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EXPERIMENTAL ANALYSIS OF DOUBLE PIPE HEAT EXCHANGER BY USING NANO – FLUIDS AL_2O_3 & SIO_2

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ABSTRACT

In this research work forced convection flows of Nano-fluids consisting of water with Nanoparticles $AL_2O_3$and SIO_2in a horizontal tube with constant wall temperature are investigated numerically. A single-phase model having two- dimensional equations is employed with either constant or temperature dependent properties to study the hydrodynamics and thermal behaviors of the Nano-fluid flow. The velocity and temperature vectors are presented in the entrance and fully developed region. The variations of the fluid temperature, local heat transfer coefficient and pressure drop along tube length are shown in the paper. Numerical results shows that the heat transfer enhancement due to presence of the Nanoparticles in the fluid in accordance with the results of the experimental study used for the validation process of the numerical model.

Keywords: *CSTR-PID-ZN-Fuzzy-MRAM-MATLAB.*

I. NANO FLUID PREPARATION METHOD

1.1 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.

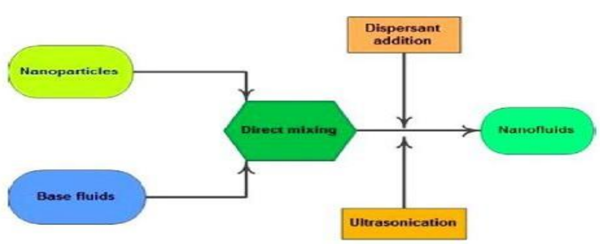

Fig 1.1.1 Two-Step Mixing Procedure Diagram of Nano- Fluid

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.

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1.2 One-Step Method

To reduce the agglomeration of Nanoparticles, Eastman et al. developed a one-step physical vapor condensation method to prepare (Al_2O_3+water and SiO_2+water) 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, polyvinylpyrrolidone (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

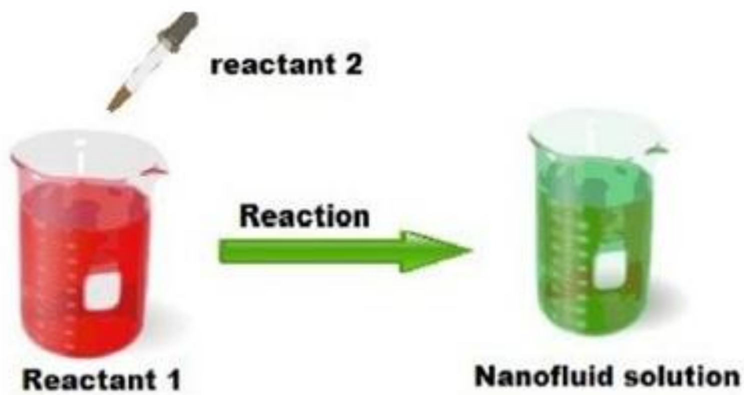

Fig1.1.2 One-Step mixing procedure of Nano-Fluid

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. EXPERIMENTAL WORK

Objective

To study the overall heat transfer co-efficient & effectiveness of the heat exchanger by using Nano fluids and making a comparison with base fluid as water at different flow rates.

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Introduction

Heat exchanger is a device in which heat is transferred from one fluid to another. The necessity for doing this arises in a multitude of industrial applications. Common examples of heat exchangers are the radiator of a car, the condenser at the back of a domestic refrigerator and the steam boiler of a thermal power plant.

Heat exchangers are classified in three categories:

- Transfer Type.
- Storage Type.
- Direct Contact Type

Theory

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.

The transfer type exchangers are further classified according to flow arrangement as

- Parallel flow in which fluids flow in the same direction.
- Counter flow in which fluids flow in the opposite direction.
- Cross flow in which they flow at right angles to each other.

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_i outlet temperature difference, inlet temperature difference and heat transfer area respectively.

Fig3.3 Double pipe Heat Exchanger apparatus

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Description:
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.

Required utilities:
- Electricity Supply: Single phase, 220 V AC, 50 Hz, 5-15 Amp combined socket with earth connection.
- Water Supply: Continuous 5 LPM at 1 Bar.
- Floor drain required.
- Bench area required: 1.75m × 0.5m.

Experimental procedure:
1. First switch ON the unit panel.
2. Start the flow of cold water through the annulus and run the exchanger as counter flow or parallel flow.
3. Switch ON the geyser provided on the panel & allow to flow through the inner tube by regulating the valve.
4. Adjust the flow rate of hot water and cold water by using valves.
5. keep the flow rate same till steady state conditions are reached.
6. Note down the temperatures on hot and cold water sides. Also note the Keep flow rate.
7. Repeat the experiment for different flow rates and for different temperatures.

Precautions & maintenance instructions:
- Never run the apparatus if power supply is less than 200 volts and more than 230 volts.
- Never switch ON mains power supply before ensuring that all the ON/OFF switches given on the panel are at OFF position.
- Operator selectors switch OFF temperature indicator gently.
- Always keep the apparatus free from dust.

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.

About heat exchanger
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.
- In waste heat recovery system.

Types:

Based on contact

1. Direct contact type of heat exchanger,
2. Non-contact type of heat exchanger.

Based on direction of flow

Direction of motion of fluid:

1. Parallel flow,
2. Counter flow
3. Mixed flow.

III. RESULTS AND DISCUSSION

3.1 Result: comparison between Nano fluids (Al_2O_3+water and SiO_2+water) and water

Table 6.1 comparison between Nano fluids (Al_2O_3+water and SiO_2+water) and water

Flow rate kg/sec	Overall heat transfer coefficient W/m^2-K	Water		Al_2O_3 (0.2% volume concentration)		SiO2 (0.2% volume concentration)	
		Parallel	counter	Parallel	counter	Parallel	counter
45	U_o	571.50	750.53	656.542	843.57	679.45	820.12
95	U_o	1185.56	1556.02	1400.50	1730.657	1436.23	1820.23

From the above results which we have obtained shows that the heat transfer rate and overall heat transfer co-efficient increases by using Nano fluids

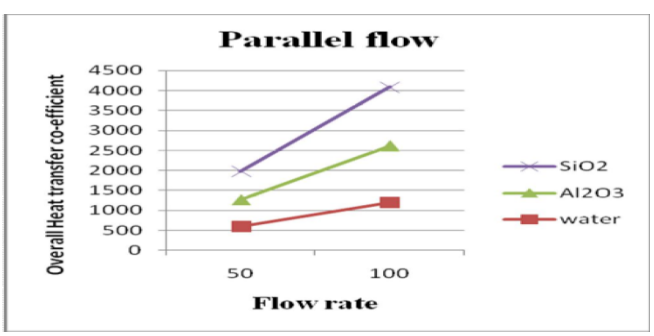

Fig 6.1a parallel flow rate vs. overall heat transfer coefficient

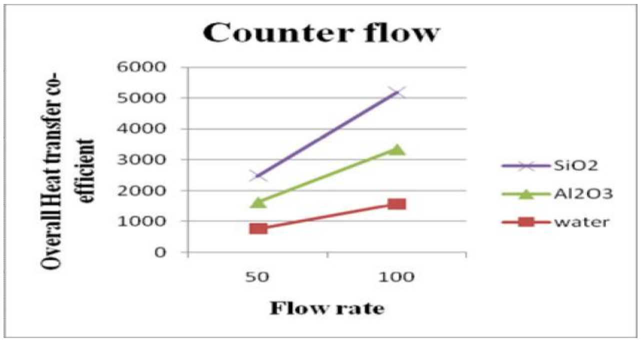

Fig 6.1b counter flow rate vs. overall heat transfer co- efficient

IV. 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 due to the thermal properties of Nano powders. so that the efficiency of the heat exchanger can be increased.

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