Improvement of Heat Transfer Coefficients in a Shell and Helical Tube Heat Exchanger Using Water / Al_2o_3 Nanofluid

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Abstract - *Improving heat transfer in helical tube heat exchanger is studied, experimented and analyzed* ***by many research peoples, it's bec****ause the fluid passing through the helical tube offers certain better advantages then straight tubes. in this paper we are concentrating on improving shell side heat transfer coefficients and net heat transfer in given experimented model, without much pressure loss is our main aim of project. So we are referring some journals for correlations of AL_2O_3 nanofluids properties and designing the model in ANSYS WORKBENCH 15 then it is meshed and solved in STARCCM+ solver for various concentrations of nanofluids. The hot fluid passes through the helical coil and cold fluid passes through the shell in a counter flow manner, water is used as a base fluid in both cases. The copper is chosen as a material of tube, where as the physics monitoring equations like mass momentum and energy are solved using turbulence of k-e two equation models. The results of temperatures are validated for experimented values that are referred and heat transfer values are plotted.*

Key Words: *Model is designed in ANSYS workbench 15 and imported model is Meshed and Solved in STARCCM+ CFD TOOL.*

1. INTRODUCTION

Shell and tube heat exchangers are used in various applications like air conditioning systems, in power plants, nuclear reactors for heat exchanging processes and also in food industries for various applications. the improving the performance of shell and tube heat exchangers is still under research many of the researchers concluded that helical coil tubes offer better advantage of heat transfer compared to Straight tubes its because of centrifugal force that develops in helical tube during the flow of fluid.

The improving techniques are of two types either by passive or active methods Active method involves surface vibration analysis and fluid vibrations were as passive method involves use of various inserts and pitch variations. since active method feels bit difficult compared to passive methods. The pitch variation improves heat transfer but causes high pressure loss and decreases heat transfer coefficients on shell side. So in order to improve the heat transfer without pressure loss and to increase the shell side heat transfer coefficients we used AL_2O_3nanofluids.

2 .LITERATURE SURVEY

[1] M.R.Salimpour done the heat transfer coefficients analysis in shell and helical tube heat exchangers and they investigated experimentally and Numerically correlations were done to check the heat transfer coefficients and Nusselt number in helical coiled pipes with circular cross section by M.R.Salimpour and his team. Their focus was on exploring the pattern of counter flow movement of fluid and temperature distributions through the pipe. From previous research it's understood that the studies and analysis are related with helical tubes and heat exchangers have analyzed with two main boundary conditions, i.e. constant heat flux across the boundary and constant wall temperature across the interference However, their boundary conditions are not found in most practical usage of heat exchangers. It's also reveals that there are very few investigations and research are carried away on the heat transfer and heat transfer coefficients improvement, in this kind of heat exchangers considering the passive techniques like coiled tube pitch and nanofluids.[4]The increased nano particle dispersion in base fluid can improves the effective thermal conductivity of the nanofluids to a significance value. [2]M. Naraki proved that the overall heat transfer coefficient improves with the increase in the nanofluids concentration from 0 to 0.4 % volume fractions. He also showed that the overall

heat transfer coefficient starts decreasing with increase in the nanofluids inlet temperature from 50 to 80°C. The use of nanofluids has increased the overall heat transfer coefficient up to 8% at nanofluids concentration 0f 0.4%. [3] The use of nano fluid has made improvement in heat transfer and AL2O3 is one nano particle which is used with base fluid to form nanofluids in several heat transfer applications. Correlation for calculating the physical and chemical properties are available From literature survey those values are referred for calculating the properties.[5] Recent experiments indicated that water based nanofluids of 29 nm CuO and 36 nm Al2O3 nano particles resulted in a range of effective thermal conductivity enhancements from 30% to 52% for CuO/Distilled water nanofluids, and 8 to 30% for Al2O3/Distilled water nanofluids, at volume fractions of 6% and 10%, respectively, and at a bulk temperatures ranging from 27.5°C to 34.7°C.
[6]All AL203 nano fluids were prepared at PH of 4.

3. OBJECTIVE OF THE WORK

3.1 Existing method

Shell and coiled tube heat exchangers provide better heat transfer which is concluded from literature survey. From existing experimental method the mass flow rate and temperatures are taken as a reference value for validation of the designed model of heat exchanger.

3.2 Proposed work

The shell and coiled tube heat exchanger is validated for experimental results, and the method to improve the heat transfer using nano fluid is the main objective of the work so properties of the nano fluids are calculated from correlations and are used for analysis and shell side heat transfer coefficients are plotted with volume fraction of nano fluids

4. METHODOLOGY

4.1 Design of the Heat Exchanger

The experimented shell and coiled tube heat exchanger is modeled in ansys workbench15 using following dimensions as mentioned in table and figure shown below, Its helical coiled tubes of different pitches are Designed and exported as a step file to starccm for further analysis.

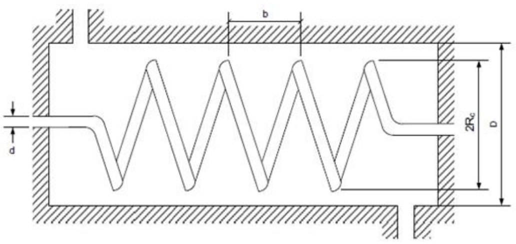

Fig 1: Schematic view of a typical shell and tube heat exchanger

Fig 2: Designed model of heat exchanger.

DIMENSIONS	VALUES
Diameter of the shell(D)	120mm
Inner diameter of coil(d)	9mm
Outer diameter of coil	12mm
Length of coil	230 mm
Pitch of the coil(b)	17 mm
Hydraulic diameter of shell	12mm

Table 1: Dimensions of heat exchanger

4.2 CFD Setup

The coiled tube heat exchanger is modeled using the dimensions data that is available from a literature survey using ansys workbench 15. To capture various physical and chemical processes occurring during analysis it is necessary to mesh the geometry with a correct approach to capture the entire complex physics involved using STARCCM+ CFD tool with the proper boundary conditions.

PARAMETER	VALUES
Tube side water flow rate	0.016
Shell side water flow rate	0.019
Tube inlet temperature	33.4°c
Tube outlet temperature	23°c - 25°c
Shell inlet temperature	10.9°C
Shell outlet temperature	14.6°C-15.6°C

Table 2: Referred Experimented values for boundary conditions

5. RESULTS AND DISCUSSIONS

The designed heat exchanger is validated for given boundary conditions shown good validation with the experimental values of exit temperatures validation results is also shown below in fig. The increased net heat transfer with concentration of nanofluids for 0.5%, 1%, 2%, 3%, and 4%.Is checked for same volume flow rate at inlet and is plotted as is shown in [fig 6]. The increase in heat transfer can also be achieved through the change of pitch, but it causes pressure loss 1100 pa for 17mm pitch tube. The pressure loss is 1300 pa for 14 mm pitch tube .The use of nano fluids shown better heat transfer and improved shell side heat transfer coefficients with concentration up to 2% [fig 4]. After that net heat transfer gain is less because of friction factors and wall shear stress developments.
The maximum heat transfer for every volume fraction is achieved at highest Reynolds number. At highest Reynolds number for 2% volume fraction, the net heat transfer improved by 10% and also the overall heat transfer coefficients increases by 12%.

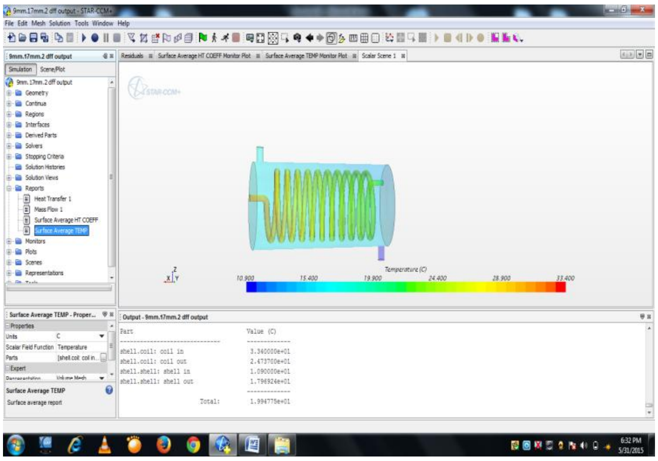

Fig 3: Showing scalar scene of temperature validation

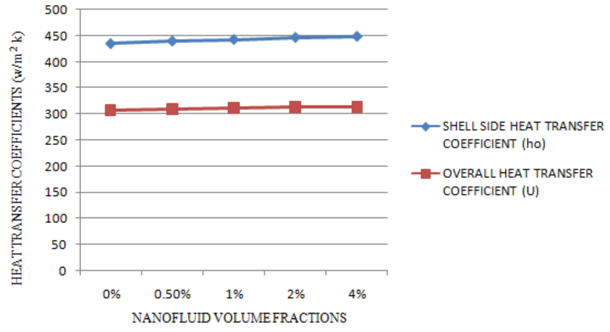

Fig 4: Plot of heat transfer coefficients for same volume Flow rate

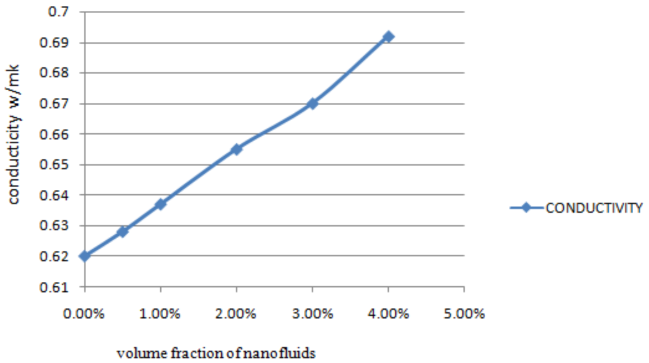

Fig 5: Plot of conductivity

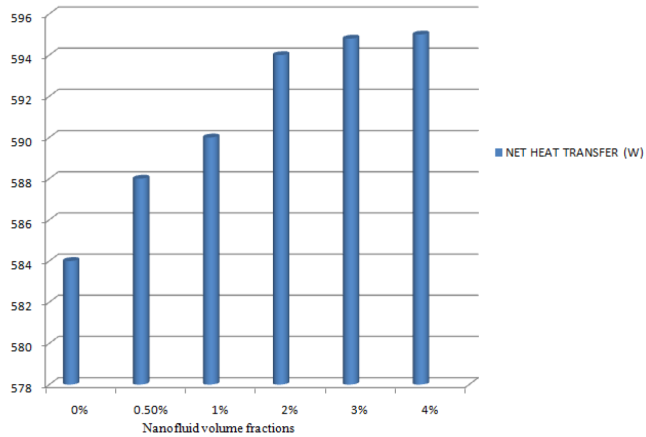

Fig 6: Plot of Net Heat transfer for same volume flow rate

6. CONCLUSION

After analyzing the results the net heat transfer increases with the addition of nano particle i.e. from 0.5 to 2% and shell side heat transfer coefficient also increases as in turn net heat transfer improves hence the objective is achieved. The possible future work is analysis with different nano particle size and heat transfer optimization with wall shear stress and friction factor effects.

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