Experimental Analysis on Heat Exchanger by using Nano Fluids

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Abstract— The Nano fluids have emerged as a new generation of heat transfer fluids attracted the attention of researchers over the past few years. Recent investigation on Nano fluids such as suspensions are often called indicates that the suspended Nano particles markedly change the transport properties and heat transfer characteristic of the suspension. Nano fluids have great thermal physical properties such as thermal conductivity, thermal diffusivity, viscosity, heat transfer coefficient as compared to their base fluids .The key feature of Nano fluid is its superior thermal conductivity. The Nano fluids like Al2O3 + water, CuO + water, TiO + water are the very commonly used in thermal systems and heat exchangers. An experimental study of performance of AL2O3 Nano fluid in a heat exchanger was studied in the present work. Nano fluid is tested in a heat exchanger by varying the percentage of Nano particles mixed with water. Pure water is used in a heat exchanger and its performance was studied. AL2O3 Nano particles are mixed in water by 0.1 % & 0.2 % volume concentration and the performance was studied. The performance comparison has made between pure water and Nano fluids tested in heat exchanger. Nano fluids can be used to improve heat transfer and energy efficiency in many thermal control systems and heat exchangers.

Keywords: Effectiveness, Heat exchanger, Heat transfer coefficient, Nano fluids, Thermal conductivity Effectiveness, Heat exchanger, Heat transfer coefficient, Nano fluids, Thermal conductivity

I. Introduction

Nano fluids are dilute liquid suspended Nano particles which have only one critical dimension smaller than~100nm. Much research work has been made in the past decade to this new type of material because of its high rated properties and behavior associated with heat transfer. . The thermal behavior of Nano fluids could provide a basis for an huge innovation for heat transfer, which is a major importance to number of industrial sectors including transportation, power generation, micro manufacturing, thermal therapy for cancer treatment, chemical and metallurgical sectors, as well as heating, cooling, ventilation and air-conditioning. Nano fluids are also important for the production of Nano structured materials for the engineering of complex fluids, as well as for cleaning oil from surfaces due to their excellent wetting and spreading behavior.

A. *Thermal Conductivity:*

Thermal conductivity is an important parameter in enhancing the heat transfer performance of a base fluid. Thermal conductivity of solid metal is higher than that of fluids, the suspended particles are expected to increase the thermal conductivity and heat transfer performance. Nano fluids clearly exhibit improved thermo-physical properties such as thermal conductivity, thermal diffusivity, viscosity and convective heat transfer coefficient. The property change of Nano fluids depends on the volumetric fraction of nanoparticles, shape and size of the nanomaterial. Thermal conductivity of various materials is indicated in the table.

TYPES	MATERIALS	THERMAL CONDUCTIVITY
Metallic materials	Copper	401
	Silver	429
Nonmetallic materials	Silicon	148
	Alumina	40
Carbon	Carbon Nano tubes	2000
Base fluids	Water	0.613
	Ethylene glycol	0.253
	Engine oil	0,145
Nano fluids	Water/Al_2O_3	0.629
	Ethylene glycol/ Al_2O_3	0.278
	Engine glycol-Water/Al2O3	0.382
	Water/TiO2	0.682
	Water/ Cuo	0.619

Table 1: Thermal Conductivity Of Nano Fluid

B. *Nano Fluid Preparation Method:*

They are two methods for preparing Nano fluids.

TWO-STEP METHOD

This is the most widely used method for preparing Nano fluids. Nanoparticles, Nano fibers, nanotubes, and other Nano materials used in this method are first produced as dry powders by chemical or physical methods. After that the Nano sized powder is to be dispersed into a fluid in the second processing step with the help of intensive magnetic force agitation, ultrasonic agitation, high-shear mixing, homogenizing, and ball milling. Two-step method is the most economic method to produce Nano fluids in large scale, because Nano powder synthesis techniques have already been scaled up to industrial production levels. Due to the high surface area and surface activity, nanoparticles have the tendency to aggregate. The important technique to enhance the stability of nanoparticles in fluids is the use of surfactants. However, the functionality of the surfactants under high temperature is also a big concern, especially for high-temperature applications.

Nano Powder

NANO POWDER

NANO FLUID

Due to the difficulty in preparing stable Nano fluids by two-step method, several advanced techniques are developed to produce Nano fluids, in one-step method.

One-Step Method:

To reduce the agglomeration of nanoparticles, Eastman et al. developed a one-step physical vapor condensation method to prepare Cu/ethylene glycol Nano fluids. The one-step process consists of simultaneously making and dispersing the particles in the fluid. In this method, the processes of drying, storage, transportation, and dispersion of nanoparticles are avoided, so the agglomeration of nanoparticles are minimized, and the stability of fluids are increased. The one-step processes can prepare uniformly dispersed nanoparticles, and the particles are suspended in the base fluid. The vacuum-SANSS (submerged arc nanoparticle synthesis system) is another efficient method to prepare Nano fluids using different dielectric liquids. The different morphologies are mainly influenced and determined by various thermal conductivity properties of the dielectric liquids. The prepared nanoparticles exhibit needle-like, polygonal, square, and circular morphological shapes. The method avoids the undesired particle aggregation fairly well. One-step physical method cannot synthesize Nano fluids in large scale, and the cost is also high, so the one-step chemical method is developing rapidly. Zhu et al. presented a novel one –step chemical method for preparing copper Nano fluids by reducing $CuSO_4 \cdot 5H_2O$ with $NaH_2PO_2 \cdot H_2O$ in ethylene glycol under microwave irradiation Well-dispersed and stably suspended copper Nano fluids were obtained. Mineral oil-based Nano fluids containing silver nanoparticles with a narrow-size distribution were also prepared by this method the particles could be stabilized by Koran tin, which coordinated to the silver particle surfaces via two oxygen atoms forming a dense layer around the particles. The silver nanoparticle suspensions were stable for about 1 month. Stable ethanol-based Nano fluids containing silver nanoparticles could be prepared by microwave-assisted one-step method .In this method, polyvinylpyrolidone (PVP) was employed as the stabilizer of colloidal silver and reducing agent for silver in solution. The cationic surfactant octadecylamine (ODA) is also an efficient phase-transfer agent to synthesize silver colloids the phase transfer of the silver nanoparticles arises due to coupling of the silver nanoparticles with the ODA molecules present in organic phase via either coordination bond formation or weak covalent interaction. Phase transfer method has been developed for preparing homogeneous and stable grapheme oxide colloids. Grapheme oxide Nano sheets (GONs) were successfully transferred from water to n-octane after modification by oleylamine.

II. Heat Exchanger

Heat exchanger is nothing but a device which transfers the energy from a hot fluid medium to a cold fluid medium with maximum rate, minimum investment and low running costs. In the 1950s, aluminum heat exchangers made moderate in the automobile industry with the invention of the vacuum brazing technique, large scale production of aluminum-based heat exchangers began to raise and grow resulting from advantages of the controlled atmosphere brazing process (Nicola brazing process introduced by ALCAN). With increasing year’s introduction of “long life” (highly corrosion resistant) alloys further improved performance characteristics of aluminum heat exchangers. Extra demands for aluminum heat exchangers increased mainly due to the growth of automobile air-conditioning system. The heat transfer in a heat exchanger involves convection on each side of fluid and conduction taking place through the wall which is separating the two fluids. In a heat exchanger, the temperature of fluid keeps on changing as it passes through the tubes and also the temperature of the dividing wall located between the fluids varies along the length of heat exchanger.

Examples: Boilers, super heaters, re heaters, air preheaters, Radiators of an automobile, Oil, coolers of heat engine, Refrigeration of gas turbine power plant.

III. Experimental Work

A transfer type of heat exchanger is one on which both fluids pass simultaneously through the device and heat is transferred through separating walls. In practice most of the heat exchangers used are transfer type. A simple example of transfer type of heat exchanger in the form of a tube type arrangement in which one of the fluids are flowing through the inner tube and other through the annulus surroundings it. The heat transfer takes place across the walls of the inner tube.

Heat transfer rate, LMTD and overall heat transfer coefficient can be calculated as follows:

$$Q = M\,C_p\,(T_o - T_i)$$

$$\Delta T_m = \frac{\Delta T_o - \Delta T_i}{\ln \frac{\Delta T_o}{\Delta T_i}}$$

$$U = \frac{Q}{A \Delta T_m}$$

Where Q is amount of heat transfer, U is overall heat transfer coefficient and ΔT_m is log mean temperature difference. M, T_o, T_i are mass flow rate, outlet temperature and inlet temperature respectively. ΔT_o, ΔT_ioutlet temperature difference, inlet temperature difference and heat transfer area respectively.

Double Pipe Heat Exchanger Apparatus:

The apparatus consists of a concentric tube heat exchanger. The hot water flows through inner tube and cold water flows through outer tubes. Direction of cold fluid flow can be changed from parallel or counter to hot water so that unit can be operated as parallel or counter flow heat exchanger. For flow measurement Rota meters are provided. A magnetic drive pump is used to circulate the hot water from a recycled type water tank, which is fitted with heaters and digital temperature controller.

IV. RESULTS

Results are discussed the comparison of overall heat transfer coefficient of Nano fluids with water and effectiveness of Nano fluids with water.

A. Overall Heat Transfer Coefficient Of Nano Fluids With Water:

Flow Rate (LPH)	Overall heat transfer co-efficient	Water (parallel flow)	Nano fluid (parallel flow)	Water (counter flow)	Nano fluid (counter flow)
150(hot water)	U_i	565.10	750.09	748.06	884.24
150(cold water)	U_o	422.7	561.13	559.6	661.48
100(hot water)	U_i	500.33	594.161	646.83	746.029
150(cold water)	U_o	374.29	443.17	484.09	558.09
50(hot water)	U_i	383.94	444.773	499.33	579.54
150(cold water)	U_o	287.21	332.726	373.54	433.547

Table 3: Comparison Of 0.2% Of Nano Fluid With Water

Flow Rate (LPH)	Overall heat transfer co-efficient	Water (parallel flow)	Nano fluid (parallel flow)	Water (counter flow)	Nano fluid (counter flow)
150(hot water)	U_i	565.10	808.86	748.06	928.523
150(cold water)	U_o	422.7	605.10	559.6	694.610
100(hot water)	U_i	500.33	619.913	646.83	772.016
150(cold water)	U_o	374.29	463.745	484.09	577.530
50(hot water)	U_i	383.94	463.745	484.09	577.530

Table 4:

Effectiveness of Nano Fluids With Water:

C-cold water, H-hot water

Flow Rate (Lph)	Water (Parallel Flow)	Nano Fluid (Parallel Flow)	Water (Counter Flow)	Nano Fluid (Counter Flow)
150h 150c	0.146	0.180	0.183	0.206
100h 150c	0.130	0.152	0.165	0.187
50h 50c	0.128	0.146	0.163	0.185

Table 5: Effectivess Of Water With Nano Fluid (0.1%)

FLOW RATE (LPH)	WATER PARALLEL FLOW)	NANO FLUID (PARALLEL FLOW)	WATER (COUNTER FLOW)	NANO FLUID (COUNTER FLOW)
150H 150C	0.146	0.193	0.183	0.213
100H 150C	0.130	0.156	0.165	0.193
50H 150C	0.128	0.150	0.163	0.192

Table 6: Effectivess Of Water With Nano Fluid (0.2%)

From the above results which we have obtained shows that the heat transfer rate and effectiveness increases by using Nano fluids.

V. CONCLUSION

From the above experimental analysis we are going to say that by using Nano fluids in the heat exchangers we can improve the overall heat transfer co-efficient &effectiveness, so that the efficiency of the heat exchanger can be increased.

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