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Experimental Heat Transfer by Nano Powder Mix Coolant

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ABSTRACT:

Cooling system plays important roles to control the temperature of car's engine. One of the important elements in the car cooling system is cooling fluid. An efficient cooling system can prevent engine from overheating and assists the vehicle running at its optimal performance. The obtained results indicated that using different percentage of nano-fluid mixtures (by mass), such as Al2O3-Water as engine coolant enhances the heat transfer rate and reduces the warm-up timing. Conductivity enhancement was found to be by increased. The size of nanoparticle used was 100 nm and heat transfer rate enhancement was found to be 41 %.The objective of this experimental study is to discuss the dependence of thermal conductivity of Al2O3nanofluid in temperature ranges from (40-75 C) under different fractions of nanoparticles from 0.5, 1% (vol.).The project deals with the investigation of thermal analysis of automobile radiator. To check the influence of working conditions as well as physical parameters on the performance of radiator. To develop a test setup wherein checking the heat transfer rate in the radiator for different inlet mass flows of coolant, different air flow rate and different mass % of al2o3 nano powder mixed in water.

Keywords: Nano-powder coolants; Radiator; Heat Transfer

INTRODUCTION: Cooling system plays important roles to control the temperature of car's engine. One of the important elements in the car cooling system is cooling fluid. The usage of wrong cooling fluid can give negatives impact to the car's engine and shorten engine life. An efficient cooling system can prevent engine from overheating and assists the vehicle running at its optimal performance. With the development of new technology in the fields of nano-materials and nano-fluids', it seems very promising to use this technology as a coolant in the internal combustion engines. In this study, a nano-fluid (Al2O3-Wateris used as an engine coolant along with an optimized heat exchanger to reduce the warm-up timing. The obtained results indicated that using different percentage of nano-fluid mixtures (by volume), such as Al2O3-Water as engine coolant enhances the heat transfer coefficient and reduces the warm-up timing.

EXPERIMENTAL SETUP AND PROCEDURE

Nano Fluid Preparation Nano fluid is a fluid in which Nano-meter sized particles are suspended.Nanoparticles are a class of materials that exhibit unique physical and chemical properties compared to those of larger physical and chemical properties compared to those of larger particles of same material. Experiments remain the primary source of information when complex flow situations such as multiphase flows, boiling or condensation are involved. The two-step method employs a two-step process to make Nano fluids in which Nanoparticles are first produced as a dry powder and the as-prepared Nanoparticles are then dispersed into a base fluid in a second processing step. A certain degree of agglomeration may occur in the Nanoparticle preparation, storage and dispersion processes, it is well known that these agglomerates require very little energy to break up into smaller constituents. And thus it is possible that even agglomerated Nanocrystalline powders can be successfully dispersed into fluids and result in good properties. This two-step process works well in many cases, especially for oxide and nonmetallic Nanoparticles. In this experimentation a two step procedure was used for preparing the Nanofluid.A measured quantity of nanoparticle was taken. It was mixed thoroughly in the water- Mechanical stirrer was used to mix it uniformly. It was kept in the sonicator and subjected to vibrations so as to reduce to problem of agglomeration. It Nanofluid was kept still for two days to check for sedimentation. Even after two days there was no appreciable sedimentation and the important fact is that the moment it was stirred again it turned into a uniform fluid with evenly suspended nanoparticles in it.The project deals with the investigation of thermal analysis of automobile radiator.To check
the influence of working conditions as well as physical parameters on the performance of radiator. Todevelop a test setup wherein checking the heat transfer rate in the radiator for different inlet mass flows of coolant, and different air flow rate.The demand for more powerful engines in smaller hood spaces has created a problem of insufficient rates of heat dissipation in automotive radiators. Upwards of 33% of the energy generated by the engine through combustion is lost in heat. Insufficient heat dissipation can result in the overheating

of the engine, which leads to the breakdown of lubricating oil, metal weakening of engine parts, and significant wear between engine parts. To minimize the stress on the engine as a result of heat generation, automotive radiators must be redesigned to be more compact while still maintaining high levels of heat transfer performance.Select details of instrumentation. Manufacture and arrange experimental setup.Experimentation: To note heat transfer rate at variable operating conditions of engine cooling system / radiator.So that outcome data will be helpful to modify or redesign the radiator in future.

EXPERIMENTAL SCHEMATIC LAYOUT:

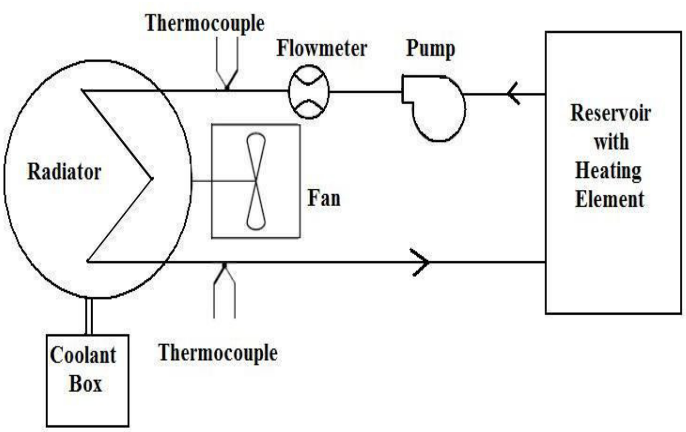


Fig. Various components used in test rig

Reservoir with heating element:In the test apparatus the hot water acting as the coolant taking heat from the engine block is provided here the help of a heating element fixed into the reservoir container. In this container the water is heated up to the range of 40-75OC

Pump:The water pump uses centrifugal force to send fluid to the outside while it spins, causing fluid to be drawn from the center continuously. The inlet to the pump is located near the center so that fluid returning from the radiator hits the pump vanes. The pump vanes fling the fluid to the outside of the pump. After this the flow rate is measured with the help of a flow meter.

Thermocouples: The most common electrical method of temperature measurement uses the thermocouple. It is based upon see-back effecti.e. when two dissimilar metals are jointed, these forms two junctions and if these junctions are maintained at different temperatures than an emf is produced and this emf depends on the temperature difference. Therefore in thermocouple emf plays thermometric property, the property which helps in holding in finding out the temperature is named as the thermometric property.

Radiator: The radiator is a type of heat exchanger in which the coolant looses heat by convection and conduction phenomenon occurring in the tubes of radiator. The radiator is generally made up of aluminum metal because of its light weight and high thermal conductivity.

Fan: A fan is installed just behind the radiator so as to increase the cooling capacity of the radiator. When the temperature of the coolant increases because of constant acceleration the fan starts operating, sucking in the air through the fins of the radiator. This fan is controlled by stepped regulator . In the apparatus the fan runs continuously to give an effect of a moving vehicle.

Coolant Tank: The coolant tank serves here an important function of controlling the coolant from overflowing. When the fluid in the cooling system heats up, it expands, causing the pressure to build up. The cap is the only place where this pressure can escape, so the setting of the spring on the cap determines the maximum pressure in the cooling system. The cap is actually a pressure release valve, and on cars it is usually set to 15 psi. When the pressure reaches 15 psi, the pressure pushes the valve open, allowing coolant to escape from the cooling system. This coolant flows through the overflow tube into the cooling bottle. This arrangement keeps air out of the system. When the radiator cools back down, a vacuum is created in the cooling system that pulls open another spring loaded valve, sucking water back in from the cooling bottle to replace the water that was expelled.

Fig :Nano fluid

Fig: Experimental set up

Objectives of Experimentation :

To find heat transfer rate at variable speed of cooling fan

To find heat transfer rate at variety of coolants

To find heat transfer rate at variable flow rate of coolant

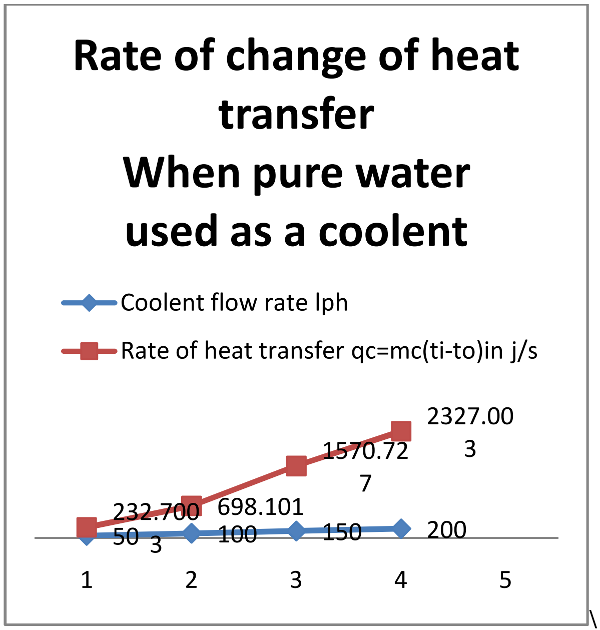
Outcome of Dissertation:To study and analyze the effect of variable operating conditions in engine coolingsystem which increases the rate of heat transfer.

Assumptions:Velocity and temperature at the entrance of the radiator core on both air and coolant sides are uniform. No phase changes (condensation or boiling) in all fluid streams. Fluid flow rate is uniformly distributed through the core in each pass on each fluid side. No stratification, flow bypassing, or flow leakages occur in any stream. The flow condition is characterized by the bulk speed at any cross section. The temperature of each fluid is uniform over every flow cross section, so that a single bulk temperature applies to each stream at a given cross section.The heat transfer coefficient between the fluid and tube material is uniform over the inner and outside tube surface for a constant fluid mass flow rate. For the extended fin of the radiator, the surface effectiveness is considered uniform and constant. Heat transfer area is distributed uniformly on each.Both the inner dimension and the outer dimension of the tube are assumed constant. The thermal conductivity of the tube material is constant in the axial direction. No internal source exists for thermal-energy generation. There is no heat loss or gain external to the radiator and no axial heat conduction in the radiator. Thermal conduction parallel to the flow direction of both the wall and the fluids are equal to zero. Humidity is 30%. Wind velocity is 4 km/hr. Room temperature is 30OC.

Experimental analysis: Effect of variety of coolants on heat transfer.

Coolant type	Coolant flow rate lph	Air flow rate m/s	Temp diff. degree Celsius	Rate of heat transfer qc=mc(ti-to)in j/s
Pure water	200	6.2	10	2327.003
Mixed 0.5% al2o3	200	6.2	12	2705.352
Mixed 1% al2o3	200	6.2	15	3282.747

When pure water used as a coolant			
Coolant flow rate lph	Air flow rate m/s	Temp diff. degree Celsius	Rate of heat transfer qc=mc(ti-to)in j/s
50	6.2	4	232.7003
100	6.2	6	698.101
150	6.2	9	1570.727
200	6.2	10	2327.003
When 0.5% al2o3 nanopowder mixed in Pure water			
50	6.2	7	394.5305
100	6.2	9	1014.507
150	6.2	11	1859.93
200	6.2	12	2705.352
When 1% al2o3 nanopowder mixed in Pure water			
50	6.2	9	492.412
100	6.2	11	1203.674
150	6.2	13	2133.785
200	6.2	15	3282.747



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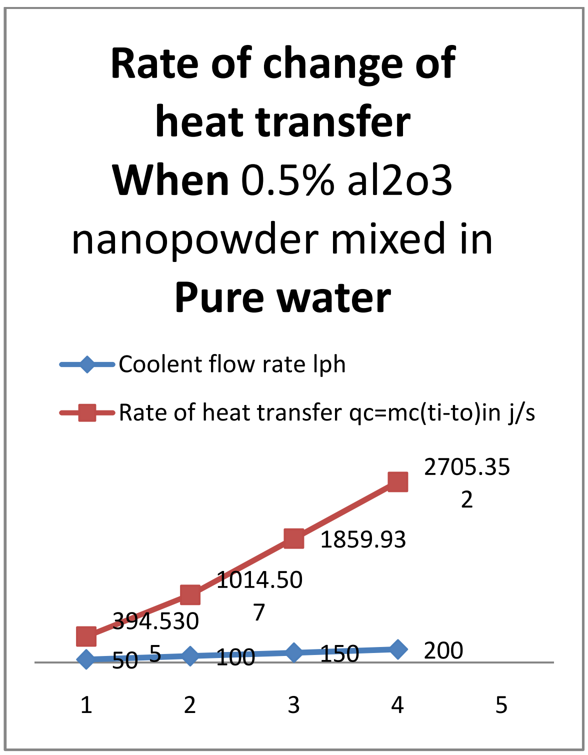
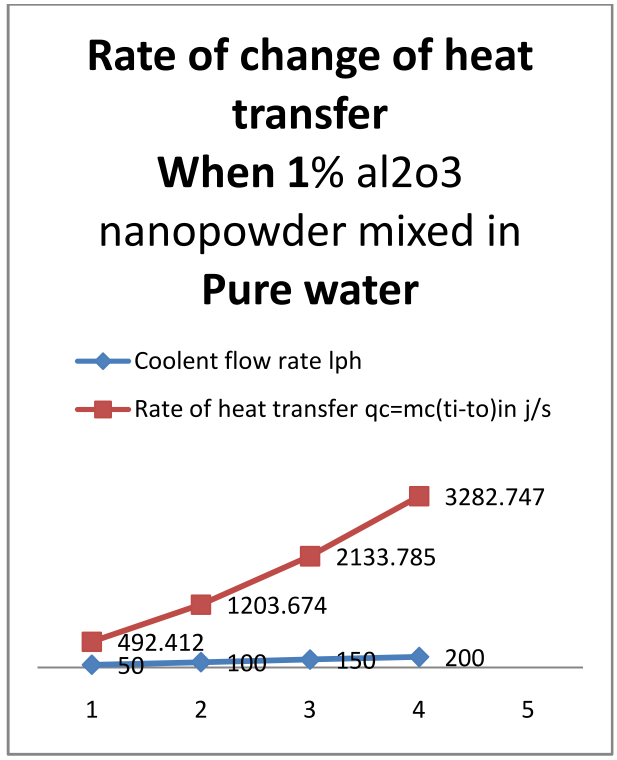
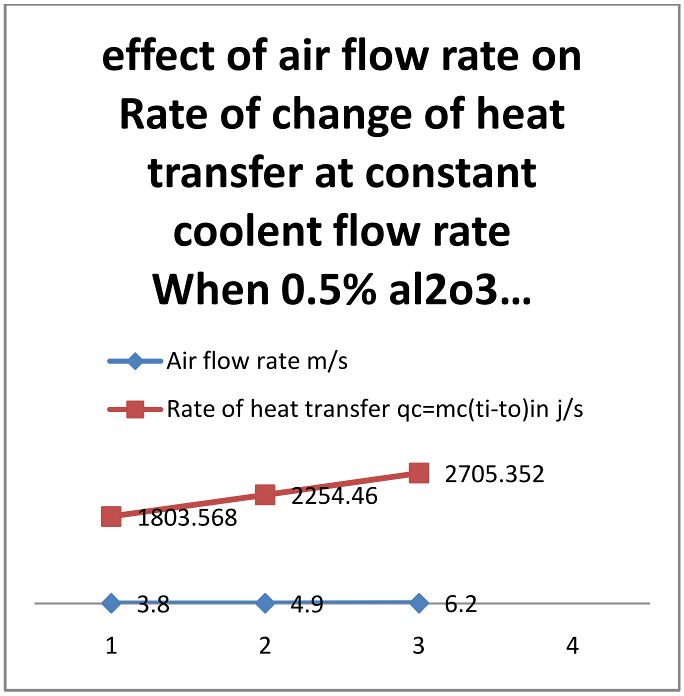


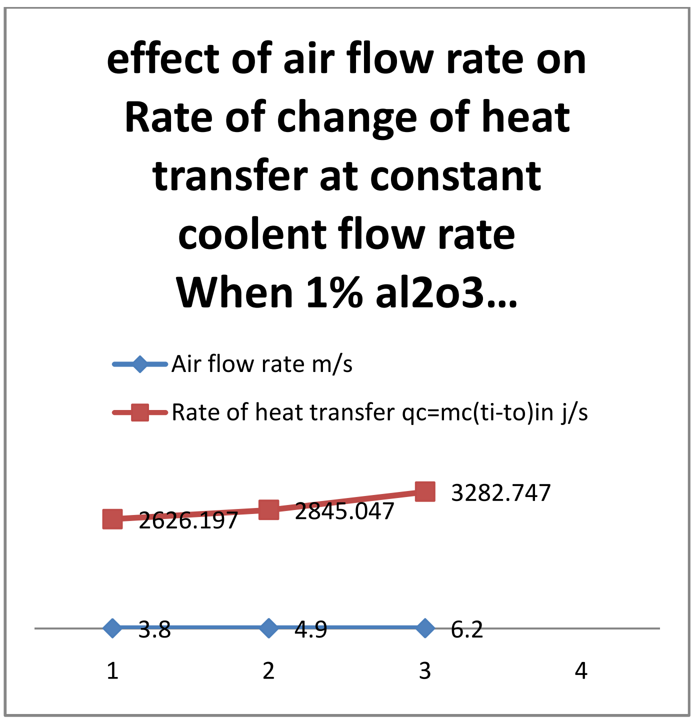


Concluding Remark:Rate of heat transfer increase as the coolant flow rate increases at constant air flow rate

Sample Effect of change of air flow rate at constant coolant flow rate 200lph on heat transfer.

When pure water used as a coolent			
Coolent flow rate lph	Air flow rate m/s	Temp diff. degree celsisus	Rate of heat transfer qc=mc(ti-to)in j/s
200	3.8	7	1628.902
200	4.9	8	1861.603
200	6.2	10	2327.003
When 0.5% al2o3 nanopowder mixed in Pure water			
200	3.8	8	1803.568
200	4.9	10	2254.46
200	6.2	12	2705.352
When 1% al2o3 nanopowder mixed in Pure water			
200	3.8	12	2626.197
200	4.9	13	2845.047
200	6.2	15	3282.747





Concluding Remark:Rate of heat transfer increase as the cooling air flow increases at constant coolant flow rate

1)11%rate of heat transfer is increased in car radiator by addition of 0.5%al2o3 nano powder of 100nm size in pure water at constant coolant flow rate of 200LPH & constant air flow rate of 6.2 m/s.

2)41%rate of heat transfer is increased in car radiator by addition of 1% al2o3 nano powder of 100nm size in pure water at constant coolant flow rate of 200LPH & constant air flow rate of 6.2 m/s.

3)Rate of heat transfer increase as the coolant flow rate increases at constant air flow rate

4) Rate of heat transfer increase as the cooling air flow increases at constant coolant flow rate

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