ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 3, Issue 4, April 2018

Advance Cooling Of Radiators by Using Nanofluids

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***Abstract*— After combustion of fuel the large heat is liberated inside the combustion chamber. The internal combustion engines are cooled by using either a liquid coolant or air. In air cooling system the air is flow over and around the cylinder, cylinder head and cylinder fins and carry away the heat. In water cooling system the coolant is circulate through a water jacket of cylinder head and cylinder wall. This coolant has absorb heat from the engine and dissipated to atmosphere by the device known as radiator. The Radiator contains number of horizontal tubes surrounded with fins. The heat is carry away by three modes of heat transfer namely Radiation, conduction and convection. Most of the convection takes place because of air flowing around the radiator fin and tube assembly and Conduction takes places between radiator tubes and fins. These coolant offer low thermal conductivity and poor heat transfer characteristics. There is large scope to design a high energy efficient, compact and light in weight automobile radiator by development of advanced nanofluids, which have better conduction and convection thermal properties and better heat transfer characteristics. This paper will introduce new concept of radiators that can adopt the high performance nanofluids. This advance cooling system also raises the total mechanical efficiency of the engine.**

***Index Terms*— Cooling, Heat Transfer, Nanofluids, Radiator, Thermal Conductivity.**

I. INTRODUCTION

We know that, ignition of air and fuel take place inside the engine cylinder and hot gases are produced. In an I.C. engine, the temperature of the gases inside the combustion chamber may differ from 350C to as high as 25000C during combustion process. On the off chance that a engine is permitted to keep running without outside cooling, the cylinder walls, piston and cylinders will exposed, to temperature might be of the range of l0000C to 15000C. Such high temperature, the metals will lose their qualities and piston will expand and seize the liner. Without cooling the efficiency of the engine will enhance but the engine will seize to run. The lubricating oil will begin to evaporate rapidly and both cylinder and piston may be damaged, if the cylinder wall temperature is allowed to rise above a about 650C. Additionally high temperature may cause extreme stresses in a few sections rendering them useless for advance activity. In perspective of this, some portion of the heat produced inside the combustion chamber is permitted to be diverted by the cooling system.

II. NEED OF COOLING SYSTEM

The cooling system is given in the IC engine to the following reasons:

- The temperature of the exhaust gases in the engine barrel comes to up to 15000C to 2000°C, if heat is not dissipated then it will damage the cylinder material as the temperature is reaches the melting point of the cylinder material.
- Due to high temperatures, the film of the lubricating oil will get oxidized, along these lines deposit carbon at surface if piston. This will bring about cylinder seizure.
- Higher temperatures bring down the volumetric Efficiency of the engine.
- Due to overheating, huge temperature contrasts may prompt a dissociation of the engine parts because of the thermal stresses

II. REQUIREMENT OF EFFICIENT COOLING SYSTEM

The two principle prerequisites of a proficient cooling system are:

1. It must be equipped for removing just around 30% of the heat produced in the combustion chamber. A lot of evacuation of heat brings down the thermal efficiency of the engine.
2. It should remove heat rapidly when the engine is hot. The cooling of engine is slow during the starting of the engine.

IV. TYPES OF COOLING SYSTEM

There are two sorts of cooling systems:
4.1 Air cooling system and
4.2 Fluid cooling system

A. Air Cooling System -

In air cooling system the air is flow over and around the cylinder, cylinder head and cylinder fins and carry away the heat. The metallic fins are casted during the manufacturing of cylinder head and cylinder. These fins increase the contact area and provide efficient cooling. On vehicles like motorcycles and aircraft, the forward motion of the vehicle supplies the air flow across the surface. It is more difficult to get uniform cooling of cylinders on air-cooled engines than on liquid-cooled engines. The flow of liquid coolants can be better controlled and ducted to the hot spots where maximum cooling is needed. The measure of heat absorbed by the air-cooling relies on the Following variables:

a) The amount of air and the velocity of air
b) The total fin surface area
c) The temperature of the fine and the cooling air.

Air-cooling is for the most part tractors of less horsepower, cruisers, bikes, little autos and little air ship engines where the forward movement of the machine gives great speed to cool the engine. Air-cooling is also provided in some small industrial engines. In this system, individual cylinders are generally employed to provide ample cooling area by providing fins. A blower is used to provide air.

Advantages of Air Cooled Engines

1. It is light in weight and simple in design due to absence of water jackets, radiator, coolant and piping connections.
2. It is almost maintenance free.
3. No antifreeze solution is required and can operate at low temperatures.
4. No problem of coolant leakage, corrosion and clogging of radiators etc.
5. The system is cheap.
6. Installation is easy.
7. No risk of damage from frost, such as cracking of cylinder jackets or radiator water tubes.

Disadvantages of Air Cooling System:

1. Heat transfer rates are less due to low heat transfer coefficient of air. Therefore, this system can only be used for low capacity engines.
2. Cooling is not uniform. It may cause the distortion of cylinder.
3. Cylinder wall temperature are high
4. If fan is used to improve heat transfer rates to lower the cylinder wall temperature, 5 to 10 % of power is lost to run the fan
5. Specific fuel consumption is high.
6. System is noisy

B. Fluid Cooling System –

In fluid cooled systems, water is utilized as a cooling medium. Different fluids or a blend of water and different fluids utilized as a part of the system to prevent freezing of the coolant at lower temperatures. In this system the cylinder walls and heads are surrounded with jackets through which the cooling liquid circulates and absorbs the heat from the hot metal walls of the engine. The liquid is then cooled by means of an air-cooled radiator system, cooling tower or cooler and recalculated through the engine jackets. Thus, the liquid coolant absorbs heat from the cylinder and rejects it to the air stream.

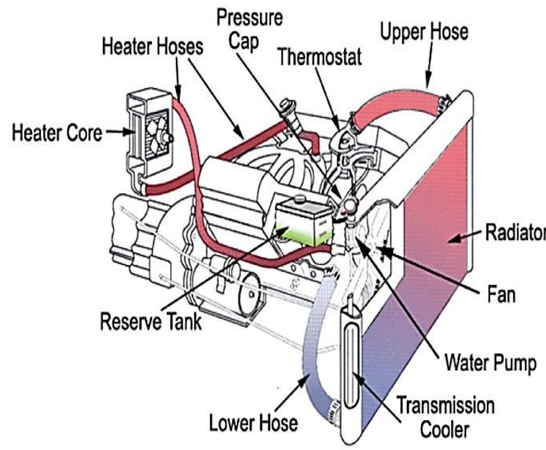

Figure I- Liquid Cooling System

It fills two needs in the working of a engine:
It takes away the excessive heat produced in the engine and save from overheating.
It keeps the engine at working temperature for effective and economical working.

This cooling system has four sorts of systems:

a) Direct or non-return system,
b) Thermo-Siphon system,
c) Hopper system and
d) Pump/constrained flow system.

Advantages of the Fluid Cooling system –

1. System design is compact with appreciably lower front area.
2. Since the rates of heat transfer are high, the system is very useful for heavy duty diesel engines.
3. More even cooling is achieved.
4. The liquid-cooled engine can be made more compact with appreciably smaller frontal area to reduce air resistance.
5. Volumetric efficiency of the engine is high.
6. Unlike air cooled engines which have to be located at the front of the vehicle to take advantage of relative motion of air for cooling, the water cooled engines can be

installed anywhere in the vehicle.
7. The fuel consumption of high compression liquid-cooled engines is lower than that for air- cooled engines.

Disadvantages of Fluid Cooling System-

1. The requirement of radiator, pump and other connections increases the weight of the engine.
2. System fails if adequate water is not circulated. It may damage engine parts.
3. Engine performance is related to climatic conditions.
4. Starting of engine is difficult in cold weather conditions and at high altitudes.
5. Scale formation in water jackets reduces heat transfer rates and cooling is affected.
6. Cost and maintenance of system is high.
7. Specific fuel consumption is high.

V. NANO FLUID AS COOLANT

Nanofluid is another sort of heat transfer medium, containing nanoparticles (1– 100 nm) which are reliably and steadily scattered in a base fluid. These disseminated nanoparticles, for the most part a metal or metal oxide improve the thermal conductivity of the nanofluid, builds conduction and convection coefficients, taking into consideration more heat exchange Nanofluids have been considered for applications as advance heat exchange liquids for just about two decades. Be that as it may, because of the wide variety and complexity of the nanofluid system, no agreement has been accomplished on the extent of potential advantages of utilizing nanofluids for heat transfer applications. The properties of stable nanofluids with metals, for example, copper, silver, gold, and oxides, in particular Al2O3, CuO, TiO2, SiO2, ZnO, and ZrO2, in water and ethylene glycol are generally researched in their potential as heat transfer liquid with applications for heat transfer in car, solar, power plants and cooling electronic apparatuses. Studies are embraced to decide approaches to balance out nanofluids from agglomeration for long turn applications. The thermo physical properties of nanofluids which are vital for applications including single stage convective heat exchange, density, specific heat and thermal conductivity.

Table-I: Thermal conductivity of a few materials, base liquids and nanofluids

	Material	Thermal Conductivity
Metallic Material	Copper	401
	Silver	429
Nonmetallic Materials	Silicon	148
	Alumina(Al_2O_3)	40
Carbon	Carbon Nano Tubes	2000
Nanofluids	Water/ Al_2O_3 (1.50)	0.629
	EG/Al_2O_3 (3.00)	0.278
(Nanoparticle Concentration %)	EG-Water/ Al_2O_3 (3.00)	0.382
	Water/TiO_2 (0.75)	0.682
	Water/CuO (1.00)	0.619

VI. PREPARATION OF NANOFLUID

Nanofluids are Prepare with two methods. A two-step process in which nanoparticles or nanotubes are first produced as a dry powder. The resulting nanoparticles are then dispersed into a fluid in a second step. Single-step nanofluid processing methods have also been developed.

A. Two-Step Methods

Counting the examinations of nanofluids, utilized a two-advance process in which nanoparticles are first created as a dry powder. Two-Step strategy is broadly used to create nanofluids because nano powders are available. A number of chemical, physical and laser-based techniques are accessible for the creation of the nanoparticles to be utilized for nanofluids.

B. One-Step Methods

The nanoparticles may agglomerate amid the drying, stockpiling, and transportation process, prompting challenges in the accompanying scattering phase of two-stage method. Thus, the stability and thermal conductivity of nanofluid are not perfect. The creation cost is high.

Compared to conventional solid liquid suspensions for heat transfer intensifications, nanofluids having properly dispersed nanoparticles possess the following advantages:

- High particular surface area and more heat exchange surface amongst particles and liquids.
- High dispersion stability with predominant Brownian motion of particles.
- Reduced pumping power as compared to pure liquid to achieve equivalent heat transfer intensification.
- Reduced particle clogging as compared to conventional slurries, thus promoting system miniaturization.
- Adjustable properties, including thermal conductivity and surface wettability, by varying particle

concentrations to suit different applications.
- Higher heat conductivity of nano particles will expand the heat exchange rate.
- Nanofluids are most appropriate for improve cooling systems.

The first test with nanofluids gave more encouraging features than they were thought to possess. The four unique features observed are listed below.
Particles size dependence. Unlike the situation with micro slurries, the enhancement of conductivity was found to depend not only on particle concentration but also on particle size. In general, with decreasing particle size, an increase in enhancement was observed.
Abnormal upgrade of thermal conductivity the most critical component saw in nanofluids was an anomalous ascent in thermal conductivity, a long ways past desires and considerably higher.
Small concentration and Newtonian behavior. Large enhancement of conductivity was achieved with a very small concentration of particles that completely maintained the Newtonian behavior of the fluid. The rise in viscosity was nominal; hence, pressure drop was increased only marginally.
Stability Nanofluids have been reported to be stable over months using a stabilizing agent.

VII. APPLICATION

Some of the main cooling applications by using Nanofluids
- Electronic applications
- Bio- and pharmaceutical-nanofluids.
- Process/extraction nanofluids
- Space and defense
- Nuclear systems cooling
- Heat transfer intensification
- Industrial cooling
- Transportation

VII. CONCLUSION

In this paper Nanofluids are utilized as a coolant in Radiators since it has High surface area and thus more heat exchange surface amongst particles and liquids contrast with different Coolants, like water and Ethylene Glycol. Higher heat conductivity of nano particles will expand the heat exchange rate. It reduce size and weight of the car radiator, may bring about increase in the mileage. The Nanofluids are most suitable for improve the cooling systems.

REFERENCES

[1] Heena Naik , Gopal Sahu ,Prakash Kumar Sen, Ritesh Sharma, Shailendra Bohidar, "A Review On Cooling System In Automobile & Cars", IRACST – Engineering Science and Technology: An International Journal (ESTIJ), ISSN: 2250-349, Vol.5, No.5, October 2015

[2] K. Singh, "Thermal Conductivity of Nanofluids", Defence Science Journal, Vol. 58, No. 5, September 2008, pp. 600-607.

[3] Marcelo S. Rocha, Eduardo L. L. Cabral, Gaianê Sabundjian, "Characterization Of Physical Properties Of Al2o3 And Zro2 Nanofluids For Heat Transfer Applications", 2015 International Nuclear Atlantic Conference - INAC 2015, ISBN: 978-85-99141-06-9

[4] K.V. Sharma, Akilu Suleiman, Hj. Suhaimi B. Hassan and Gurumurthy Hegde, "Considerations on the Thermophysical Properties of Nanofluids", Engineering Applications of Nanotechnology, Topics in Mining, Metallurgy and Materials Engineering, DOI 10.1007/978-3-319-29761-3_2

[5] Gupta H.K, Agrawal G.D, Mathur J, "An overview of Nanofluids: A new media towards green environment", International Journal of Environmental Sciences, Volume 3, No 1, 2012, ISSN 0976- 4402.

[6] P.Suganya, G.Subburaj, S.Ragupathy, T.Ajith, K.Vinothkambly, "Advance Cooling Of Radiators By Using Copper-Oxide Nanofluids" International Conference on Explorations and Innovations in Engineering & Technology (ICEIET - 2016), ISSN: 2349 - 9362

[7] Kiran Sebastian, Jinson Paul, "Advances In Cooling Systems," International Journal of Engineering Science Invention Research & Development; Vol. III, Issue I, July 2016, e-ISSN: 2349-6185

[8] N. K. Chavda, " Effect Of Nanofluid On Heat Transfer Characteristics Of Double Pipe Heat Exchanger: Part-Ii: Effect Of Copper Oxide Nanofluid," IJRET: International Journal of Research in Engineering and Technology eISSN: 2319-1163, pISSN: 2321-7308, Volume: 04 Issue: 04, Apr-2015

[9] S. Ferrouillat, A. Bontemps, O. Poncelet, O. Soriano, J. A. Gruss, ”Influence of Nanoparticle Shape Factor on Convective Heat Transfer of Water-Based ZnO Nanofluids. Performance Evaluation Criterion,” International Journal of Mechanical and Industrial Engineering (IJMIE), ISSN No. 2231 –6477, Volume-1, Issue-2, 2011

[10] K. Abdul Hamid, W. H. Azmi, Rizalman Mamat, N. A. Usri, Gholamhassan Najafi, “Effect Of Titanium Oxide Nanofluid Concentration On Pressure Drop,” ARPN Journal of Engineering and Applied Sciences, VOL. 10, NO. 17, September 2015 ISSN 1819-6608