ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

# Performance Improvement of an Engine Block by Using Various Cutting Fluids

**M. Varaprasad**
Department of Mechanical Engineering,
Global College of Engineering and Technology,
Kadapa, A.P 516003, India.

**K. Ashok Kumar**
Department of Mechanical Engineering,
Global College of Engineering and Technology,
Kadapa, A.P 516003, India.

***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. 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. This thesis was conducted to study the effectiveness of various types cooling agent in the vehicle cooling system which will influence the operation time of the engine block mainly cylinder in the light vehicle cooling systems. Theoretical calculations were done to determine the overall heat transfer coefficient and heat lost by the cylinder by varying the fluids and material of cylinder. Three main types of fluids were used in this study, which are1. Distilled water, 2. Distilled water with Ethylene glycol and 3. Organic acids. Thermal analysis is done on the cylinder by varying the materials Cast Iron, Aluminum alloys 7475 and 606.***

## INTRODUCTION

### Cooling Systems in Vehicles

Although gasoline engines have improved a lot, they are still not very efficient at turning chemical energy into mechanical power [1]. Most of the energy in the gasoline (perhaps 70%) is converted into heat, and it is the job of the cooling system to take care of that heat. [Leong, 2010]In fact, the cooling system on a car driving down the freeway dissipates enough heat to heat two average-sized houses! The primary job of the cooling system is to keep the engine from overheating by transferring this heat to the air, but the cooling system also has several other important jobs [Nice, 2012].The engine in your car runs best at a fairly high temperature. When the engine is cold, components wear out faster, and the engine is less efficient and emits more pollution. So another important job of the cooling system [2] is to allow the engine to heat up as quickly as possible, and then to keep the engine at a constant temperature [Ofria, 2006].

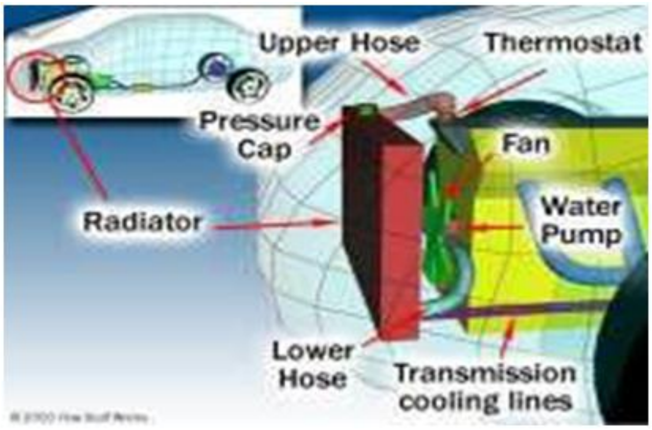


Figure 1.1: The Basic Parts of the Car Engine

Inside your car's engine, fuel is constantly burning. A lot of the heat from this combustion goes right out the exhaust system [3], but some of it soaks into the engine, heating it up. The engine runs best when its coolant is about 200 degrees Fahrenheit (93 degrees Celsius). At this temperature:

- The combustion chamber is hot enough to completely vaporize the fuel, providing better combustion and reducing emissions.

**Cite this article as:** M. Varaprasad & K. Ashok Kumar, "Performance Improvement of an Engine Block by Using Various Cutting Fluids", International Journal & Magazine of Engineering, Technology, Management and Research, Volume 5 Issue 11, 2018, Page 20-25.

- The oil used to lubricate the engine has a lower viscosity (it is thinner), so the engine parts move more freely and the engine wastes less power moving its own components around.
- Metal parts wear less.

## TYPES OF COOLING SYSTEMS

There are two types of cooling systems found on cars: liquid-cooled and air-cooled.

### Air Cooling

Some older cars, and very few modern cars, are air-cooled. Instead of circulating fluid through the engine, the engine block is covered in aluminum fins that conduct the heat away from the cylinder. A powerful fan forces air over these fins, which cools the engine by transferring the heat to the air [4].

### Liquid Cooling

The cooling system on liquid-cooled cars circulates a fluid through pipes and passageways in the engine. As this liquid passes through the hot engine it absorbs heat, cooling the engine. After the fluid leaves the engine, it passes through a heat exchanger, or radiator, which transfers the heat from the fluid to the air blowing through the exchanger.

Although gasoline engines have improved a lot, they are still not very efficient at running chemical energy into mechanical power. Most of the energy in the gasoline (perhaps 70%) is converted into heat, and it is the job of the cooling system to take care of that heat. In fact, the cooling system on a car driving down the freeway dissipates enough heat to heat two average-sized houses! The primary job of the cooling system is to keep the engine from overheating by transferring this heat to the air, but the cooling system also has several other important jobs [5]. The engine in your car runs best at a fairly high temperature. When the engine is cold, components wear out faster, and the engine is less efficient and emits more pollution. So another important job of the cooling system is to allow the engine to heat up as quickly as possible, and then to keep the engine at a constant temperature.

## HEAT TRANSFER CALCULATIONS

The overall heat transfer coefficient for a wall or heat exchanger can be calculated as:

$$1 / U A = L / k A + 1 / hA \quad \ldots\ldots. (1)$$

Where

U = the overall heat transfer coefficient ($W/m^2K$)

A = the contact area for each fluid side ($m^2$)

k = the thermal conductivity of the material (W/mK)

h = the individual convection heat transfer coefficient for each fluid ($W/m^2K$)

L= the wall thickness (m)

The thermal conductivity - k - for some typical materials (varies with temperature)

Alloy Cast Iron: 53.3 W/mK

Aluminium 6061: 205 - 250 W/mK

Aluminium 7475: 138 W/mK

More about conductive Heat Transfer

Thermal Conductivity for Several Materials

The convection heat transfer coefficient - h - depends on

The type of fluid - gas or liquid

The flow properties such as velocity

Other flow and temperature dependent properties Heat transfer coefficient for some common fluids:

Tap Water: $5000 W/m^2K$

Distilled Water: $10\,000\ W/m^2K$

Distilled water with Ethylene Glycol: $350\ W/m^2K$

## ENGINE SPECIFICATIONS

Length of the cylinder: 0.072 m

Bore diameter: 0.0685 m

Thickness of cylinder: 0.004 m

Heat Transfer Q = U A (Tg - Tc)

U = Over all heat transfer coefficient

A = Area of cylinder

Tg = Temperature inside cylinder

Tc = Temperature of coolant

Area of cylinder = $1.235e^{-5}\ m^2$

Overall heat transfer coefficient:

$$\frac{1}{UA} = \frac{L}{kA} + \frac{1}{hA}$$

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## METHODOLOGY

### CAD

Computer-aided design (CAD) [6], also known as computer-aided design and drafting (CADD), is the use of computer technology for the process of design and design-documentation. Computer Aided Drafting describes the process of drafting with a computer. CADD software, or environments, provide the user with input-tools for the purpose of streamlining design processes; drafting, documentation, and manufacturing processes. CADD output is often in the form of electronic files for print or machining operations. The development of CADD-based software is in direct correlation with the processes it seeks to economize; industry-based software (construction, manufacturing, etc.) typically uses vector-based (linear) environments whereas graphic-based software utilizes raster-based (pixelated) environments.

CADD environments often involve more than just shapes. As in the manual drafting of technical and engineering drawings, the output of CAD must convey information, such as materials, processes, dimensions, and tolerances, according to application-specific conventions.

CAD may be used to design curves and figures in two-dimensional (2D) space; or curves, surfaces, and solids in three-dimensional (3D) objects [7].

CAD is an important industrial art extensively used in many applications, including automotive, shipbuilding, and aerospace industries, industrial and architectural design, prosthetics, and many more. CAD is also widely used to produce computer animation for special effects in movies, advertising and technical manuals.

The modern ubiquity and power of computers means that even perfume bottles and shampoo dispensers are designed using techniques unheard of by engineers of the 1960s. Because of its enormous economic importance, CAD has been a major driving force for research in computational geometry, computer graphics (both hardware and software), and discrete differential geometry.

The design of geometric models for object shapes, in particular, is often called computer-aided geometric design (CAGD).

Current computer-aided design software packages range from 2D vector-based drafting systems to 3D solid and surface modellers. Modern CAD packages can also frequently allow rotations in three dimensions, allowing viewing of a designed object from any desired angle, even from the inside looking out. Some CAD software is capable of dynamic mathematic modeling, in which case it may be marketed as CADD — computer-aided design and drafting [8].

CAD is used in the design of tools and machinery and in the drafting and design of all types of buildings, from small residential types (houses) to the largest commercial and industrial structures (hospitals and factories).

### Introduction to PRO/Engineer

Pro/ENGINEER is a feature based, parametric solid modeling program. As such, its use is significantly different from conventional drafting programs. In conventional drafting (either manual or computer assisted), various views of a part are created in an attempt to describe the geometry. Each view incorporates aspects of various features (surfaces, cuts, radii, holes, protrusions) [9] but the features are not individually defined. In feature based modeling, each feature is individually described then integrated into the part.

The other significant aspect of conventional drafting is that the part geometry is defined by the drawing. If it is desired to change the size, shape, or location of a feature, the physical lines on the drawing must be changed (in each affected view) then associated dimensions are updated. When using parametric modeling, the features are driven by the dimensions (parameters). To modify

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the diameter of a hole, the hole diameter parameter value is changed [10]. This automatically modifies the feature wherever it occurs - drawing views, assemblies, etc. Another unique attribute of Pro/ENGINEER is that it is a solid modeling program.

The design procedure is to create a model, view it, assemble parts as required, then generate any drawings which are required. It should be noted that for many uses of Pro/E, complete drawings are never created. A typical design cycle for a molded plastic part might consist of the creation of a solid model, export of an SLA file to a rapid prototyping system (stereo lithography, etc.), use of the SLA part in hands-on verification of fit, form, and function, and then export of an IGES file to the molder or toolmaker. A toolmaker will then use the IGES file to program the NC machines [11]which will directly create the mold for the parts. In many such design cycles, the only print created will be an inspection drawing with critical and envelope dimensions shown.

### Different Modules in PRO/Engineer

- Part Design
- Assembly
- Drawing
- Sheet Metal

### FEA

Finite Element Analysis (FEA) [12] was first developed in 1943 by R. Courant, who utilized the Ritz method of numerical analysis and minimization of variation calculus to obtain approximate solutions to vibration systems. Shortly thereafter, a paper published in 1956 by M. J. Turner, R. W. Clough, H. C. Martin, and L. J. Topps established a broader definition of numerical analysis. The paper centered on the "stiffness and deflection of complex structures".

FEA consists of a computer model of a material or design that is stressed and analyzed for specific results. It is used in new product design, and existing product refinement. A company is able to verify a proposed design will be able to perform to the client's specifications prior to manufacturing or construction. Modifying an existing product or structure is utilized to qualify the product or structure for a new service condition. In case of structural failure, FEA may be used to help determine the design modifications to meet the new condition.

There are generally two types of analysis that are used in industry: 2-D modeling, and 3-D modeling. While 2-D modeling conserves simplicity and allows the analysis to be run on a relatively normal computer, it tends to yield less accurate results. 3-D modeling, however, produces more accurate results while sacrificing the ability to run on all but the fastest computers effectively. Within each of these modeling schemes, the programmer can insert numerous algorithms (functions) which may make the system behave linearly or non-linearly. Linear systems are far less complex and generally do not take into account plastic deformation. Non-linear systems do account for plastic deformation, and many also are capable of testing a material all the way to fracture.

## RESULTS

### DISTILLED WATER WITH COOLANT-350

| | Nodal temperature k | Thermal gradient | Thermal flux |
|---|---|---|---|
| Aluminium alloy 6061 | 558 | 69.2373 | 12.4627 |
| Aluminium alloy 7475 | 558 | 80.1391 | 11.0592 |
| Cast iron | 558 | 33.3209 | 17.7601 |

Table 7.1 Distilled Water with Coolant 350 Results

### DISTLLED WATER WITHOUT COOLANT-10000

| | Nodal temperature | Thermal gradient | Thermal flux |
|---|---|---|---|
| Aluminium alloy 6061 | 558 | 29.2302 | 5.2614 |
| Aluminium alloy 7475 | 558 | 35.9186 | 4.95676 |
| Cast iron | 558 | 11.45 | 6.10019 |

Table 7.2 Distilled Water with Coolant 1000 Results

## ORGANIC ACID:

| | Nodal temperature | Thermal gradient | Thermal flux |
|---|---|---|---|
| Aluminium alloy 6061 | 558 | 186.023 | 33.4842 |
| Aluminium alloy 7475 | 558 | 199.027 | 27.4657 |
| Cast iron | 558 | 130.521 | 69.5676 |

Table 7.3 organic acid results

## CONCLUSION

In this thesis a cylinder in the engine of a car is designed and modelled using Pro/Engineer. The present used material for engine block is cast iron. It is replaced with aluminium alloys 7475 and 6061 due to their high conductivity values and less densities. Three types of fluids were considered, Distilled Water , Distilled Water with Coolant Ethylene Glycol and organic acid

Theoretical calculations were done to determine the overall heat transfer coefficient and heat lost by engine cylinder. By observing the values, using material Aluminium alloy 6061 and fluid organic acid has high heat transfer rate.

Thermal analyses were done in Ansys to determine the heat transfer rate analytically on the engine cylinder. By observing the analysis results, using Cast Iron for cylinder and fluid organic acid has high heat transfer rate since thermal flux is more. But by using Cast Iron the weight of the engine block increases, so using Aluminium alloy 6061 is better since its density is less than that of Cast Iron and also the heat transfer rate is almost same as Cast Iron.

So we can conclude that by analytically and theoretically Aluminium Alloy 6061 is better for cylinder. But cooling fluid organic acid is better analytically and Distilled water with coolant is better theoretically.

## REFERENCES

[1].Leong, K.Y., Saidur, R., Kazi, S. N., & Mamun, A. H. (2010). Performance Investigation Of An Automotive Car Radiator Operated With Nanofluid-Based Coolants (Nanofluid As A Coolant In A Radiator). Applied Thermal Engineering, Vol 30, Issue 17/18, P2685-2692.

[2].Mohd Rajuli, M. B. (2006). Teknologi Automotif : Pengenalan Sistem. Petaling Jaya : IBS Buku Sdn Bhd.

[3].Nice, K. (n.d.). How Car Cooling Systems Work. Retrieved 11 July 2012

[4]. Leong, K.Y., Saidur, R., Kazi, S. N., &Mamun, A. H. (2010). Execution Investigation OfAn Automotive Car Radiator Operated With Nanofluid-Based Coolants (Nanofluid As A Coolant In A Radiator). Connected Thermal Engineering, Vol 30, Issue 17/18, P2685-2692.

[5].Heat and Mass switch with the guide of R.K. RajputMohdRajuli, M. B. (2006). TeknologiAutomotif :PengenalanSistem. PetalingJaya : IBS BukuSdn Bhd.

[6]. Nice, K. (n.D.). How Car Cooling Systems Work.Retrieved eleven July 2012 from http://car.Howstuffworks.Com/coolingsystem3. Htm

[7]. Ofria, C. (2006). A Short Course on Cooling Systems. Recovered eleven July 2012 from http://www.Familycar.Com/classroom/Cool ingSystem.Ht

[8].ASHRAE hand digital book 2005. Essentials, American Society of Heating, Refrigerating and Air-molding Engineers Inc. Atlanta.

[9].Choi, S.U.S., 1995. Upgrading warm conductivity of liquid with nanoparticles. In: Siginer, D.A., Wang, H.P. (Eds.), Developments and Applications of Non-Newtonian Flows, FED-V.231/MD-V.66. ASME, New York, ninety nine– one zero five.

[10].Das, S.K, Putra, N., Thiesen, P., Roetzel, W., 2003.Temperature reliance of warm conductivity improvement for nanofluids, Journal of Heat Transfer, 125, 567 – 574.

[11].Natural convective heat transfer from a narrow vertical flat plate with a uniform surface heat flux and with different plate edge conditions by Patrick H. Oosthuizen, Jane T. Paul, Frontiers in Heat and Mass Transfer (FHMT), 1, 013006 (2010), DOI: 10.5098/hmt.v1.1.3006

[12].Laminar flow analysis over a flat plate by computational fluid dynamics by Rajesh Khatri, Pankaj Agrawal, Mohan Gupta, Jitendra verma, International Journal of Advances in Engineering & Technology, May 2012. ISSN: 2231-1963