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Study On Concentric Tube Heat Exchanger With Different Nano Fluids For Enhancing The Heat Transfer: A Review

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Abstract : *In this article, studies on different characteristics of nanofluids like Thermal conductivity, viscosity, density, specific heat and heat transfer performances of concentric tube heat exchanger with nano fluids for enhancing the heat transfer. This paper also presents a procedure for preparing a nanofluid which is a suspension consisting of nanophase powders and a base liquid. Various Enhancement methods are applied to increase thermal performance of heat transfer devices such as treated surfaces and different nanofluids. These are used to augment the heat transfer by creating turbulence in the fluid flow and it increasing the heat transfer. The numerical and experimental results showed from different studies that an different nanofluids are could be one of the reasons for higher performance augmentation methods with the water as working fluids heat exchangers. The numerical and analytical investigation for nanofluids gives better performance compare than water and oils from review study.*

Keywords: *Nanofluids, Heat transfer, Heat exchanger, enhancement techniques*

INTRODUCTION

Thermal properties of liquids play a decisive role in heating as well as cooling applications in industrial processes. Thermal conductivity of a liquid is an important physical property that decides its heat transfer performance.

Conventional heat transfer fluids have inherently poor thermal conductivity which makes them inadequate for ultra high cooling applications. Scientists have tried to enhance the inherently poor thermal conductivity of these conventional heat transfer fluids using solid additives following the classical effective medium theory (Maxwell, 1873) for effective properties of mixtures. Fine tuning of the dimensions of these solid suspensions to millimeter and Micrometer ranges for getting better heat transfer performance have failed because of the drawbacks such as still low thermal conductivity, particle sedimentation, corrosion of components of machines, particle clogging, excessive pressure drop etc. Downscaling of particle sizes continued in the search for new types of fluid suspensions having enhanced thermal properties as well as heat transfer performance.

HISTORY OF NANO FLUID

The twenty-first century is an era of technological development and has already seen many changes in almost every industry. The introduction of nano science and technology is based on the famous phrase "There's Plenty of Room at the Bottom" by the Nobel Prize-winning physicist Richard Feynman in 1959. Feynman proposed this concept using a set of conventional-sized robot arms to construct a replica of themselves but one-tenth the original size then
using that new set of arms to manufacture a even smaller set until the molecular scale is reached.

PROPERTIES OF NANOFLUIDS

It may be noted that particle size is an important physical parameter in nanofluids because it can be used to tailor the nanofluid thermal properties as well as the suspension stability of nanoparticles. Researchers in nanofluids have been trying to exploit the unique properties of nano particles to develop stable as well as highly conducting heat transfer fluids. The key building blocks of nanofluids are nanoparticles; so research on nanofluids got accelerated because of the development of nanotechnology in general and availability of nanoparticles in particular. Compared to micrometer sized particles, nanoparticles possess high surface area to volume ratio due to the occupancy of large number of atoms on the boundaries, which make them highly stable in suspensions. Thus the nano suspensions show high thermal conductivity possibly due to enhanced convection between the solid particle and liquid surfaces. Since the properties like the thermal conductivity of the nano sized materials are typically an order of magnitude higher than those of the base fluids, nanofluids show enhancement in their effective thermal properties. Due to the lower dimensions, the dispersed nanoparticles can behave like a base fluid molecule in a suspension, which helps us to reduce problems like particle clogging, sedimentation etc. found with micro particle suspensions. The combination of these two features; extra high stability and high conductivity of the dispersed 'nanospecies' make them highly preferable for designing heat transfer fluids. The stable suspensions of small quantities of nanoparticles will possibly help us to design lighter, high performance thermal management systems.

HISTORY OF HEAT EXCHANGER

In the 1950s, aluminium heat exchangers made moderate inroad in the automobile industry with the invention of the vacuum brazing technique, large scale production of aluminium-based heat exchangers began to raise and grow resulting from advantages of the controlled atmosphere brazing process (Nocolok brazing process introduced by ALCAN). With increasing years introduction of "long life" (highly corrosion resistant) alloys further improved performance characteristics of aluminium heat exchangers. Extra demands for aluminium heat exchangers increased mainly due to the growth of automobile air-conditioning systems.

EXISTING STUDIES ON NANOFLUID

K.Senthilkumar, P.Palanisamy, R.Vinoth and S.Perumal, studied numerically for concentric tube heat exchanger using dimpled tubes with AL_2O_3 Nanofluid. The results shows the heat transfer and nusselt numbers are increased compared with smooth tube heat exchanger. In this article AL_2O_3 Nanofluid is used. From the CFD results the ellipsoidal dimpled tube could enhance the heat transfer more efficiently than smooth and spherical dimpled tube with AL_2O_3 Nanofluid.

M. Muraleedharan,et.al. Studied experimentally measured thermal and optical properties of Al2O3-Therminol_55 nano heat transfer fluid (nHTF) in conjunction with a specially developed line focusing Fresnel lens based solar thermal concentrator. The solar concentrator thermal efficiency increased with the proportion of NPs attaining a maximum of 52.2% for 0.1 vol%Al2O3 nHTF. Directly absorbing nHTFs along with the solar collector developed in this study are predicted to be strong candidate to replace conventional metallic tube receiver using concentrators due to advantages of size compaction and higher thermal conversion efficiencyThe solar concentrator thermal efficiency increased with the proportion of NPs attaining a maximum of 62.7% for 0.1 vol% Al2O3 nHTF.

S.Perumal.et.al,, study on heat transfer, friction factor and thermal performance analysis of double pipe heat exchanger using different enhancement techniques. The numerical and experimental results shows the heat transfer and friction factor for different augmentation surfaces with different nanofluids is given higher than that for the smooth concentric tube heat exchanger.

Hemat Ranjbar.et.al. Effect of g-Al2O3 and MgO nanoparticle on surface tension of Tri Ethylene Glycol (TEG) was studied for different nanoparticle concentrations. The effect of nanoparticle size on surface tension was analyzed as well. Using experimental data, five empirical and thermodynamic-based models; i.e., RedlicheKister (RK), Malanovsky-Marsh (MM), Jufu et al. (JBZ), Chunxi et al. (CWZ) and Santos et al. (SFF) were evaluated for surface tension estimation, and it was found that SFF method is the best method to correlate nano fluid surface tension in this study.

K.Senthil kumar, S.Perumal,et.al, studied about Numerical analysis of a triple concentric tube heat exchanger using dimpled tube geometry for increasing the heat transfer compare than double pipe heat exchanger. From the numerical result shows the overall heat transfer co efficient and effectiveness of spherical dimpled triple pipe heat exchanger is higher than that double pipe heat exchanger.

Jinghai Xu.et.al. Paper presents a multi-parameter investigation of Al2O3 nano-particles dispersed in distilled water, Ethylene glycol and ethylene glycol–distilled water mixture (50/50 vol. %). The nano-fluid samples were prepared with ultrasonic processing with particle concentration up to 9 wt. %. Samples were characterized by transmission electron microscope imaging, particle surface charge (zeta potential), particle aggregate size, light absorbance and pH. The thermal conductivity and viscosity of the nano-fluid samples were measured. 10.9% enhancement in thermal conductivity was observed in ethylene glycol–distilled water mixture based nano-fluid with 5 wt. % Al2O3 nano-particles loading.

Alpesh Mehta.et.al. This paper shows the research work on heat exchanger using nano fluid. In this paper we are using compact heat exchanger as heat transferring device while Al2O3 as a nano fluid. The effect of the nano fluids on compact heat exchanger is analyzed by using 6 –NTU rating numerical method on turbo-charged diesel engine of type TBD 232V-12 cross flow compact heat exchanger radiator with unmixed fluids consisting of 644 tubes made of brass and 346 continuous fins made of copper. Comparative study of Al2O3+ water nano fluids as coolant is carried out.

Ravi Sankar.et.al, The fluids dispersed with nanoparticles known as nanofluids are promising for heat transfer enhancement due to their high thermal conductivity. In the present study, a literature review of nanofluid thermal conductivity is performed. Limited study has been done about this aspect of the thermal conductivity of nanofluids up to now. Investigation of the thermal performance of nanofluids at high temperatures may widen the possible application areas of nanofluids.

Todd P. Otanicar,,et.al. Solar collectors have been proposed for a variety of applications such as water heating; however the efficiency of these collectors is limited by the absorption properties of the working fluid, which is very poor for typical fluids used in solar collectors. It has been shown that mixing nanoparticles in a liquid nanofluid has a dramatic effect on the liquid thermo physical properties such as thermal conductivity. Experimental and numerical results demonstrate an initial rapid increase in efficiency with volume fraction, followed by a leveling off in efficiency as volume fraction continues to increase.

T. Coumaressin.et.al, Evaporating heat transfer is very important in the refrigeration and airconditioning systems. HFC 134a is the mostly widely used alternative refrigerant in refrigeration equipment such as domestic refrigerators and air conditioners. Heat transfer coefficients were evaluated using FLUENT for heat flux ranged from 10 to 40 kW/m2, using nano CuO concentrations ranged from 0.05 to 1% and particle size from 10 to 70 nm. The results
indicate that evaporator heat transfer coefficient increases with the usage of nanoCuO.

Somayeh Toghyani,et.al., In this paper, the performance of an integrated Rankine power cycle with parabolic trough solar system and a thermal storage system is simulated based on four different nano-fluids in the solar collector system, namely CuO, SiO2, TiO2 and Al2O3. This study reveals that by increasing the volume fraction of nano-particles, the energy efficiency of the system increases. At higher dead state temperatures, the overall energy efficiency is increased, and higher solar irradiation leads to considerable increase of the output power of the system. It is shown that among the selected nano-fluids, CuO/oil has the best performance from energy perspective.

Hemat Ranjbar,et.al., Effect of g-Al2O3 and MgO nanoparticle on surface tension of Tri Ethylene Glycol (TEG) was studied for different nanoparticle concentrations. Furthermore, the effect of nanoparticle size on the Nano-fluid
surface tension was investigated. Results showed that surface tension increases for some particle concentrations and decreases for some others. Experimental data was correlated with some empirical and thermodynamic base models. Results proved that CWZ, JBZ and SFF models are appropriate for prediction of surface tensions while RK and MM methods result in higher deviations.

Jinghai Xu.et.al., This paper presents a multi-parameter investigation of Al2O3 nano-particles dispersed in distilled water, ethylene glycol and ethylene glycol–distilled water mixture (50/50 vol.%). The nano-fluid samples were prepared with ultrasonic processing with particle concentration up to 9 wt.%. Samples were characterized by transmission electron microscope imaging, particle surface charge (zeta potential), particle aggregate size, light absorbance and pH. he degradation of nano-fluid thermal conductivity enhancement over time is found to be related to the gravity-driven particle sedimentation. Nano-fluids containing larger particle aggregates show higher viscosity augmentation. However, the extent of viscosity augmentation is not proportional to the extent of particle aggregation.

M.M. Sarafraz.,et.al., The present work mainly focuses on the pool boiling heat transfer of aqueous alumina nano-fluids up to critical heat flux point on a circular surface at two mass concentrations of 0.1%, 0.3% and nanoparticle size of 20 nm and 50 nm. Nano-fluids were prepared using two-step method and were stabilized by nonylphenolethoxylate (NPE), non-ionic surfactant. Surface of the heater was modified by CNC micro machinery
Technique and concentric circular microstructures (CCM) were created on the surface with different geometrical specifications. Accordingly, a modified mechanism was proposed for enhancing the CHF in nano-fluids, which was the combination of liquid absorption from the bulk of nano-fluids, by the deposition layer and inflow capillary wicking action inside the deposition layer, which leads to the rewetting phenomena in dry-out regions.

A.E. Kabeel.et.al., In the present study, the effects of alumina nano-fluid concentration on sharp-edge orifice flow characteristics in both cavitations and non-cavitations turbulent flow regimes are numerically investigated. At different concentration of AL2O3 nonmetallic particles (2%, 4%, 6%, 8%, and 10%) volume fractions in pure liquid water as a base fluid. The results show that for increasing the nonmetallic particle volume fraction from 0.0 to 10%, the turbulent kinetic energy decreases by 20.87% in average downstream the orifice in the whole region, the turbulent intensity decreases by 11.11% in average downstream the orifice in the whole region, the turbulent intensity decreases by 11% in average in the whole region, and the volume fraction of vapor increases by 16.9%.

Arash Karimipour.,et.al., The forced convection of nanofluid flow in a long microchannel is studied numericallyaccording to the finite volume approach and by using a developed computer code.Microchannel domain is under the influence of a magnetic field with uniform strength. The hot inlet nanofluid is cooled by the heat exchange with the cold micro channel walls. However at larger amounts of Re, the nanofluid composed of nanoparticles with higher thermal conductivity works better.

Valery Ya. Rudyak., Transport properties of nanofluids are extensively studied last decade. This has been motivated by the use of nanosized systems in various applications. The viscosity of nanofluids is of great significance as the application of nanofluids is always associated with their flow. It was shown that size of nanoparticles is the key characteristics of nanofluids. In addition the nanofluid is more structural liquid than the base one.

Stephen U. S. Choi., Low thermal conductivity is a primary limitation in the development of energy-efficient heat transfer fluids that are required in many industrial applications. In this paper we propose that an innovative new class of heat transfer fluids can be engineered by suspending metallic nanoparticles in conventional heat transfer fluid. Theoretical study of the thermal conductivity of nanofluids with copper nanophase materials are presented, the

Potential benefits of the fluids are estimated, and it is shown that one of the benefits of nanofluids will be dramatic Reductions in heat exchanger pumping power.

Seok Pil Jang., The addition of a small amount of nanoparticles in heat transfer fluids results in the new thermal phenomena of nanofluids (nanoparticle-fluid suspensions) reported in many investigations. However, traditional conductivity theories such as the Maxwell or other macro scale approaches cannot explain the thermal behavior of nanofluids. Comparison of model predictions with published experimental data shows good agreement for nanofluids containing oxide, metallic, and carbon nanotubes.

Clement Kleinstreuer., Nanofluids, presents well-dispersed (metallic) nanoparticles at low- volume fractions in liquids, may enhance the mixture's thermal conductivity, over the base-fluid values. Thus, they are potentially useful for advanced cooling of micro-systems. Focusing mainly on dilute suspensions of well-dispersed spherical nanoparticles in water or ethylene glycol, recent experimental observations, associated measurement techniques, and new theories as well as useful correlations have been reviewed, it will be necessary to consider not only one possible mechanism but combine several mechanisms and compare predictive results to new benchmark experimental data sets.

Yimin Xuan.et.al This paper presents a procedure for preparing a nano¯uid which is a suspension consisting of nanophase powders and a base liquid. By means of the procedure, some sample nano¯uids are prepared. Their TEM photographs are given to illustrate the stability and evenness of suspension. A theoretical model is proposed to describe heat transfer performance of the nano¯uid ¯owing in a tube, with accounting for dispersion of solid particles.

P Fari˜nas Alvari˜no,et.al., The aim of the reported investigation is to asses the effect of brownian and thermophoretic diffusion in nanofluids convective heat transfer. In order to capture these effects, a new equation for particles distribution had to be considered. Momentum and energy equations have been reformulated in order to include Brownian and thermophretic diffusion. The observed heat transfer enhancement by the nanofluid has Been attributed to its transport properties rather than to another transport mechanism.

J. A. Eastman,.et.al., It is shown that a ''nanofluid'' consisting of copper nanometer-sized particles dispersed in ethylene glycol has a much higher effective thermal conductivity than either pure ethylene glycol or ethylene glycol containing the same volume fraction of dispersed oxide nanoparticles. The results are anomalous based on previous theoretical calculations that had predicted a strong effect of particle shape on effective nanofluid thermal conductivity, but no effect of either particle size or particle thermal conductivity.

William Evans.et.al., We use a kinetic theory based analysis of heat flow in fluid suspensions of solid nanoparticles _nanofluids_ to demonstrate that the hydrodynamics effects associated with Brownian motion have only a minor effect on the thermal conductivity of the nanofluid. They findings are consistent with the predictions of the effective medium theory as well as with recent experimental results on well-dispersed metal nanoparticle suspensions.

W. Yu and S.U.S. Choi., presents Nanofluids, a new class of solid/liquid suspensions, offer scientific challenges because their measured thermal conductivity is one order of magnitude greater than predictions. It has long been known that liquid molecules close to a solid surface form layered solid-like structures. this ordered nanolayer has a major impact on nanofluid thermal conductivity when the particle diameter is less than 10 nm, a new direction is indicated for development of next-generation coolants.

Wenhua Yu.,et.L., This study provides a detailed literature review and an assessment of results of the research and development work forming the current status of nanofluid technology for heat transfer applications. Nanofluid technology is a relatively new field, and as such, the supporting studies are not extensive. The current state of knowledge is presented as well as areas where the data are presently inconclusive or conflicting. Heat transfer enhancement for available nanofluids is shown to be in the 15–40% range, with a few situations resulting in orders of magnitude enhancement.

Tran.P.X .et.al.,presents Another method for synthesis of nano fluid is the laser ablation method, which is used to produce alumina nano fluids . from the results nanofluids gives better performance.

Patel.H.E,et.al., it exhibits Pure chemical synthesis is also an alternative method which has been used by Patel [6] to prepare gold and silver nanofluids.

S.Perumal.et.al.,It shows the theoretical and experimental study of a concentric tube heat exchanger using dimpled tubes for enhancing the heat transfer. The dimpled surface is creating the turbulence inside the tube and it used to increase the heat transfer rate.

Zhu et al., also used one-step pure chemical synthesis method for preparing nanofluids using copper nano particles dispensed in ethylene glycol. The observed more heat transfer enhancement by the nanofluid.

Mushtaq et al. Investigated the effect of channels geometry (the size and shape of channels) on performance of counter flow micro channel heat exchanger and used liquid water as a cooling fluid. They found that the effectiveness of heat exchanger and pressure drop were increased by decreasing the size of channels and claimed depending on the application of which type of heat exchanger is used.

Mushtaq I. Hasan.,et.al., numerically investigated the performance of counter flow micro channel heat exchanger with MEPCM suspension as a cooling fluid. He fund that using MEPCM suspension lead to improve thermal performance of CFMCHE but also lead to extra increase in pressure drop and resulting in decreasing the overall performance with using suspension as a cooling medium.

CONCLUSION

From this article making nanofluid and we get from literature review we are going to design and develop a Heat Exchanger by using nanofluids. We are also using design software and experimental to design heat exchanger. The study of the rheological properties of liquids requires systematic experiments with varying concentration, material, and shape of nanoparticles and varying properties of the base fluid. Interesting results can also be expected in the case where the base fluid is itself non-Newtonian. Limited study has been done about this aspect of the properties of nanofluids up to now. Investigation of the thermal performance of nanofluids at high temperatures may widen the possible application areas of nanofluids.

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