A Review Paper On Cooling Ability Of Nanofluids

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ABSTRACT:

Cooling system is one of the important systems of study. It is responsible to carry large amount of heat waste to surroundings. The heat transfer through radiator can be improved by maximizing the heat transfer area and increasing the heat transfer coefficient. The heat transfer coefficient can be increased either by using more efficient heat transfer methods or by improving the thermo physical properties of the heat transfer material i.e. coolant. Earlier, Water was widely used in radiator as a coolant for its good ability to holding heat, transfer heat and can be readily obtained. Also the mixture of water & ethylene glycol later introduced as a coolant. Both of them having certain merits & demerits. With the advancement of nanotechnology, the new generation of heat transfer fluids called, “Nanofluids” have been developed and researchers found that these fluids offer higher thermal conductivity compared to that of conventional coolants. Nanofluids which consist of a carrier liquid, such as water, ethylene glycol dispersed with tiny nano-scale particles known as nanoparticles. This review paper deals with the study and fabrication of the existing cooler modified with a radiator through which refrigerant fluids of nanoparticles are passed.

KEYWORDS:

Heat Transfer Enhancement, Multiwalled Carbon Nanotubes, Nanofluid and Nanoparticles.

INTRODUCTION:

A wide variety of industrial processes involve the transfer of heat energy. Throughout any industrial facility, heat must be added, removed, or moved from one process stream to another and it has become a major task for industrial necessity. These processes provide a source for energy recovery and process fluid heating/cooling.

The enhancement of heating or cooling in an industrial process may create a saving in energy, reduce process time, raise thermal rating and lengthen the working life of equipment. Some processes are even affected qualitatively by the action of enhanced heat transfer. The development of high performance thermal systems for heat transfer enhancement has become popular nowadays. A number of work has been performed to gain an understanding of the heat transfer performance for their practical application to heat transfer enhancement. Thus the advent of high heat flow processes has created significant demand for new technologies to enhance heat transfer

There are several methods to improve the heat transfer efficiency. Some methods are utilization of extended surfaces, application of vibration to the heat transfer surfaces, and usage of micro channels. Heat transfer efficiency can also be improved by increasing the thermal conductivity of the working fluid. Commonly used heat transfer fluids such as water, ethylene glycol, and engine oil have relatively low thermal conductivities, when compared to the thermal conductivity of solids. High thermal conductivity of solids can be used to increase the thermal conductivity of a fluid by adding small solid particles to that fluid. The feasibility of the usage of such suspensions of solid particles with sizes on the order of 2 millimeters or micrometers was previously investigated by several researchers and the following significant drawbacks were observed (Das and Choi, 2006).

1. The particles settle rapidly, forming a layer on the surface and reducing the heat transfer capacity of the fluid.

2. If the circulation rate of the fluid is increased, sedimentation is reduced, but the erosion of the heat transfer devices, pipelines, etc., increases rapidly.

3. The large size of the particles tends to clog the flow channels, particularly if the cooling channels are narrow.

4. The pressure drop in the fluid increases considerably.

5. Finally, conductivity enhancement based on particle concentration is achieved (i.e., the greater the particle volume fraction is, the greater the enhancement—and greater the problems, as indicated above).

Thus, the route of suspending particles in liquid was a well known but rejected option for heat transfer applications. However, the emergence of modern materials technology provided the opportunity to produce nanometer-sized particles which are quite different from the parent material in mechanical, thermal, electrical, and optical properties.

3.1 NANOPARTICLES USED:

There are various metallic, non metallic nanoparticles and multiwalled carbon nanotubes (MWCNT) which are currently used with base fluids to enhance the thermal performance of the cooling systems for example: MgO_2, Al_2O_3, TiO_2, CuO Common base fluids are water, ethylene glycol and oil.

3.2. NANOFLUID PREPARATION METHODS

Two methods are used for prepared nanofluid which are:

3.2.1: ***Single-Step Method***: This method is include preparation of nanoparticles combining and synthesis of nanofluid, nanoparticles are prepared by Physical or chemical process. In this method, dispersion of nanoparticles, drying, storage and transportation are avoided, therefore, nanoparticles agglomeration is minimized and fluids stability is increased. However, this method used only for low vapor pressure fluids.

3.2.2: ***Two-Step Method***: The nanoparticles are manufacture as a powder by some suitable techniques in this method, then dispersing the nanopowder the base fluid. In both steps of this method, there's agglomeration of nanoparticles during nanoparticles storage and transportation. Simple techniques used to decrease particle aggregation and improve dispersion behavior such as ultrasonic agitation. Since several companies adopted the nano powder synthesis techniques, so, the two-step synthesis method are economically advantageous. In this study, the second method is used.

4. RADIATOR AS COOLING DEVICES:

The radiator is part of the cooling system of the engine Automobile radiators utilize mostly a crossflow heat exchanger. The two working fluids are generally air and coolant. As the air flows through the radiator, the heat is transferred from the coolant to the air. The purpose of the air is to remove heat from the coolant, which causes the coolant to exit the radiator at a lower temperature than it entered at.

5. LITERATURE SURVEY:

B. Farajollahi et.al: in their experiment, study heat transfer characteristic of γ-Al203 in water and Ti02 in water under turbulent flow condition. Comparison of the heat transfer behavior of two nanofluids indicate that at a certain peclet number, heat transfer characteristics of TiO2/water at its optimum nanoparticle concentration are greater than those of γ-Al203/water nanofluid.γ-Al203/water nanofluid possess better heat transfer behavior at higher nanoparticle concentration.

Baoguo Pan et al : In order to meet the cooling needs of high heat flux (HHF) internal plasma facing components (PFC) of fusion reactor, experimental investigations of hypervapotron (HV) heat transfer enhancement with the alumina–water nanofluids were carried out. Real-time temperature data of the four specified positions at the root of HV fins were acquired by the temperature sensors and used to analyze the heat transfer performance enhancement under each of the corresponding conditions.

E. Shekarian et al: gave an introduction to the needs of using nanofluids are presented follow by preparing procedure and its applications as well as the effective parameters on nanofluid conductivity. The investigated parameters in this paper are: nanofluid type, nanoparticle shape, and size, acidity, base fluid type, nanofluid surface charge, nanofluid concentration, and temperature. The results show that all the mentioned parameters have significant effect on nanofluid conductivity.

Golakiya Satyamkumar et al: used nanofluids in radiator instead of water. Researchers said that they can improve the thermal efficiency of radiator. So cooling effect of the radiator is improved and also the overall efficiency of the engine.

Jaafar Albadr et al: perform case study on forced convective heat transfer and flow characteristics of a nanofluid consisting of water and different volume concentration of Al2O3 (30nm) nanofluid (0.3% - 2%) flowing in shell and tube heat exchanger counter flow under turbulent flow condition. The result showed that convective heat transfer coefficient is slightly higher than that of base fluid at same mass flow rate and at same inlet temperature.

Johnathan J. Vadasz et al: studied Heat transfer enhancement in nanofluids suspensions. They gave the possible mechanisms and explanations in their study paper. They carried out experiments in which the thermal conductivity of fluids is studied by adding very small amounts of suspended metallic or metallic oxide nanoparticles (Cu, CuO, Al2O3) to the fluid, or alternatively using nanotube suspensions.

Kailash Nemade et al: reported enhancement of thermal conductivity of CuO based nanofluids via probe sonication time. The novelty of present work is that enhancement in thermal conductivity was achieved by simply increasing probe sonication time. The experimental results show that thermal conductivity increases smoothly with probe sonication time characteristics that these nanofluids possess that make them suitable for such applications. Application involves industrial applications, nuclear reactors, transportation, electronics as well as biomedicine and food.

Kazem Bashirnezhad et al: an attempt has been made to cover the latest experimental studies performed on the viscosity of nanofluids. Through experiments, the real effects of volume fraction, temperature, particle size, and shape on the viscosity of nanofluids will be determined. The aim of this paper is to review the latest experimental studies conducted on viscosity of nanofluids by considering the parameters such as method, base fluid type, temperature, particle size and shape, volume concentration, acidity (pH value), shear rate, surfactants, and particle aggregation.

Kedar N. Shukla et al: In this study, a new analytical model for the effective thermal conductivity of liquids containing dispersed spherical and non-spherical nanometer particles was developed. In addition to heat conduction in the base fluid and the nanoparticles, we also consider convective heat transfer caused by the Brownian motion of the particles.

M. Srinivasa Rao et al: Biodiesel emulsions were prepared using surfactants and were tested in an engine. Emulsion was an efficient method to mitigate the NO level Aluminium oxide hydroxide (AlO(OH)) nanoparticles were used as a fuel borne catalyst. Significant reduction in level of pollutants in emissions using nanoparticles. Characterization of AlO(OH) nanoparticles using XRD and TEM was analyzed.

Majid Zarringhalam et al: in their study paper gave the Experimental study of the effect of solid volume fraction and Reynolds number on heat transfer coefficient and pressure drop of CuO–Water nanofluid. The Result shows that generally heat transfer coefficient of nanofluids is higher than that of base fluid. Moreover, it is observed that heat transfer coefficient and Nusselt number of nanofluids increases with an increase in solid volume fraction and Reynolds number. But the rate of this increase in low Reynolds numbers was more than that at high Reynolds numbers.

Mohammad Hossein Aghabozorg et al: in their paper gave the Experimental investigation of heat transfer enhancement of Fe2O3-CNT/water magnetic nanofluids under laminar, transient and turbulent flow inside a horizontal shell and tube heat exchanger. The experimental study of Convective heat transfer performance of Fe-CNT/water magnetic nanofluids in laminar, transient and turbulent flow through shell and tube heat exchanger is given briefly in this paper. The experiment were carried at the three kind of heat flux (with voltages 80, 120 and 150 V).

Nishantkumar et. Al: in there experiment used shell and tube heat exchanger, water based and ethylene glycol CuO TiO2 based nanofluids with0.02%, 0.04% and 0.06 have been used as working fluid for different flow rate of nanofluids. This enhancement was investigated with regards to various factors, concentration of nanoparticles, types of base fluids, sonification time and inlet temperature. The effect of Nusselt number and Reynolds number of suspended nanoparticles on heat transfer characteristics have been investigated.

Purna Chandra Mishra et al: have found the dependence of thermal conductivity of nanofluid on its material, shape, size, temperature, viscosity. Nanofluids applied in various engineering fields critically require the suitability of thermal conductivity particularly in heat transfer applications. This paper presents an extensive review on theoretical and experimental works done on thermal conductivity of nanofluids.

Ravi agarval et al: this paper showed CuO nanoparticles from two different starting precursors show different properties. CuO–distilled water nanofluids give superior thermal conductivity results. Thermal conductivity is more sensitive to volume percent change at higher concentration. CuO–distilled water nanofluids show higher thermal conductivity sensitivity. Sensitivity analysis for thermal conductivity was also performed.

Radrigo Vidonscky Pinto et al: in their review show how nanoparticles affect of the thermal transport mechanisms, stating that the brownian motion of nanoparticles, particle clustering and formation of an interface layer around the nanoparticle are widely acknowledged. They also reviewed thermal conductivity and heat coefficient enhancement in nanofluids convention and boiling applications.

R J Bhatt et al: in there review showed application of nanofluid in automobile industry. The nanofluid has been used in radiator to decrease size and efficiency of radiator. Automobile radiators can be made energy efficient and compact as heat transfer can be improved by nanofluids. Reduced or compact shape may results in reduced drag, increase the fuel economy, and reduces the weight of vehicle.

Sadegh Aberoumand et al: Rheological properties of applied nanofluids have been discussed. Synthesis and stability of nanofluids have been discussed. Convective heat transfer (forced and mixed) of applied nanofluids flow inside curved tubes have been discussed. Convective heat transfer enhancement of Ag-Heat Transfer oil nanofluids, flow inside curved tubes, has been investigated empirically in the thermal entrance region.

S.S. Abhishek et al: in there review gave introduction to nanofluids. The paper focuses on preparation methods of nanofluids and its advancements. The characteristics and the various thermal properties of nanofluids are discussed in this paper. The preparation of nanofluids with controllable microstructure is one of the key issues.

T. Coumaressin et al: HFC 134a is the mostly widely used alternative refrigerant in refrigeration equipment such as domestic refrigerators and air conditioners. Though the global warming up potential of HFC134a is relatively high, it is affirmed that it is a long term alternative refrigerants in lots of countries. By addition of nanoparticles to the refrigerant results in improvements in the thermophysical properties and heat transfer characteristics of the refrigerant, thereby improving the performance of the refrigeration system.

Yimin Xuan et al: presents a procedure for preparing a nanofluid which is a suspension consisting of nanophase powders and a base liquid. By means of the procedure, some sample nanofluids are prepared. The theoretical study of the thermal conductivity of nanofluids is introduced. The hot-wire apparatus is used to measure the thermal conductivity of nanofluids with suspended copper nanophase powders. Some factors such as the volume fraction, dimensions, shapes and properties of the nanoparticles are discussed.

Zena K. Kadhim et al: Experimental investigations have been carried out in this paper to study the enhancement of heat transfer characteristics for cross flow integral finned tube heat exchanger with using of MGO nanofluid. The study includes designing and manufacturing of test section from pyrex glass with dimensions (250 x 500 x 1200) mm width, height and length respectively. The apparatus has a single copper tube with eight passes.

CONCLUSION:

1. The heat capacity dissipation and the efficiency factor (EF) of Nano coolant (NC) are higher than ethyl glycol-water (EG/W), and the TiO2 NC are higher than Al2O3 NC. The overall heat transfer coefficient increases with enhancing volumetric flow rate of the Nano fluid significantly.

2. Cooling capacity and effectiveness increase with increase in mass flow rate of air and coolant. Also increasing the inlet liquid temperature decreases the overall heat transfer coefficient.

3. The overall heat transfer coefficient decreases with increasing inlet temperature of the Nano fluid.

4. Nano fluid offer higher heat-transfer properties compared to that of conventional coolant.

5. Requirement of pumping power reduce with the use of Nano fluid in radiator.

6. A blend of 50/50 mix of water and ethylene glycol in which corrosion inhibitors have been incorporated is much more effective than using water and ethylene glycol alone. While water alone is good coolant but the enormous corrosion problems associated with it, is enough to discourage its use.

7. The heat transfer behaviour of the Nano fluid were highly depended on the particle concentration, the flow condition and depended on the temperature.

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