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EXPERIMENTAL INVESTIGATION OF HEAT TRANSFER CHARACTERISTICS USING NANOFLUIDS IN AN AUTOMOTIVE RADIATOR

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ABSTRACT:

Heat exchangers play an important part in the field of energy conservation, conversion, and recovery. Nanofluids, on the other hand, display much superior heat transfer characteristics compared to traditional heat transfer fluids. A model is fabricated using radiator, pump, fan, pipes, temperature indicators, square type iron rod. Heat transfer – An ever-rejuvenating phenomenon from and for decades together. Though numerous approaches like geometrical modifications and heat transfer enhancing approaches are instigating, developing and pioneering the studies on heat transfer is remarkably new with innovating approaches. Recent past is the evident for the suspension of high thermal conductive nanoparticles in conventional fluids in order to improve the heat removal from the various electro-mechanical components. Engine cooling is a primary requisite in automobile using radiator. In this work base fluid water is replaced with conventional nano fluids. The inlet and outlet temperatures of Water, Copper oxide, Aluminium Oxide nano particles are studied. Later the heat transfer rates are calculated and compared with the base fluid(water).

INTRODUCTION

A radiator is the key component of the engine's cooling system. Its main role is to disperse a mix of antifreeze and water throughout its fins, which releases some of the engine's heat while taking in cool air before continuing to pass the rest of the engine.

An essential requirement for an automobile cooling system is miniaturization of the thermal system in addition to its ultra-high performance. The vital role in the development of energy efficient fluids is played by "thermal conductivity" of the heat transfer fluids. Previously used coolants such as water, ethylene glycol (EG), and oil put many restrictions in the growth of developing an efficient thermal system mainly because of their poor thermal conductivity.

Nanotechnology helped in obtaining nanosized particles which lies in the range from 1 to 100 nm and to form nanofluids when mixed with some base fluids like water, EG etc., to find the solution for thermal systems. Most of the thermal properties in nanofluids like thermal conductivity are superior to the base fluids which have certainly helped them in gaining a lot of attraction. A lot of research work has been completed by different authors on the different metal oxide-based nanofluids and their effect on various properties in comparison with the base fluids.Nanofluids have many emerging and potential applications particularly in heat transfer applications including cooling of electronic chips, hybrid-powered engines, vehicle thermal management, micro-electronics, pharmaceutical processes, engine cooling, fuel cells, domestic refrigerator, chiller, heat exchanger, coolants used in machining, nuclear reactors, energy efficiency enhancement, boiler flue gas temperature reduction, for cooling the welding apparatus and high heat-flux devices like microwave tubes and LASER diode arrays and also have prominent role in biological sciences as well. Kostis addressed the areas of applications of nanofluids in many engineering devices to improve its efficiency

LITERATURE SURVEY

Horuz (1998)"An alternative for road transport refrigeration" Tr. J. Of Engineering and Environmental Scienceconducted an experimental investigation into the effect on the performance of the IC engine of introducing the VAR system into the exhaust system and also the provision of appropriate off-road/slow running cooling systems, in order to take account of the reduction in exhaust gas flow in slow running traffic or stationary situations or when the vehicle is parked and cooling is still required. Builtin eutectic plates could provide temporary cooling under such conditions. Such plates could be recharged by redirecting the cooling effect from the main body to the eutectic plate during off-load periods of continuous full-load travel.

Wang X, Xu X, Choi SUS: (1999) "Thermal conductivity of nanoparticlefluid mixture" J Thermophys Heat transfer due to the low pressure operation compared with a 50/50 mixture of ethylene glycol and water, which is the universally used automotive coolant. The Nano fluid has a high boiling point, and it can be used to increase the normal coolant operating temperature and then reject more heat through the existing coolant system and also contribute to a reduction in friction and wear. It is conceivable that greater improvement of savings could be obtained in the future but with time Nanofluids degrade radiator material and Erosion of radiator material will be there. Choi studied the development of energy efficient Nano fluids and smaller and lighter radiators. A major goal of the Nanofluids project is to reduce the size and weight of the HV cooling systems by >10% thereby increasing fuel efficiency by >5%. Nano fluids enable the potential to allow higher temperature coolants and higher heat rejection in HVs. A higher temperature radiator could reduce the radiator size by perhaps 30%.

Srikhirin P, Aphornratana S, ChungpaibulpatanaS.(2001)"A review of absorption refrigeration technologies. Renew Sustain Energy" they give initialization of work that Absorption refrigeration was discovered by Nairn in 1777, though the first commercial refrigerator was only built and developed in 1823 by Ferdinand Carré, who also got several patents between 1859 and 1862 from introduction of a machine operating on ammonia–water. By the 19th century, systems operating on ammonia–water found wide application in residential and industrial refrigerators. Systems operating on lithium bromide–water were commercialized in the 1940's and 1950's as water chillers for large buildings air conditioning

Liu M-S, Lin MC-C, Tsai CY, Wang C-C(2006). "Enhancement of thermal conductivity with Cu for Nanofluids using chemical reduction method" Investigated the thermal conductivity of copper–water Nanofluids produced by chemical reduction method. Results showed 23.8% improvement at 0.1% volume fraction of copper particles. Higher thermal conductivity and larger surface area of copper nanoparticles are attributed to this improvement. It is also noted that thermal conductivity increases with particle volume fraction but decreases with elapsed time.

Assael, M. J.; Metaxa, I. N.; Kakosimos,K.&Constantinou, D. (2006)."Thermal Conductivity of Nanofluids-Experimental and

Theoretical", Smaller the size the greater the stability of colloidal dispersion and the greater the stability of colloidal dispersion the greater the probability of interaction and collision among particles and collision among particles and fluid and the greater the effective heat energy transport inside the liquid

Alam Shah A(2006)."A proposed model for utilizing exhausts heat to run an automobile air-conditioner"Studied the possibility of operating a triple fluid vapour absorption system using engine exhaust power. From the analysis it was concluded that there is a possibility of operating a triple fluid system using engine exhaust power. 18.

EXPERIMENTAL SETUP

Experimental Setup The heat transfer rate of the nanofluid coolant was measured using an experimental setup as shown in Fig. 1. It consists of a car radiator, an electric heater, a reservoir tank, a centrifugal pump, an air blower, flow control valves and K-type thermocouples to measure inlet and outlet fluid temperature. An electrical heater of 2 kW was used to heat the coolant in the reservoir tank. The coolant was circulated using a 0.25 HP centrifugal pump. A globe valve was used to vary the flow rate of the coolant fluid entering the radiator in between 3-6 lit/min. Two K-type thermocouples were placed at the inlet and the outlet of the radiator to measure the coolant temperatures. Thermocouples were also fixed on both the sides of the radiator wall surface to measure air temperatures.

Experimental Procedure

The forced convective heat transfer experiment was conducted in the radiator experimental setup using pure water, water/propylene glycol mixture (70:30), and water/propylene glycol/TiO2nanofluid (0.1% and 0.3% by volume). The coolant in the reservoir tank was heated up to the desired temperature and circulated through the radiator using the pump. The inlet temperature of the coolant to the radiator is kept constant at the nominal operating temperature range between 50°C to 80°C. The coolant flow rate was varied between 3 to 6 l/min. The air flow rate to the radiator was kept constant at an average of 4m/s.

The outlet temperature of the coolant was recorded using K-type thermocouple. Furthermore K-type thermocouples were fixed on the radiator wall on both the sides to record the air temperature.

Radiator Types and Construction :- In common language, the radiators are referred to as heat exchangers which are used to transfer the thermal energy from one medium to the other with a purpose of cooling and heating. A radiator consists of a large amount of cooling surface which contains a huge quantity of air that gets spread through the effect of water in order to cool down

RELATED WORK

EQUIPMENT ARRANGEMENT

Experimentation equipment was arranged as shown in the figure. The main components are radiator, water sump, exhaust fan, recalculating pump, water heater, solenoid magnetic coil, Probe type so nicator. The circulating pump was fixing at the bottom of water sump. water for recalculating water. This pump outlet was connected to the radiator inlet pipe. Its outlet was connected to the water collecting sump.

Without Nanofluids

In this experimentation was done without nano particles. The water heating coil tip was dip in to the water sump. Set the thermostat at a temperature of 50 degrees centigrade then after few minutes circulate the water into the radiator. Behind radiator the exhaust fan was arranged for cooling purpose. For temperature measurement the thermocouples (Temperature indicator) are attached to the water sump. At initial arrangements these are indicating the temperature difference of water before circulating and after circulating into the radiator.

With Aluminum Oxide Nano fluids

the experimentation was done with only Aluminum Oxide Nano fluids.Theprocedure is same as like trail 1. But in trail 1we get desired results of temperature drop with compared to the base fluid experimentation because of adding Aluminum Oxide nano fluid concentration. The Aluminum Oxide nano fluid observes from the radiator in this trail we use one level of concentration percentage of nano fluids are used they are 0.1%, respectively.

With Copper Oxide Nano fluids

In trail – 3 the experimentation was done with only copper oxide nano fluids. The procedure is same as like trail 1. But in trail 1&2 we get desired results of temperature drop with compared to the base fluid experimentation because of adding cooper oxide nano fluid concentration. The copper nano fluid observes from the radiator in this trail we

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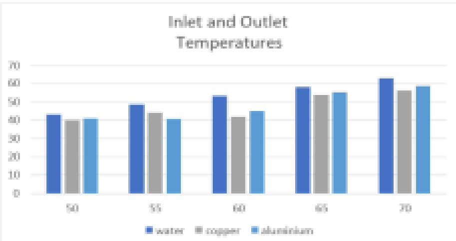
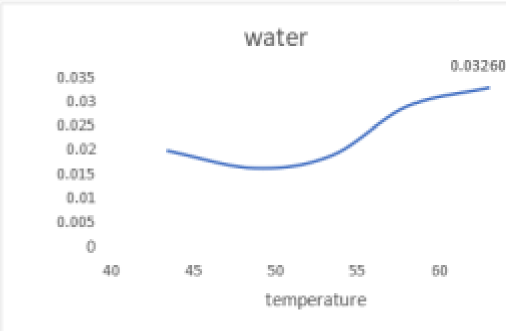
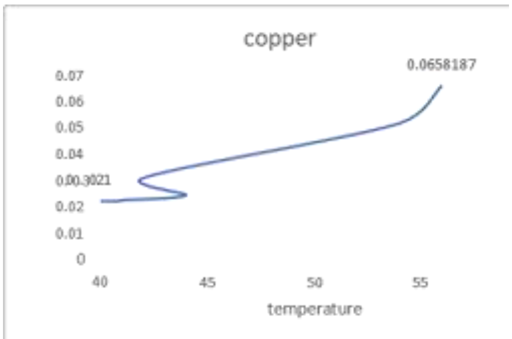
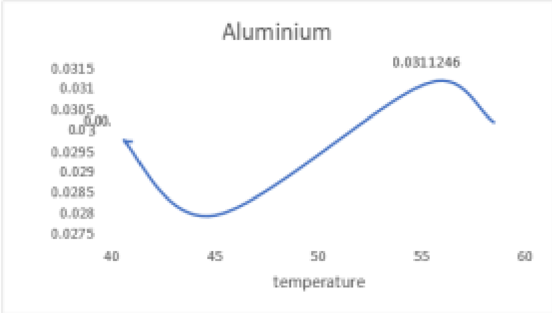
use one level of concentration percentage of nano fluids are used they are 0.1%, respectively.

SAMPLE RESULTS









CONCLUSION

An experimental survey is conducted on automobile radiator with different working fluids such as water, Al2O3/water and CuO/water nanofluids.

It can be observed from the experimental results that suspension of high thermal conductive nanoparticles in conventional radiator fluid would able to enhance the heat transfer rate due to their inherent higher thermal properties.

It is noticed from the results that CuO particle suspended nanofluid offers higher convective currents and subsequent Nusselt number. One can conclude from the results that relatively high thermal conductive CuO nanoparticles exhibits better thermal balance than the other fluids

REFERENCES

➢ HaipingHong a BrianWrightaJesseWensel a SunghoJinb Xiang RongYebWalterRoyc "Enhanced thermal conductivity by the magnetic field in heat transfer nanofluids containing carbon nanotube” . Volume 157, Issues 10–12, June 2007, Pages 437-440.

- S.M. Peyghambarzadeha , S.H. Hashemabadib , S.M. Hoseinia , M. Seifi Jamnanib “Experimental study of heat transfer enhancement using water/ethylene glycol based nanofluids as a new coolant for car radiators” International Communications in Heat and Mass Transfer 38 (2011) 1283–1290.
- Babu Rao Ponangiab, V. Krishnaab, K.N. Seetharamuab . “Performance of compact heat exchanger in the presence of novel hybrid graphene nanofluids” International Journal ofThermal Sciences 165 (2021) 106925.
- LersakNakharintr, PaisarnNaphon, Magnetic field effect on the enhancement of nanofluids heat transfer of a confined jet impingement in mini-channel heat sink. Volume 110, July 2017, Pages 753-759.
- Mohd Muzammil Zubair1 Md. Seraj2 Mohd. Faizan1 Mohd Anas2 Syed Mohd. Yahya1 “Experimental study on heat transfer of an engine radiator with TiO2/ EG-water nano- coolant” SN Applied Sciences (2021) 3:434.
- XilongZhang, YongliangZhangExperimentalstudy on enhanced heat transfer and flow performance of magnetic nanofluids under alternating magnetic field. Volume 164, June 2021.
- Mohammad Hossein Aghabozorga1 Alimorad Rashidib2 Saber Mohammadic3 “Experimental investigation of heat transfer enhancement of Fe2O3-CNT/water magnetic nano fluids under laminar, transient and turbulent flow inside a horizontal shell and tube heat exchanger”. Volume 72, April 2016, Pages 182-189
- Lei Shia,b, YanweiHua,b, YurongHea,b , “Magneto-responsive thermal switch for remotecontrolled locomotion and heat transfer based on magnetic nanofluids”. Volume 71, May 2020, 104582.
- M. Sheikholeslami, M. Jafaryar, E. Abohamzeh, A. Shafee, H. Babazadeh, Energy and entropy evaluation and two-phase simulation of nanoparticles within

a solar unit with impose of new turbulator, Sustainable Energy Technol. Assess. 39 (2020) 100727.

- Y. Mohammadfam, S.Z. Heris, L. Khazini, Experimental investigation of Fe3O4/ hydraulicoil magnetic nanofluids rheological properties and performance in the presence of magnetic field, Tribol. Int. 142 (2019) 105995.