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A Review on Heat Exchanger Performance Improvement by different Nano Materials

Aashish Kumar Rangari*1, Gouraw Beohar2, M. R. Singh3

Mechanical Department, Shri Ram Institute of Technology, Jabalpur, India

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Abstract

The main objectives of designing of heat exchanger are to improve heat transfer, reducing total time to achieve heat transfer and increase total energy of the process. These efforts related to increases in efficiency, is created by direct and indirect methods. These methods mainly consist of creation of turbulence, expansion of heat transfer area. The thermal conductivity is defined as heat transfer capacity of liquid basically water and mineral oil. Results in poor heat transfer capacity of different fluids used in heat exchanger is reduced the total heat transfer of exchanger. The heat transfer occurs in nano fluids consisted nano particles have better heat conductivity properties than ordinary liquid.

KEWYWORDS: Heat Exchanger, CFD, Nano Materials**,** FEA.

1. INTRODUCTION

Heat exchanger is most significant equipment in all industries and double pipe heat exchanger counter flow is known as most efficient heat exchanger in all type. In all process industries it is known for transferring heat in different processes. The main objectives of designing of heat exchanger are to improve heat transfer, reducing total time to achieve heat transfer and increase total energy of the process. These efforts related to increases in efficiency, is created by direct and indirect methods.

2. REVIEW ON NANO MATERIALS

E.J. Onyriuka et al [1] investigate turbulence in double pipe heat exchanger with nano fluids, casted by bark of mango tree. Basically it is constructed through bark with 100 nm particles. By this two-phase mixture is obtained and analysis is done by Finite Element. Consideration with turbulent flow number which is associated with Reynold there is more than two-third rise in heat coefficient number which is known as Nusselt Number. By comparison researcher directly showed more than 200 percent increment while using nano particles. In continuation to this the Nusselt number can be decreased by 0.76 percent when researcher increases the 1 percent of volume. This will help in increasing heat transfer of liquid.

L. Syam Sunder et al [2] investigates the different volume of nano fluid of ferrous oxide with help of double pipe heat exchanger. There were different type of pitch coil ratios, and effectiveness of heat exchanger is evaluated. By investigation different particles concentration as per volume of fluids. Test results showed different pitch ratios with varied volume like 0.005, 0.01, 0.03, and 0.06 percent with different pitch ratio 1 to 1.8. results showed increment in Nusselt number up to 10 % with 0.06 percent volume of nano material. The values of Nusselt elevated with 26% and 38% with other values of concentration for respective Reynold number values 16540 and 28950 respectively

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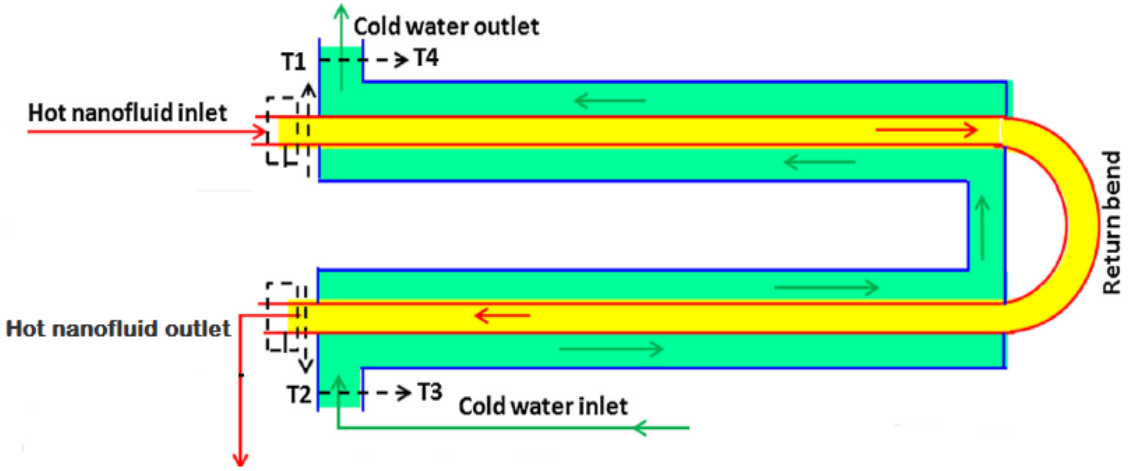

Fig. 2.1 Schematic diagram of the experimental setup [1].

B. Saleh et al [3] investigate the double pipe U bend type heat exchanger with CO_2 emissions of Nano fluid with MWCNT mixed with water. Reynold number ranges from 3501 to 11999 with different concentration value of 0.051 to 0.31 used in research. Results showed for viscosity is increased up to 16 % and 10 % thermal conductivity at temperature of approx 70 degree. The heat transfer coefficient, Nusselt number and thermal performance is increased upto 45 %, 30 % and 30 %. At concentration of 0.3 % pressure drop is near about17% and friction factor is 14. The effectiveness of heat exchanger is increased up to 2.5 % and also number of transfer unit up to 3% as compared with water and nano particles. CO2 emissions are 80 kg which is less as compared with water CO2 percentage which is 85 kg of CO2. In energy sense is also 400 MJ and reduced up to 390 MJ.

Fig. 2.2Experimental test facility line diagram [2].

Sarafraz et al [4] showed his results regarding drop in pressure and total transfer coefficient of carbon nanotube type. In this experiment researcher proposed a setup of twin pipe heat exchanger, Inner and outer diameter with 6 mm and 12 mm respectively. The Nano fluids constructed with help of COOH which deionized with water of two step procedure. By use of

forced convection method laminar flow of approx. 1000 Reynold number and turbulent flow with 11000 Reynold number various parameters were to be measured by this experiment. Parameters like concentration of mass, drop in pressure and flow rate is measured. By investigation researcher found increment in conductivity more than 50% and higher heat transfer coefficient for 0.3 % concentration.

Bashtani et al [5] determined the total effect of Al2O3 mixed with water in double pipe heat exchanger with special arrangement of tabulators. The present experiment work examined the Reynolds range of 3100 to 13500 with different temperature of fluid termed as hot and cold fluid. Experiment clearly showed the tabulator of six gear mounted on entrance and total efficiency of heat exchanger is increased by more than 70 %. Experiment also validates the increasing local Nusselt number and heat transmission. As per results concentration increased with the nano particles. It is 1.2 times higher than pure water. So the Reynolds number higher when Nano particles are in concentration.

B. Kamenik et al; [6] investigates the performance of nano fluids heat exchanger with turbulent flow range. Turbulent flow region are taken from $4x\ 10^3$ to 1.8×10^5, for validate the method known as Stochastic Collocation. Research showed maximum impact of nano fluid thermal conductivityin performance of heat exchanger.

Arun Kumar Tiwari et al. [7] researches nano particles volume range from zero to 3% range to calculate the different parameters like effectiveness and performance of heat exchanger. The study also distinguishes the maximum heat transfer and convective heat transfer for different nano fluids. The calculated value for heat transfer is varies from 35 % to 14% as per concentration of nano fluids with particle at respective flow 3 liters per minute. Research proposed the maximum performance valve is lesser than optimum value of nano concentration in transfer of heat.

Heydar Maddah et. al. [8] analysed the exergy values in double pipe heat exchanger with alumina and titanium oxide nano particles with turbulent flow inside pipe. The Reynolds number for given fluid is varied from 3×10^3 to 12×10^3 range with twist ratio varies from 2 to 8.0. The vital parameters during exergy analysis are variance analysis where the results showed improved exergy during experiment by using twist angle and tapes.

K.Y. Leong et. al. [9] investigates the nano fluids with ethylene glycol in cooling arrangement of automobile. Research used copper nano particles to calculate heat transfer in automobile cooling arrangements. Study also suggested that nano fluid usage in radiators will help in improving heat transfer tendency in vehicle. In comparison with conventional type coolant where low conductivity occurred, by introducing the nano fluids, coolant can achieve increased heat transfer coefficient and better performance. Researcher achieved 4% more heat transfer with the help of cooper nano fluid by adding 1.9% particles in the coolant base.

G. Jamuna Rani et al. [10] investigate the heat exchanger of cross flow type with different nano fluids like alumina, titanium and silica oxides in different fluids like air and water. The study also concluded its result with ANN analysis supported with computational fluid dynamics. Thermal performance comparison has been done with respect to cooling system performance by using different oxides of aluminum, titanium and silica types. Research also suggested the maximum heat transfer of nano fluids when introduced in cross flow type heat exchangers.

Jaafar Albadr et al [11] investigated the heat transfer and characteristics of nano fluids in forced condition. Fluids like alumina oxide with nano particles in varying concentration of 0.3 to 2% with counter flow arrangement. Investigation conducted with approx 30 nano meters particles with unchanged flow and temperature at inlet. The convective heat transfer increased with volume concentration of nano fluids increased.

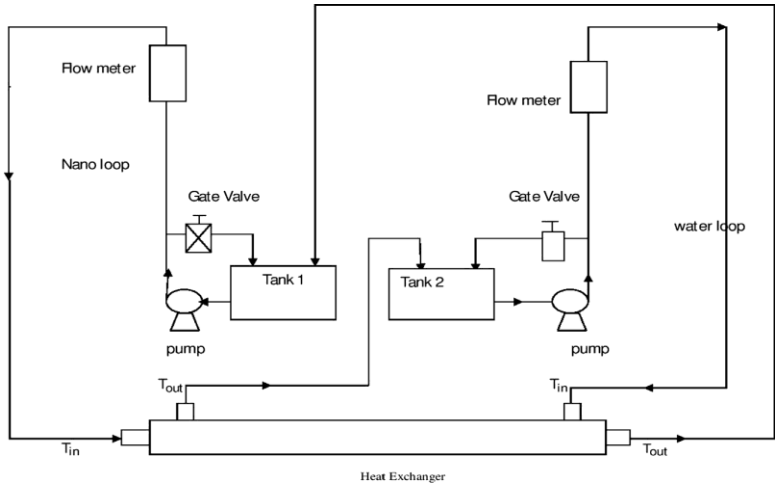

Fig.2.3Systemdiagram of the experimental setup [6].

Cong Wang et al; [12] investigated helical coiled by computational fluid dynamics method and experimental method. By comparing results the total flux of heat and heat transfer coefficient is increased more than 100 percent. Drop of pressure constraint showed more 10% increment with reference to the heat flux.

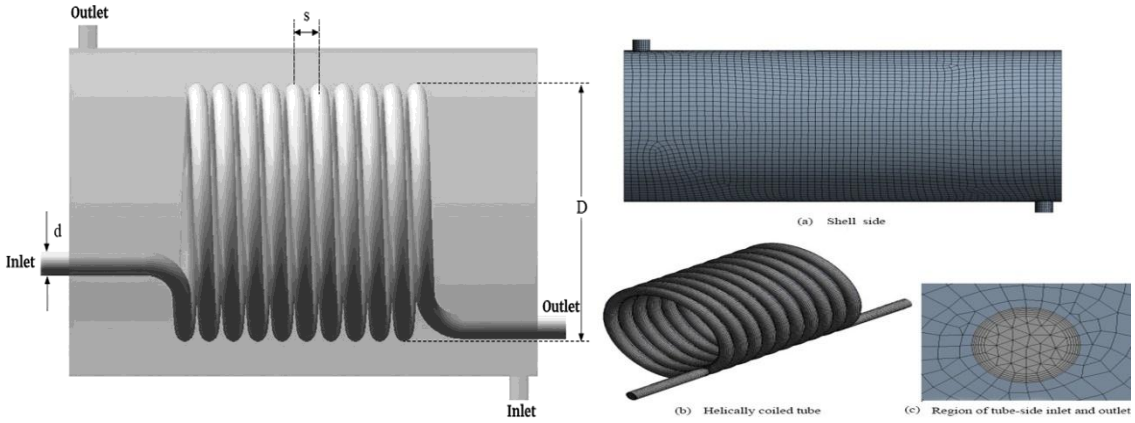

Fig.2.4(a)Physical model of helically coiled tubeFig.2.7(b) Grid of the shell-side and tube-side [7].
heat exchanger.

M.M. Elias et al. [15] investigated the effect of different particle shape of nano particles by studying the different constraints like heat transfer and entropy of heat exchanger constructed with baffles and angle variation in baffles. There is different heat transfer coefficient value with 20, 30 ,40 and 50 baffles. The value of 20 baffles heat transfer coefficient is 12% , 20%, 29% and 18 % higher than baffles used 30 , 40 50 and conventional segmentalbaffles value with use of Boehme alumina particles.

Hasan Kücük et al. [16] investigated the pressure drop and shell side transfer of heat in tube type heat exchanger. There are mini channel made with copper is used with construction of 3mm and length of 24 cm in configuration of triangular shape. With variation in reynold number of 5000 the total pressure drop is more than two time with respect to conventional macro type heat exchanger.

S.M. Peyghambarzadeh et al. [13] research about convective heat transfer in forced circulation with nano fluid in water and pure water. Alumina nano fluid with water circulated with maximum 1 % concentration in more than 30 tubes in vertical arrangement. Turbulent regims with elliptical cross section, the mass flow rate is at constant rate with temperature range 50 degree Celsius.

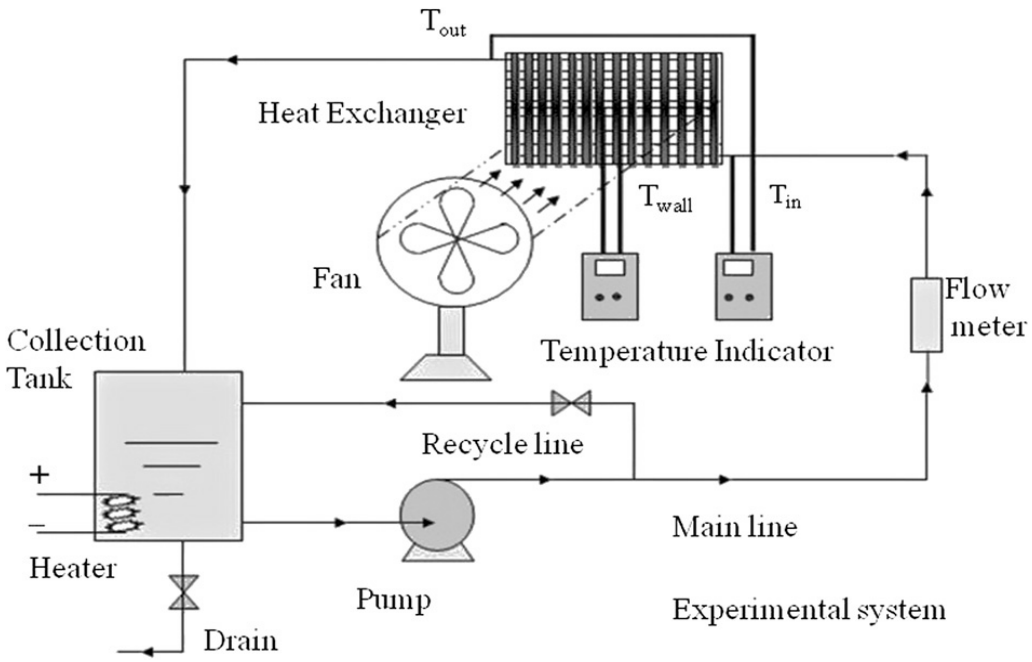

Fig.2.5Experimental setup of flat tube automobile radiator [9].

Jonn Are Myhren et al [14] investigated the radiators models to verify the performance by CFD models. Ventilation heat output in radiators is increased by 21% with lower supply if water temperatures.

Rajashekhar Pendyala et al [15] investigates with numerical analysis using carbon nano tubes and graphite nano tubes fluids. Different concentration of nano tubes with zero to 2% in slice modeling used. In the core areas heat flux values calculated with conditions examined the velocity and different temperature profile. As per comparsion of nano particle oils and without nano particles oil. Higher heat transfer rate obtained in nano particles added transfer oil.

3. CONCLUSION

In present scenario there are lots of works regarding nano fluids, here in this research work double pipe heat exchanger is taken. Most of research work conducted on operation of nano fluids with higher heat transfer coefficient. Double pipe heat exchangers are most used heat exchanger in terms of industrial and power plants processes. It is feasible because different volume in different pressure especially in high pressure can be used in this type of system. In these present research nano fluids with low concentration with liquids is taken for testing.

The thermal conductivity of ordinary fluids limits the bulk of them. Recently, there has been interest in using Nano particles to modify heat transfer performance of suspensions. However, they will face a variety of challenges while using these suspensions due to the vast size of the micro and macro-sized particles, including clogging of flow channels due to poor suspension stability, erosion of the heat transfer device, and an increase in pressure drop. Modern material technology helps us to produce Nano-meter sized particles that their mechanical and thermal properties are different from those of the parent materials. Recently, there has been interest in using Nanoparticles to modify heat transfer performance of suspension.

- The study carried out Finite Element Analysis (FEA), there is further needed to verify it practically and analytically with different Nano fluids.
- A comparison study with different nano particles and future work can deduce a equation for effectiveness and better performance

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