Review on Performance Investigation of an Automotive Car Radiator Operated with Nano fluids based Coolant

Juneriya A. Shaikh[1], Prof. Tushar A. Koli[2], Dr. Vijay H. Patil[3]

[1-3]*Mechanical Department, GF's Godavari College of Engineering, Jalgaon.*

Abstract — *In this paper, we will review the performance investigation of an automotive car radiator by using nano fluids based coolant. This work will investigates the use of aluminium oxide (Al2O3) and copper nanopaticle(CU) nanoparticles. There are two occurrence happening in a heat exchanger: fluid flow in channels and heat transfer between fluids and channel walls. Thus, enhancement to heat exchangers can be achieved by improving the processes occurring during those phenomena. Nanofluids, display much superior heat transfer characteristics compared to traditional heat transfer fluids. The investigation is planned to be conducted for wide ranges of Peclet numbers, and volume concentrations of suspended nanoparticles. The outcome expectation is to measure the significance of Peclet number on the heat transfer characteristics[4]. This review is to investigate the concept of using nanofluid in heat exchangers. The optimal volume concentrations in which the heat transfer characteristics become the maximum enhancement is also addressed. Finally, the structure of different nanofluidis will be compared.*

Keywords-*Nanofluids, Automotive Car Radiator, Heat Transfer Enhancement, Aluminum oxide, Copper Nanoparticle.*

1. INTRODUCTION

It has been theoretically approved that using Nano particles can update the performance of the heat transfer. This investigate the concept of using Nano fluid in heat exchangers experimentally. Nano fluids are engineered infusion made of a base fluid and nanoparticles (1-100 nm) [5]. Nano fluids have elevated thermal conductivity and single-phase heat transfer coefficients than their base fluids. The concept of Nano fluids refers to a new kind of heat transmission fluids by draping Nano scaled metallic or non-metallic particles in base fluids. Energy transmission of the Nano fluid is affected by the properties and dimension of nanoparticles also solid volume[21]. We are seeking to practically prove what has already been done theoretically, which is that Nano fluids would increase the efficiency of a system with a slight or no pressure drop. This will mean that Nano fluids can be used in industrial settings to rise the efficiency of the systems for nominal costs. This project is a continuance of all the other theoretical studies that have been done on the subject. We will experimentally prove that Nano particles in fluids will enhance efficiency without compromising pressure. This would mean that the technology would be a step closer to being used in industrial settings. The major application of this project is in industrial heat transfer settings like power plants, desalination plants, and maybe even in the Radiators of trucks. The project is meant to increase the efficiency of current systems without significant investment, and reduce the cost of future systems by increasing the efficiency of smaller parts to do the job.

2. SYSTEM DESIGN

One of main problems is controlling the flow of the nanoparticles that we have to overcome as illustrated in the next chapter. The relationship between the amount of nanoparticles in the water flow and heat transfer efficiency is directly proportional, however, its behavior reverse at a specific point and the pressure drop is inversely proportional to heat transfer efficiency, [1]. Accordingly optimization between these parameters should be conducted, meaning to reach the highest possible efficiency with the least possible pressure drop.

Moreover, as engineers we consider engineering standards, environmental, economic, manufacturing, and safety issues. As a result, we have taken into consideration the engineering standards for parts and equipment selection. The main equipment in our prototype are a fan, ultra sound, car radiator, electric water pump, heater, and a water container, tubes, valves, pressure gage, and temperature sensors. Most of the parts and some of the equipment are locally made following the SASO standards. The car radiator, the fan, and the water pump we have used are South Korean made, which follows the national standard KATS (The Korean Agency for Technology and Standards), [2].

Figure (3.1) illustrates the project architecture. It shows the function of the system with the devices and the way the whole system operate. The approach of the system design started with finding a heat exchanger and we chose a car radiator with a fan. However, the water pump used in cars are mechanical (it connects to the engine) which cannot be properly worked in the experiment. This caused us to try an electrical pump with features that. In addition, we planned to use woody frames for the fan

and heat exchanger to fix them on the table. We need to find the best quality places with the minimum prices (to control our budget) to do the frames and the table. After choosing the proper parts and devices, we used SolidWorks software in order to simulate the assembly of the system. Last but not the least, we must assemble the components of the experiment in the way we instructed by the advisor with the consideration of previous works. Finally, we will do several experiment with and without using nanoparticles and publish our results and recommendations we observed.

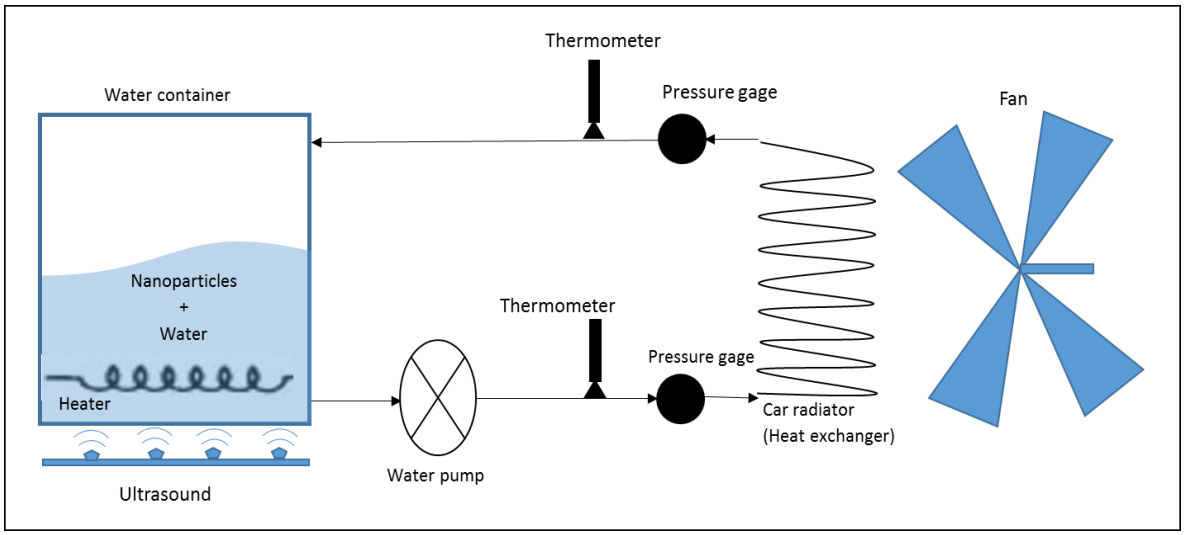

Figure (3.1) project architecture diagram

Our project design that can be used to transfer heat from hot water in a heat exchanger to Nano-fluid and make temperature determination for the same by using two thermo- couples in the cycle. The complete system includes flow meters that will be fitted in the pipes and carrying Nano-fluid to check its flowing rate. All the components are available and fit together perfectly. Here are the components and the alternatives found:

- The shell and tube heat exchanger is made up of stainless steel type 316 L, 248 mm long consisting of 37 tubes.
- The two flow loops 2.2 mm used in auto air-condition systems and they are so chosen for their size matching.
- A heating unit is also a household water heater because its outlets fit in the thermo controller unit.
- For the tanks we used Household water size 20-liter.
- Two thermometer to measure temperature units of inlet and outlet
- One pump (GP/05HPN1 S6) was selected because they are available and their outlets exactly match the flow loop diameter and also the flow meter.

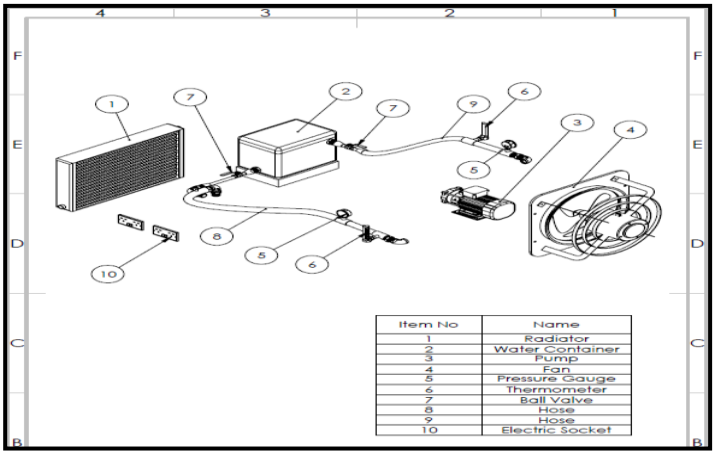

Figure (3.4), Exploded view of the design of the experimental set up

3. EQUATIONS USED IN THE CALCULATION.

The values listed in the chapter four tables were obtained from the following equations.

$\square_{\square} = \square_{\square}\square_{\square}$

$C_h = \dot{m}_h c_p$

$Q_{air} = C(T_{in} - T_{out})$

$Q_{water} = C_h(T_{in} - T_{out})$

$Q_{max} = C_{min}(T_{h,in} - T_{c,in})$

$\in = \frac{Qair}{Qwater}$ **Or** $\in = \frac{Qwater}{Qair}$ (the greater value is in the denominator) equation (3.1

.

$Qactual = Qmax \in$

$Qactual = UAs\Delta Tlm$

$\Delta Tlm = F\Delta Tlm,CF$

$\Delta Tlm, = \frac{\Delta\square_1 - \Delta\square_2}{\ln(\Delta T_1/\Delta T_2)}$

$\Delta T1 = Th,in - Tc,out$

$\Delta T2 = Th,out - Tc,in$

$\Delta P = \frac{L}{f.D} \frac{V^2}{2\rho}$

$V = \frac{\sqrt{4\dot{m}}}{\pi D}$

$D = \frac{4ab}{2ab}$

4. PROJECT MANAGEMENT

Since our project had two parts, the first part was to do the adequate preparation and organization where the other part was to do some experimental tests to prove the excellence of the theory. And because we run of time, we shall to work on it and exert more efforts to finish it on time and therefore we had determined times for every part in details to achieve our target for the final experiment. As all you know, the final phase was our priority although we had facing a lot of obstacles.

We had faced some difficulties finding some of the required parts and when these parts found, they were not be within the good quality. Also our biggest problem was the continual changes of these parts to execute and finish our project in a good picture.

5. EXPECTED CONCLUSION

To put our work in a few words, the project was intended to design an experiment to study the enhancement of heat transfer rate in car radiator systems using nanoparticles. We were required to complete the experiment within 4 months and provide a detailed report illustrating our work into it. The main aim of this project is to prove experimentally what already has been proved theoretically that Nano fluids increase the heat transfer rate with no pressure drop. Despite facing some inconsistencies of results due to environment conditions, the goal of the project has been achieved. Another important outcome of this project is that adding nanoparticles to fluids does not affect friction between the layers of fluids.

REFERENCES

[1] Choi, S., & Eastman, J. (1995). Enhancing Thermal Conductivity of Fluids with Nanoparticles. Argonne, IL: Argonne National Laboratory.
[2] Mohammed, H. A., Bhaskaran, G., Shuaib, N. H., & Saidur, R. (2011). Heat transfer and fluid flow characteristics in micro channels heat exchanger using nanofluids. Renewable and Sustainable Energy Reviews, 1502-1512.
[3] Etemad, S. G., & Farajollahi, B. (n.d.). Heat transfer of nanofluids in a shell and tube heat exchanger. Isfahan, Iran: Isfahan University of Technology.
[4] Xuan, Y., & Li, Q. (2003). Investigation on Convective Heat Transfer and Flow Features of Nanofluids. Journal of Heat Transfer,125, 151-155.
[5] Dr.Hiregoudar Yerrennagoudaru1 , Manjunatha.k 2 ,B.Vishnu Prasad 3 , Sandeep .k 4 ,S.Veeresh Kumar, Nanofluids for heat exchanger
[6] Maré, T., Halelfadl, S., Sow, O., Estellé, P., Duret, S., & Bazantay, F. (2011). Comparison of the thermal performances of two nanofluids at low temperature in a plate heat exchanger. Experimental Thermal and Fluid Science,35(8), 1535-1543. doi:10.1016/j.expthermflusci.2011.07.004
[7] Kats. (2017). Isoorg. Retrieved 15 Apr, 2017, from https://www.iso.org/member/1663.html
[8] Said, Z., et al., Performance enhancement of a Flat Plate Solar collector using Titanium dioxide nanofluid and Polyethylene Glycol dispersant. Journal of Cleaner Production, 2015.
[9] Das, P.K., et al., Synthesis and characterization of TiO 2–water nanofluids with different surfactants. International Communications in Heat and Mass Transfer, 2016.
[10] Abdul Hamid, K., et al., Thermal conductivity enhancement of TiO2 nanofluid in water and ethylene glycol (EG) mixture. Indian Journal of Pure & Applied Physics (IJPAP), 2016. 54(10)
[11] Rudyak, V.Y. and A.V. Minakov, Thermophysical properties of nanofluids. The European Physical Journal E, 2018
[12] Murshed, S., et al., Morphology and thermophysical properties of non-aqueous titania nanofluids. Heat and Mass Transfer, 2018
[13] Naraki, M., et al., Parametric study of overall heat transfer coefficient of CuO/water nanofluids in a car radiator. International Journal of Thermal Sciences, 2013.
[14] Leong, K., et al., Performance investigation of an automotive car radiator operated with nanofluid-based coolants (nanofluid as a coolant in a radiator). Applied Thermal Engineering, 2010
[15] Elsebay, M., et al., Numerical resizing study of Al 2 O 3 and CuO nanofluids in the flat tubes of a radiator. Applied Mathematical Modelling, 2016.
[16] Li, X., C. Zou, and A. Qi, Experimental study on the thermo-physical properties of car engine coolant (water/ethylene glycol mixture type) based SiC nanofluids. International Communications in Heat and Mass Transfer, 2016
[17] De Leon, O. and K.V. Wong, Applications of Nanofluids: Current and Future, in Nanotechnology and Energy. 2017, Pan Stanford.
[18] Heris, S.Z., et al., Experimental study of heat transfer of a car radiator with CuO/ethylene glycolwater as a coolant. Journal of Dispersion Science and Technology, 2014.
[19] Oliveira, G.A., E.M.C. Contreras, and E.P. Bandarra Filho, Experimental study on the heat transfer of MWCNT/water nanofluid flowing in a car radiator. Applied Thermal Engineering, 2017.
[20] Zafar Said1, M. El Haj Assad1, Ahmed Amine Hachicha1, Evangelos Bellos2, Mohammad Ali Abdelkareem, Duha Zeyad Alazaizeh, Bashira A. A. Yosef, "Enhancing the performance of automotive radiator using nanofluids.
[21] V. N. Anbazhagan, R. Rejikumar, TeshomeBekeleKotu, "Analysis of Heat Transfer Coefficient of Nano Fluids".