NANO FLUIDS FOR SHELL-TUBE HEAT EXCHANGER APPLICATIONS

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Key words:
Hybrid nanofluid, nusselt number, heat transfer rate, shell-tube heat exchanger, thermal conductivity.

Introduction:
In an automobile the power is produced by combustion of air and fuel mixture. Only 25-30% of the power is utilized in petrol engines and about 30-35% of the power is utilized in diesel engines, and remaining power is wasted in the form of exhaust and heat. Due to this excess heat, the engine temperature becomes extremely high and that leads to increase in thermal stress of engine parts, lubricant loses its viscosity property. It causes quick wear of engine parts and finally engine may get seized. To avoid all these, it is necessary to remove excess heat from the engine by using engine cooling system. Heat exchangers find wide applications in various sectors. Also, they are available in wide variety which may be classified as tubular types namely double pipe which has one inner tube and another outer tube, shell and tube type which has a bundle of pipes, and spiral tube type where tubes are wrapped. They may be further classified into plated type which is gasket thin plate type, spiral thin plate or lamella and extended surface type namely plate fin and tube fin. The stream arrangement in the heat exchangers may be parallel streams, counter streams, or cross streams type. Shell and tube heat exchangers are the most extensively utilized heat exchangers in the industries which may be chemical process or oil refineries where high pressure applications is a requirement.

Objectives:
1. To design and develop a suitable shell and tube heat exchanger test rig for varied heat recovery applications.
2. To synthesize nano fluids using (Deionised water+ nano particles+ surfactant) and characterization of the developed nano fluids
3. To conduct experiments to determine the performance of developed shell tube heat exchanger test rig
4. To study the stability heat transfer rate on developed nano fluids

Methodology:
Preparation of Nano fluid
The preparation of nano fluid plays a major role to achieve proper dispersion of nano-particles in the base fluid. During the preparation of nano fluid there will be a higher chance of formation of precipitation or sedimentation in the solution. This will result in decrease in thermal conductivity of nano fluid and hence heat transfer effect decreases. To overcome this problem, proper surfactants (dispersants) were used in the present work. In this experiment hybrid nano-fluids were prepared to increase the heat transfer rate of the working medium. Initially nano-particles of MWCNT, CuO and Graphene in the
range from 50-100nm were procured from Sigma Aldrich Corporation chemicals company. In this study to prepare nano-fluids the equivalent weight of each nanoparticles was taken and weighed systematically and were added gradually to the deionized water. Then 500ml of deionized water (base fluid) is taken in a beaker and subjected to magnetic stirring process. The duration of stirring action is around 30 minutes. During the stirring action the surfactant is added to the mixture in order to stabilize the solution. Surfactant used in the preparation of hybrid nanofluid is Sodium Dodecyl Sulphate (SDS). Fig. 1 shows Nanofluids used in the study.

Later, the mixture of nanoparticles with ethanol undergoes sonication process in bath sonicator by using ultrasonic cleaners. Sonication process is carried out for 120 minutes to achieve uniform distribution of nano-particle in the base fluid. By doing sonication process, the agglomerated nano-particles disperse and a homogeneous nanofluid with smaller sized nanoparticles is obtained [12]. After the completion of the ultra-sonication process the nanoparticles were allowed to get dry completely and it is converted into amorphous form. The amorphous nanoparticles are then weighed with respect to the required quantity in order to mix with the base fluid.

![Figure 1 Nano fluids used in the study](image)

### Results:
(MWCNT’S + Ethylene glycol + Deionized Water)

<table>
<thead>
<tr>
<th>Sl. no</th>
<th>Distilled Deionized Water</th>
<th>Ethylene Glycol/Deionized Water</th>
<th>Volume flow rate (m³/s)</th>
<th>Nu (Nusselt no)</th>
<th>h (Co-efficient of heat transfer) W/m²K</th>
<th>Q (Heat transfer rate)</th>
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</table>

Graphene + Ethylene Glycol(70%) + Deionized Water(30%)

<table>
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<th>Volume flow rate (m³/s)</th>
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Conclusion:
In the present study the performance of aqueous based hybrid nanofluid MWCNT-CuO and graphene as a automobile radiator coolant has been experimentally investigated at different inlet temperatures. The weight fraction of nanoparticle is varied from 0.05-0.15 %wt. The experiment was conducted with the variation of nano-coolant flow rates from 3 L/min to 7 L/min and at the temperature range of 50°C to 80°C with regular increments of 10°C.

From this study following conclusions can be drawn:

- Significant increase in the heat transfer rate was observed with increase in hybrid nano-coolant flow rate.
- Increase in the hybrid nano-coolant flow rate enhances the Nusselt number and convective heat transfer coefficient.
- With the increase in the nano-coolant flow rates, the heat transfer rate, Nusselt number and the convective heat transfer coefficient enhances for all values of nano-particle weight concentration.

Scope For Future Work:
- By producing suitable composition of nano fluid which is used in various heat exchangers, radiation and exhaust gas recovery applications
- By using these nano fluids we can increase the heat exchange rate and in exhaust gas recovery applications