
6	B. Farajollahi	shell and tube heat exchanger using	$Al_2O_{3,}$/water and	0.3-2%		The result shows that at optimum particle concentration TiO2 gives higher heat transfer characteristics than Al2O3 due to size of particle. while γ -Al2O3 gives better heat transfer coefficient at higher particle concentration
7	Sommers and Yerkes perform	Microchannel	Al2O3–propanol	0.5–3	Re =1800-2800	Significant enhancement of heat transfer coefficient
8	Y ones A fshoon, Ahmad Fakhar	shell and tube heat exchanger	CuO-Water	0.015,0.031,0.078,0.157 and 0.236	Re =3000	The best volumetric concentration is 0.078 % because with increasing the concentration pressure drop decreases and heat transfer coefficient increases
9	RahinHassani	thermally developing region of a circular tube	$Al_2O_{3,}$-water	0 to 0.5	Re=1400	22.63% heat enhances thermal performance
10	MehrdadKarimzadehkhoai	Critical heat flux	CuO, Al_2O_3	0.02to 3%		12.5 % rise in heat flux by CuO as compasre to Al2O3

IV. CONCLUSIONS

The results show that the heat transfer coefficient enhancement is increases with increase in volume concentration of nanofluid in water. At same particle concentration and flow rate the CuO, Al2O3/water, COOH-CNT/Water nanoflid gives higher effectiveness than that of pure water. From the above results obtained, it was concluded that the Overall performance of shell and tube heat exchanger depends on nanomaterial and particle concentration of nanofluid.

V. ACKNOWLEDGMENT

The heading of the Acknowledgment section and the References section must not be numbered.

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