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***Research paper***

# Characterization of AL2O3 Nano Particles in Engine Oil for Enhancing the Heat transfer rate

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**Abstract**

Selection of suitable engine oils becoming more challenging for automobile engineers. Life of the engine majorly depends upon engine oil, type of fuel being used and various other thermal and structural characteristics of the engine. Dissipation of heat is one of the major consideration in the design of automobile engines. Generally engine oils are used for the lubrication between piston and cylinder but to enhance the cooling effectiveness Nano-particles are added in the lubricant, so that internal heat generation in the engines can be minimized. Nano-fluids are playing a vital role in heat transfer applications because of its enhanced thermal conductivity nature and generally these fluids are colloidal mixture of Nano particles and base fluids. Intense research studies over Nano fluids are very high because of their sublime behavior.Recently. Advanced research over Nano technology has gone to a situation where two or more Nano particles are made to mix in a base fluids and generally we call this as hybrid Nano fluids. In this work, preparation of Al2O3 nanoparticles and mixing them with 10W30 engine oil were carried out. By various techniques thermal characteristics of fluid are identified with different parameters.

***Keywords***: *Nano-fluid, Lubricants, Thermal conductivity*

## 1. Introduction

In the recent century, technology has reached to a level of micro because of the many constraints like shape, size etc.., but our researchersstep ahead and started working on Nano and Pico level (to the level of atom). Particles with Nano size ($10^{-9}$ m) is known as Nanoparticle which was derived from great scientist Richard Feynman. Nano particles have tremendous properties because of which it was given more importance. It has a unique nature, its properties will get changed based on the size of the nanoparticle. These are synthesized in different techniques like ball milling, chemical vapor deposition, and physical vapor deposition. This synthesis can be done in two approaches namely top-down and bottom-up. In the top-down approach macro sized particle is made into smaller particles (Nano) and in bottom-up approach involves building the atom or molecule.

Nano fluids are the new classes of heat transfer fluids. Generally these are prepared by dispersing nanoparticles in any solutions such as water, ethylene etc. Lot of exploitations being carried out on the Nano fluids (coolants) because of their improved characteristics such as boiling point, thermal conductivity and heat transfer rate. The main idea of Nano fluids (combination of Nano particles with base fluid) is to increase the thermal conductivity. From the past 5 to 10 decades, lot of research went on over the properties of particles in liquid suspensions. By considering different sizes of particles (mille, micro, and Nano) scientists have proven that size of particle is one of the major constraints in characterizing the liquids. Hence, Nano fluids and Nano particles are playing a key role to review the thermal features and potential applications

## 2. Literature Review

Touloukian and Ho (1970) confirmed thermal conductivity of Cu is 700 times greater than that of engine oil at room temperature.

Masuda et al. proved that there is a 32% and 11% improvement in the thermal conductivity of water based Al203 and Nano fluids in recent advances synthesis of nanomaterials for both metallic and non-metallic particles in Nano dimension were realized.

Choi (1995) for the first time 13 coined this word of Nano fluid. He investigated over the Nano fluids about its transport behavior with several experimentations.

Koa et al. (2007) worked on CNT and on methods of Nano fluids preparation, he calculated characteristics like viscosity and pressure drop of Nano fluids. He observed from his work that Nano fluids in the turbulent flow regimes develops low friction when compared to base fluids alone.

Wang et al. calculated the thermal conductivity of Nano fluids with a method called steady state parallel plate. Here Al2O3 and CuO Nano particles are made to disperse in various mediums and concluded for fluid mixture thermal conductivity is high.

Masuda et al. worked on convectional heat transfer Nano fluids (water based al2o3 and tio2) and proved 32% and 11% improvement of thermal conductivity.

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Choi et al. worked Nano fluids for enhancing the thermal conductivity and shown that there is a dramatic reductions (thermal conductivity) in heat exchangers.

Chen et al. investigated on ethylene glycol titanium Nano fluids and proved shear viscosity of Nano fluid is a function of both element absorption and temperature of Nano fluids.

Lee et al. worked on cuo and al2o3 Nano particles and calculated the thermal conductivity. He stated that to determine thermal conductivity of any Nano fluid, thermal conductivity of Nano particles materials not be a governing parameter.

Eastman et al. worked on Nano fluids and proven there is a drastic increase in thermal conductivity by considering ethylene glycol-based Nano fluids containing copper nanoparticles.

Yurong et al. worked on flow of Nano fluid in a vertical pipe by considering laminar and turbulent flows. By mixing nanoparticles in a base fluid both augmentation and thermal conduction has increase to a greater extent along with the increased viscosity.

Xuan and Rotzel. He has used two different approaches for predicting the convective heat transfer of Nano fluids. Finally improvement in a heat transfer rate of Nano fluid is investigated.
Pak and Cho worked on tio2 and al2o3 nanoparticles and studied about the convective heat transfer when this are mixed in water under turbulent flow condition, he concluded that there is an improvement in heat transfer of 35% for al2o3/water Nano fluid with 2.78%. Volume fraction.

Hwang et al. considered Al2O3 Nano fluids (35 nm), and proved that there is a considerable heat transfer augmentation without any rise in heat transfer coefficient augmentation.

Heris et al. investigated over CuO and Al2O3 Nano fluids by considering base fluids as water at different concentrations like laminar flow convective heat transfer in a circular tube with a constant wall temperature. He proved there is an increase in heat transfer coefficient by more Nano particles and peclet number. He stated that several factors are to be considered for the improvement of heat transfer in Nano fluid.

Chon C.H. et al. did experimental work on al2o3 nanoparticles revealed that thermal conductivity as function of temperature in correlation with the size of nanoparticles (11nm-150nm) and validated it with a key mechanism of Brownian motion.

## 3. Experimental Investigation

In the present work AL2O3 nanoparticles (amorphous) are added at different quantity in 10W30 engine oil by using sonication technique.



(a)



(b)

**Fig. 1 (a, b)**. ULTRA-SONICATION TECHNIQUE

From redwood viscometer, viscosity of the oil is calculated before and after adding nanoparticles. At a range of (30°C, 60°C, and 80°C) to calculate the thermal conductivity KD2-pro is used

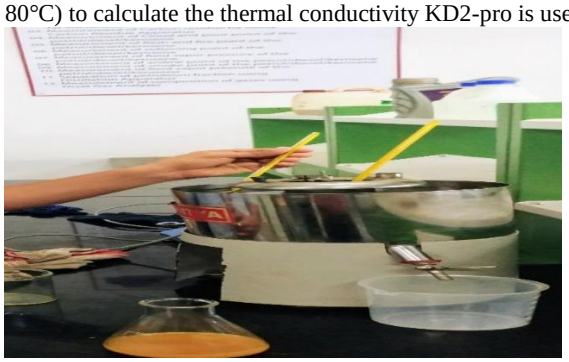


**Fig** 2. Redwood Viscometer Setup



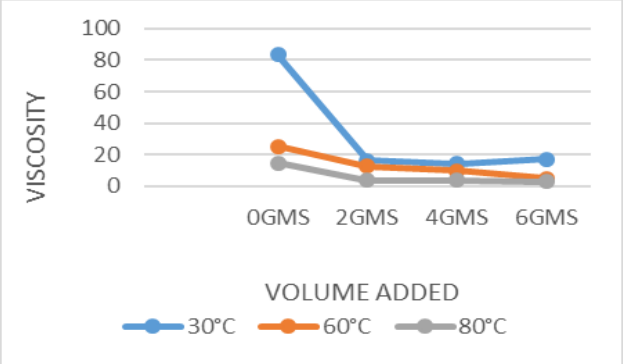
**Fig** 3. Kd2-Pro Setup

## 4. Results

Viscosity values which are obtained by with and without adding al2o3 nanoparticles at different temperatures using redwood viscometer is represented in the below table and graph.

**Table 1.** Viscosity values of 10w30 engineoil

| Volume added | 30°C | 60° | 80°C |
|---|---|---|---|
| 0GMS | 83.54 | 25.31 | 14.54 |
| 2GMS | 16.36 | 12.665 | 3.503 |
| 4GMS | 14.236 | 9.875 | 3.503 |
| 6GMS | 16.968 | 4.984 | 2.828 |

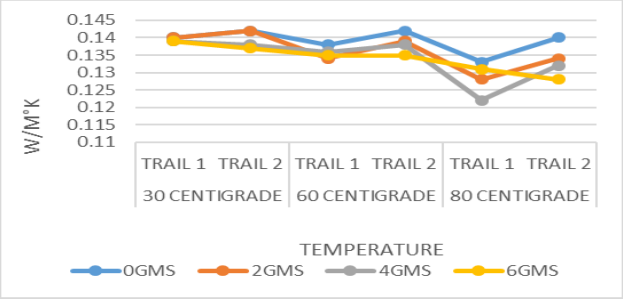



**Graph 1.** Viscosity of 10w30 engine oil

Following are the tables and graphs which are obtained with different concentration levels at different temperatures indicating decrease in thermal conductivity.

**Table 2.** Thermal conductivity of 10w30 engine oil for two different trails

| VOLUME ADDED | 30°C | | 60°C | | 80°C | |
|---|---|---|---|---|---|---|
| | TRAIL 1 | TRAIL 2 | TRAIL 1 | TRAIL 2 | TRAIL 1 | TRAIL 2 |
| 0GMS | 0.14 | 0.142 | 0.138 | 0.142 | 0.133 | 0.14 |
| 2GMS | 0.14 | 0.142 | 0.134 | 0.139 | 0.128 | 0.134 |
| 4GMS | 0.139 | 0.138 | 0.136 | 0.138 | 0.122 | 0.132 |
| 6GMS | 0.139 | 0.137 | 0.135 | 0.135 | 0.131 | 0.128 |

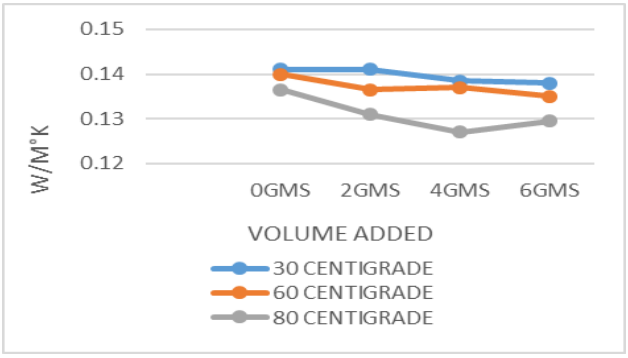



**Graph 2.** Thermal conductivity of 10w30 engine oil for two different trails

**Table 3.** thermal conductivity of 10w30 engine oil for mean values

| VOLUME ADDED | 30°C | 60°C | 80°C |
|---|---|---|---|
| 0GMS | 0.141 | 0.14 | 0.1365 |
| 2GMS | 0.141 | 0.1365 | 0.131 |
| 4GMS | 0.1385 | 0.137 | 0.127 |
| 6GMS | 0.138 | 0.135 | 0.1295 |

**Graph 3.** Thermal Conductivity Of 10w30 Engine Oil For Mean Values




## 5. Conclusion

From the results it was observed that viscosity and thermal conductivity of the 10w30 engine oil has come down even after adding AL2O3 nanoparticles. Viscosity and Thermal conductivity of 10w30 engine oil is getting decreased by maximum of 82.9% and 2.12% at 30°C, 80.3% and 3.5% at 60°C, 80.5% and 5.12% at 80°C respectively after adding nanoparticles at different ratios.

Therefore by adding AL2O3 nanoparticles, heat transfer rate has been decreased because of low thermal conductivity and engine performance will be reduced to a smaller extent. Finally it was found that the cost of product has increased by 80%.

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