

# Improved Performance of Carbon Nanotube Enriched Engine Coolant

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**Abstract**—The quality of an engine coolant plays a crucial role in the performance of an engine. A good quality engine oil quickly and substantially removes extra heat generated from the engine. It keeps the engine cool during the engine performance. Carbon Nanotube (CNT) based engine coolants are promising materials for such applications. The exceptionally high thermal and electrical conductivity of Carbon nanotubes adds to the additional quality performance of engine coolant. However, carbon nanotubes are immiscible in water-based coolants. To have a stable solution, a surfactant has to be used with it. In the present study organic surfactant like aloe vera, Cordia myxa (Lasoora) juices were used and found to be very effective in making CNT soluble in the water-based coolant. This enhances both thermal and electrical conductivities of coolant. In the present study, CNT enriched coolants were subjected to thermal and electrical conductivity measurements. Various compositions of the solution with carbon multi-walled nanotubes were used. It is observed that carbon nanotube enhances the thermal as well as the electrical conductivity of the coolant. Out of various compositions, organic coolant with Cordia myxa (Lasoora) juice as a surfactant shows extraordinary performance.

**Keywords-component; CarbonNanotubes, Cordia myxa, electrical conductivity, polyvinyl alcohol, thermal conductivity**

## I.INTRODUCTION

Nowadays, people need high performance automotive vehicles to do their work faster. Seeing this, the demand for the vehicle is increasing continuously. Automotive industries continuously doing development for making high efficient engines that consume less fuel to attract the customers. There are various methods to increase the efficiency of the engine. One of the methods for increasing the performance of the vehicle is the use of good coolant.[1].The engine performance depends on the fuel economy and less emission. This paper discusses the improved fluid based on carbon nanotubes. The thermal and electric conductivity of a good coolant should be high. Nanofluids belongs to a new class of heat transfer fluids that are prepared by

dispersing nanometer-sized particles in base fluids like water. The nanoparticle dispersion in the base fluid is a tricky phenomenon due to surface tension effects. An appropriate surfactant has to be taken for proper and uniform dispersion. Nanoparticles help in enhancing the thermal and electrical conductivity[2]. High thermal conductivity ensures faster heat transfer and keeps the engine cool for a longer time. Moreover high thermal conductivity helps in transferring heat to the radiator for final removal to the atmosphere. The performance of the heat engine is found to be higher using the nanofluid due to the high thermal conductivity of coolant compared to the conventional coolants. It is found to have attracted attention in recent years as a new generation of heat transfer fluids in a vehicle cooling system. This is due to their excellent thermal and electrical performance.[3].The effect on engine performance using Cordia myxa solution in water with Carbon nanotubes, as engine coolants have been studied. Cordia myxa (also called Boraginaceae, clammy cherry, or lasoora) is a species of flowering plant in the borage family. The commonly used coolant for the automotive engine is ethylene glycol. But it is a toxic material [4]. As an alternative coolant fluid water-based using Cordia myxa with CNT is found to be a good coolant as it is non-toxic.[5]. Being water-based coolant it has certain limitations as it cannot be used in freezing low-temperature regions. In the present study, a new type of natural surfactant is extracted from the Cordia myxa fruit pile. Cordia myxa is locally known as "Bumber" and is a plant-based gum. Cordia has high nutritive value, rich in antioxidants. The cordial gum is an anionic polysaccharide having strong adhesive properties [6]. In the coolant system of the engine generally, the water is used for the heat transfer. Using a liquid coolant system, the heat is removed by the circulating coolant surrounding the engine [7].

## II. EXPERIMENTAL METHODOLOGY

### A. Preparation of solution

The collected fruit piles were washed with distilled water and gum was taken out from the piles. This gum, CNT, and water are mixed in different concentrations. It is noticed that only limited CNT molecules (1-2% in volume) could be dispersed in water [Fig 1]. Even the increased quantity of Cordia myxa could not help to increase CNT quantity in water. This is primarily due to the weak van der Waals bond with CNT. Even the excessive use of magnetic stirring does not help much rather it increases chances of opening up the CNT in flat sheets and to be avoided.



Fig 1: Solution of Cordia Myxa, CNT in water and black in colour.

After this, the mixture is filtered using a filter paper (Wattman Filter Paper No 0). We prepared a sample at different concentrations of CNT (0.2g), Cordia myxa (5g), and Water 100ml. After this prepared sample, we add 80% and 60% water of this sample. Three samples were prepared initially. After that thermal conductivity of the fluid is measured using the synchronized digital thermometer based set-up [Fig. 2]. The electrical conductivity of different samples was measured using set-up as shown in Fig. 3.

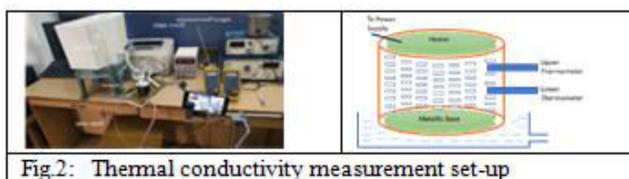


Fig 2: Thermal conductivity measurement set-up

### B. Experimental Set-up for measurement of thermal conductivity

The thermal conductivity of the liquid is measured by the layer method. Digital thermometers of sensitivity are  $0.01^{\circ}\text{C}$  for used to measure the temperature of a section of a liquid kept in a container made of Teflon (4.7cm diameter and length 0.94 cm). Heating is done by an electrical metallic heater. Heating is done at top of the container. Heat flow is from top to bottom to minimize convection currents. To ensure the unidirectional heat flow the bottom of the chamber was filled with cooled running water. The temperature difference at two different levels was measured using two separate digital thermometers. The variation of temperature difference was recorded with time till a steady state is reached. The temperature difference depends on the nature of the liquid and dimensional parameters. Thermal conductivities are compared and ratios are taken to remove the dimensional effects. The temperature difference depends on the thermal conductivity of the liquid. Temperature differences were recorded for various concentrations and compared to find the relative increment of thermal conductivity.

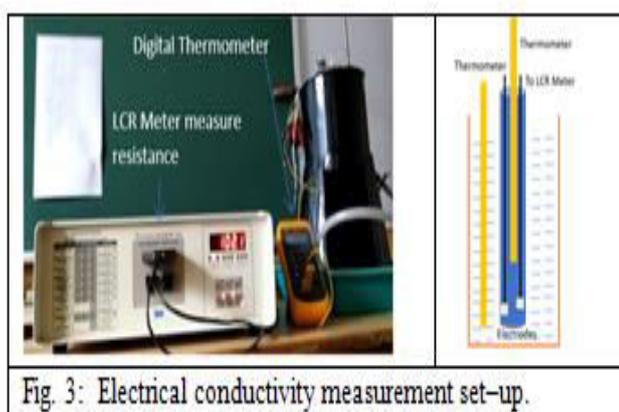


Fig. 3: Electrical conductivity measurement set-up.

### C. Experimental Set-up for measurement of electrical conductivity

We make two electrodes which are kept in a test-tube. This test tube is filled with a liquid sample. Electrodes are attached to the LCR meter for the measurement of electrical resistance. Also, connections are made for the digital thermometer to measure the temperature of the liquid. This test tube is put in the water bath. This water is heated by a heating rod. Temperature is measured by a digital thermometer to regulate the rate of rising temperatures. Measurement of the electrical resistance with temperature provides the necessary electrical conductivity of various concentrations. The variation of temperature was recorded with resistance until a steady-state is reached. The resistance depends on the concentration of CNT in the solution. This provides additional information for the presence of CNT in the solution. The resistance depends on the

electrical conductivity of the liquid. Temperature and resistance were recorded for various concentrations and compared to find the relative increment of electrical conductivities.

PROPERTY	CARBON NANOTUBES	WATER	LASOORA+CNT+WATER(measured)
THERMAL CONDUCTIVITY	>3000W/mK	0.605W/mK	1.218W/mK
ELECTRICAL CONDUCTIVITY	10 $\square$ s/m	5.0x10 <sup>-4</sup> s/m	214.38 x10 <sup>-4</sup> s/m

Table 1 represents the known values thermal and electrical conductivities of CNT, water, and prepared coolants. CNT has high thermal and electrical conductivity [8]. When mixed with water + Cordia myxa it enhances the electrical and thermal conductivities of the prepared coolant.

### III.EXPERIMENTAL RESULTS

To have a stable solution of CNT in distilled water, the surfactant has to be used with it. In the present study, organic surfactants like lasoora pile gum were used in the water –CNT system various compositions of the solution with carbon multi-walled carbon nanotubes and were subjected to thermal and electrical conductivity study. The present study is on the thermal and electrical properties of various proportions of coolant, water, and CNT. In this study concentration of CNT is ranged between 1.16g/L to 1.90g/L. The behavior of electrical and thermal conductivity show by graphical representation for the concentration of 1.54g/L. We measure the temperature difference and time of the prepared sample using the apparatus set-up in fig.2. T

Thermal conductivity is given as:

$$K = \frac{Ql}{tA(T_2 - T_1)}$$

Here Q is heat flow in time t across length l through the area of cross-section A. Heat flow is Q=Vit. Here V is the supply voltage I is current to the heater. Let  $K_s$  and  $K_{st}$  are thermal conductivities of sample and standard liquids,  $|(T_2 - T_1)|_s$  and  $|(T_2 - T_1)|_{st}$  are temperature difference between to heaters for a sample and standard liquid respectively at the steady-state. If dimensional parameters are kept constant the ratio of thermal conductivities are given as:

$$\frac{K_s}{K_{st}} = \frac{|(T_2 - T_1)|_{st}}{|(T_2 - T_1)|_s}$$

From the above relation, the thermal conductivity of the sample liquid is determined. Similarly, measurements for electrical conductivity of sample liquid are done by measuring the electrical resistance at a given

temperature of the prepared sample. This is done using the apparatus set-up in fig.3. Comparing ratios of their respective electrical resistances, the electrical conductivity of the prepared sample is measured with the standard sample (Double distilled water at room temperature). At this concentration, we draw the graph for thermal and electrical conductivity. Out of various compositions, organic surfactant cordial myxa pile gum shows extraordinary performance.

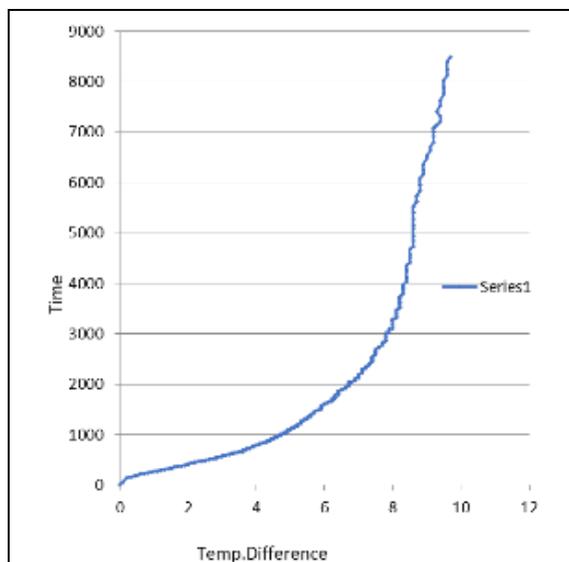


Fig.4: Graph between Temp. Difference and Time

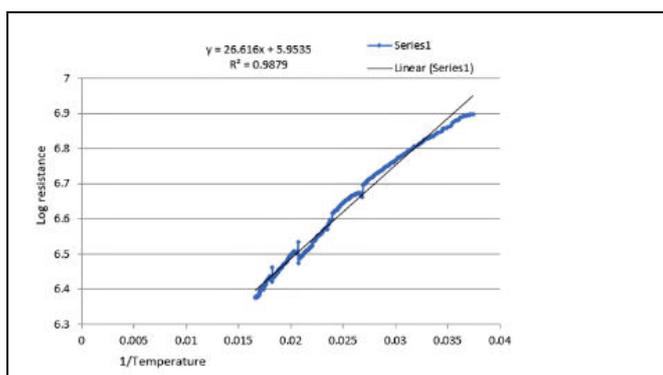
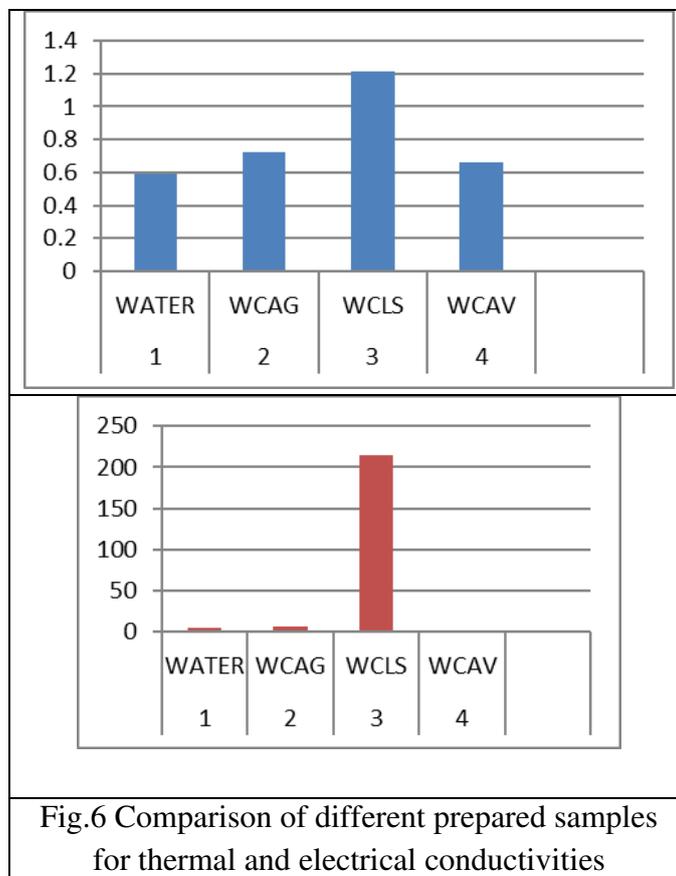


Fig 5: Graph between 1/T and log resistance

#### IV. RESULTS AND DISCUSSIONS

Above is the comparative chart of thermal (In Blue) and electrical (in orange) for pure water, Water-CNT-ethylene glycol (WCAG.), Water-CNT-Lasoor (WCLS.), and Water-CNT-aloe vera (WCAV.) are plotted in the following figure. Y-axis is arbitrary in scale to show comparison. All values are rationalized for CNT concentration of 1.8g/L.



To select the suitable coolant mixture lasoor, CNT and water were considered. Ripened *Cordia myxa* fruit pulp has a natural polysaccharide. These monosaccharide units bounded together by glycosidic linkage tend to adsorb CNT. Kouta Sgikawa et al found in their study the ionic beta-1,3-glucans wrap around CNT (single and double-walled) to form water-soluble complexes with the ionic group on their exterior. Bonding is van-der Waals with CNT, however, polysaccharide makes strong bonding with a water molecule. The complex functional group is responsible for holding CNT dispersed in water. Such molecule complexes form a mesh of thermal conduction web in the water-CNT system and enhancing the thermal conductivity.[9] Thermal conductivity of CNT with Lasoor is found to be increased by 101 % in comparison the fluid without CNT (Base fluid) . And electrical conductivity is also increased by 4187% in comparison to the base fluid. We conclude that the more amount of water is added then thermal and electrical conductivity is decrease. All of the formulations were homogeneous with an odor and color related to *Cordia* extract showed a proper

consistency. They were physically stable. Further it is noticed that there exists an optimum concentration for maximum conductivities. At low concentration of lasoora, CNT dispersion is limited and mobility of CNT in the solution is high. This results in higher thermal conductivity, However due to low concentration of CNT, electrical conductivity is low. whereas at moderate lasoora concentration initiates to coagulation of CNT (in lump formation). This results in the loss of thermal the thermal connectivity. However due to movement of lumps electrical conductivity still shows a increasing trend. On further increase in concentration of CNT, lump formation is enhanced. This increases the thermal conductivity as bulk heat is also carried by the lumps due to their movements. However electrical conductivity is restricted as surface to volume ratio decreases[10].

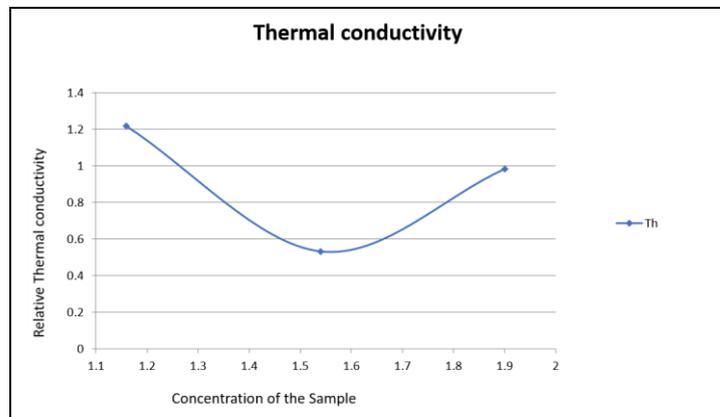


Fig.7: The thermal conductivity at different concentration

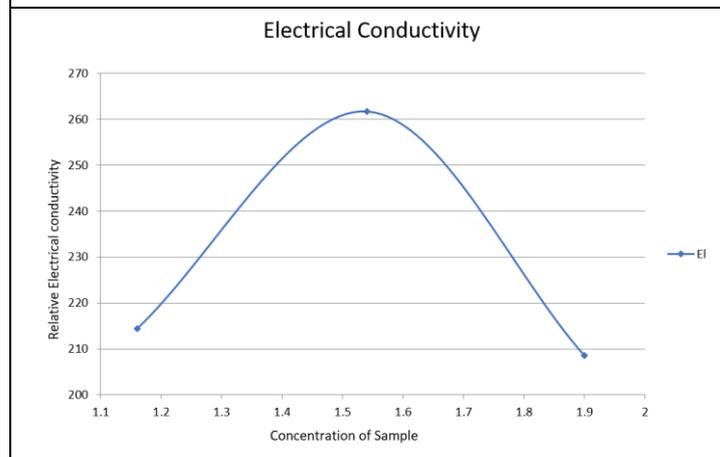


Fig.8: The electrical conductivity at different concentration

## V.CONCLUSION

The experimental study represents the changing material of coolant normally ethylene glycol as a coolant which is low thermal and electrical conductivity as compared to lasoora nanofluids and CNT's.[11-22]. Cordia myxa shows the good performance of different concentration .

By obtaining results and comparison the conclusion has been done

\*Cooling capacity increase with an increase in inlet coolant temperature.

\*Cooling capacity using nanofluid is much higher than using base fluid.

\*Thermal conductivity is increase as compared to the base fluid.

\*Electrical conductivity is increase as compared to the base fluid.

\*Both thermal and electrical conductivity show the optimization at a particular concentration.

\*Fig 4 and Fig 5 shows extraordinary performance of electrical and thermal conductivity. Fig 4 shows the good thermal conductivity at higher temp. Fig 5 shows the performance of electrical conductivity at 50°C.

\*Fig 7 and Fig 8 shows the best result of thermal and electrical behavior.

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