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PERFOMANCE UPGRADING OF ENGINE BY OIL COOLING SYSTEM

Kiran Kenny, Shibu Augustine, Prasidh E Prakash,Arjun G Nair

Malabar College of Engineering and Technology, Kerala Technological University

kirankenny33@gmail.com, shibuaugustine@gmail.com, prasidhearath@gmail.com, arjunagn911@gmail.com

Abstract: This deals with the process of, upgrading engine performance by oil cooling system for future vehicle applications result in the increase of high engine power, low fuel consumption. The wish to prevent the future situation where the engine oil could become very hot, formed the basis for this work. Engine oil, heat transferring rate and overall design of engine cooling systems were noted and studied. The most significant section was to make sure that the oil must not exceed the certain temperature limit. This gave answers to how the oil and engine components gets affected, if the oil exceeds the set temperature limit.

To get an explict and measurable parameters, the goal of this paper was defined by estimating, the heat transfer demands will be in the future. An analysis was made to inspect how and if, the challenger use another kind of oil cooling. Concepts that showed to be interesting were analyzed more extremely with performance simulations and packaging studies. Concepts were analyzed and the performance simulations indicated that all the presented concepts can reach the heat transfer goals set earlier in this process. They however may use different methods, and meet the objective with different levels of efficiency. All the ideas which are noted with their heat transfer performance results and their advantages and disadvantages. The idea that showed to be the important in an oil cooling perspective, was to attach an extra heat exchanging device in series after the current plate heat exchanger. This is also a solution which will helps the current engine oil cooler by handling the extra heat produced during certain driving occasion. Best concept reached a heat transfer range of 40 kW at half of the air flow rate required by the second best concept. The concepts that has been presented will incriminate a change in the current oil cooling system design. The lack of accessible space in automobiles will also result in some rearranging of components in order to make space for an additional heat exchanger.

I. INTRODUCTION

It has been identified that we may run into problems with inadequate engine oil cooling in future as the power output increases to levels significantly higher than today. The reason for the problem with the oil cooling can be the following:

a) More heat will be generated to both the oil and engine coolant due to increased engine power.

b) Desire to allow a higher maximum towing weight.

c) The opportunities to scale up the existing system limited by lack of available space for components on and around the engine system.

In most cases the insufficient oil cooling may neither appear on low performance versions of engine nor in normal driving conditions only when the cars performance is maximized to its limits, such as top speed driving, long and heavy accelerations or towing a heavy trailer uphill the oil cooling will be inadequate.

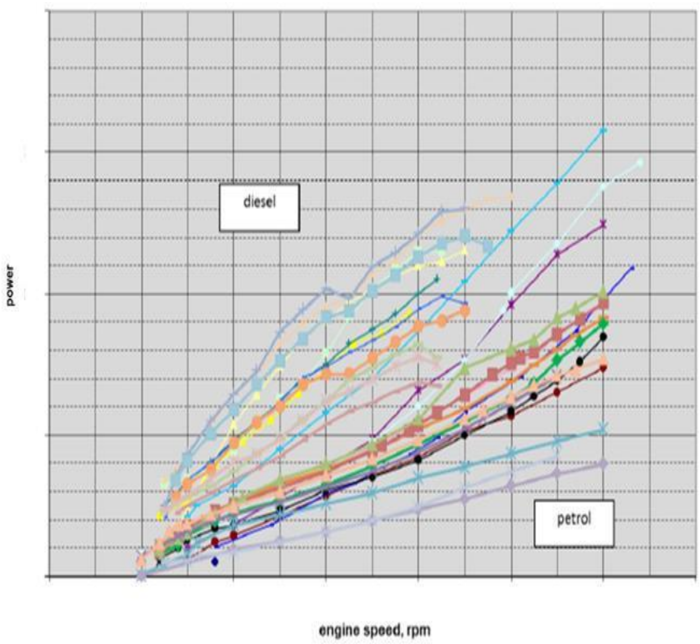


Figure 1. Oil cooler heat rejection at for difference engines

Here we are using an additional radiator oil/air system to meet the needs. In order to check which one is more suitable, we are using different types of metals as radiator coil.

II. AUTOMATIVE ENGINE OIL SYSTEM

Lubricating moving parts in the engine, preventing premature wear of bearings, shafts etc. are the main functions of oil system. Engine oil also cools some of the components which are not possible to cool with water, protect components against corrosion and rust. The function of the oil pump is to draws oil from the oil sump through a tube and pumps the oil through a filter to clean the oil. To control the oil pressure in the engine, there is a pressure relief valve after the pump . The valve can route oil directly back to the sump or the pump inlet and in that way regulate the pressure in the lubrication channels. The oil travels through the channels usually cast in the engine block and head. Cross-drillings are present to supply oil from the channels to the main bearings and camshaft bearings. The drillings in the crankshaft also supply oil to the connecting-rod bearings. More passages are present in order to supply oil to other moving parts in the engine. From each lubricated surface the oils gravity fed back to the pump system..

III.HEAT TRANSFER TO OIL

In an internal combustion engine the main sources of heat transfer to the engine oil are the pistons, friction between moving partS. Pistons are the only oil cooled components in the engine that takes up heat directly from the combustion process. When the piston is forced down, the fuel in the combustion chamber gets ignited some of the energy is converted to mechanical energy. Then a big portion of the remaining heat is dissipated into the exhaust gas, and gets evacuated from the combustion chamber via the exhaust valve. The remaining heat is transferred, through convection and radiation, to the parts that are next to combustion chamber. The main components which make up the combustion chamber are the cylinder head, the cylinder block and the pistons depicted in Fig.1. They take up heat from combustion chamber. Cylinder head and the cylinder block are cooled by the water cooling system while the pistons are cooled by the engine oil

IV.HEAT EXCAHNGERS

The basic explanation for how a heat exchanger functions is that one warm and one cold medium flows close to each other, with a surface between them. The hot medium transfers thermal energy to the cold medium. This makes the cold medium warmer and also warm medium cooler, and therefore a heat exchange has been made. This is a method to exchange heat between two mediums without mixing them. The heat transfer in a heat exchanger depends on the following aspects:

- The type of heat exchanger, material and design.
- Thermal conductivity of the flowing mediums in the heat exchanger

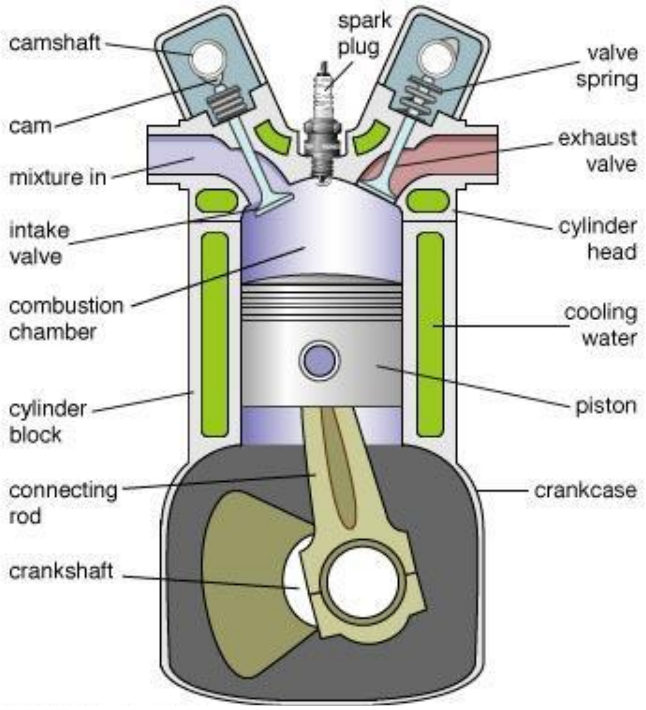


Fig. 1. Cross section of engine cylinder.

- Difference in temperature for the two mediums.
- Mass flow to the heat exchanger inlets.
- Turbulence or laminar flow in the mediums.

Thermal conductivity of different heat exchanger materials is shown in the fig.2.

Material	25°C	125°C
Silver	406	430
Copper	401	400
Gold	310	312
Aluminium	205	215
Iron	80	68
Carbon	54	51
Stainless Steel	16	17

Fig.2. Thermal Conductivity of heat exchanger materials

V.OIL SYSTEM TEMPERATURE

It is important to keep the optimal oil temperature in the oil system. If the temperature exceeds the predefined temperature, the engine will be affected. The temperature of the coolant will rise from the outlet of the heat exchanger when the oil temperature gets higher. This leads to a higher temperature in the whole cooling system which in turn affects the engine.

On earlier cars the allowed oil temperature was considerably lower than today. Earlier the oils used were one hundred percent mineral oil. But after starting to mix synthetic oil with the mineral oil, and today using only synthetic oils, the allowed temperature came up to a higher level. The reason that the mineral oil did not manage the high temperature was that, the mineral oil started to break down at high temperatures and therefore losing its properties. The engine oil that is used is a fully synthetic oil manufactured by Castrol, which has a viscosity class of SAE 0W20. When the companies introduced their latest engine generation, they switched from 0W30 to 0W20 to reduce friction in the engine. The oil is manufactured according to the European Automobile Manufacturers Association (ACEA) C2-standard and they use the same oil in both diesel and petrol engines, for all power levels. The maximum oil temperature set by companies is around 150 °C. The oil itself can however handle higher temperatures before it starts to break down. Tests performed by Castrol shows that the oil can withstand a temperature of around 170 °C for six hours, before the additives in the oil starts to react and break down. The maximum temperature of around 150 °C is set because the kinematic viscosity of the oil becomes too low at temperatures above 150°C. A high share of fuel in the oil typically occurs in engines where the oil rarely reaches its working temperature, preventing the fuel in the oil from evaporating. This can be seen in such cars where the customer mostly drives short distances. Diesel has a lower viscosity compared to engine oil. Therefore the mixing with fuel will decrease the overall viscosity of the oil/fuel-mixture. The oil has a kinematic viscosity of around 4,0 cSt at 150 °C. At viscosities below 4,0 cSt the oil pump cannot supply sufficient oil. The lubrication properties are not the only problem with getting a higher oil temperature. The oil is used for cooling the bottom of the piston and if the oil is too hot, the piston could get too hot which might cause the combustion to misfire.

VI.ADDITIONAL RADIATOR OIL/AIR

Oil to air cooler or OTA was attached to the cooling system. The OTA has been attached serially from the oil outlet of the standard oil to water system which was pumped through the OTA for extra cooling of the oil. In some cases where oil to water system provides enough cooling, no oil will be pumped along the OTA and can be controlled by a valve called thermal bypass valve, that will be activated by temperature of oil.OTA needs to be placed anywhere in the automobile where adequate air flow is present. Here it is also preferred that the OTA needs to be set near to oil connections in the system to reduce length of the pipes bypass valve.

This system with the OTA radiator is shown in fig3.Here in this system the oil is collected to a tank from the oil sump. A thermal bypass valve has been fitted to this tank. When the temperature of oil gets increased the bypass valve gets opened and the DC pump which is connected to this system, pumps the hot oil to the extra radiator present outside the engine where the oil gets cooled by air.

The main advantages are, the plate heat exchanger's performance doesn't need to be improved or to increased.

The solution which is added "on top" of the existing system to increase the oil cooling in high-level performing engines. The only need to handle the excess heat in utmost situations which is activated by the oil temperature. Main disadvantages are, Oil pipes or hoses needs to be positioned in between the engine and OTA. The engine gets harmed, if there is a possible oil pressure drop occurs. Packaging needs to have in mind the potential damage of the radiator and hoses. An adapter has to be made for oil outlet- and oil inlet to the system.

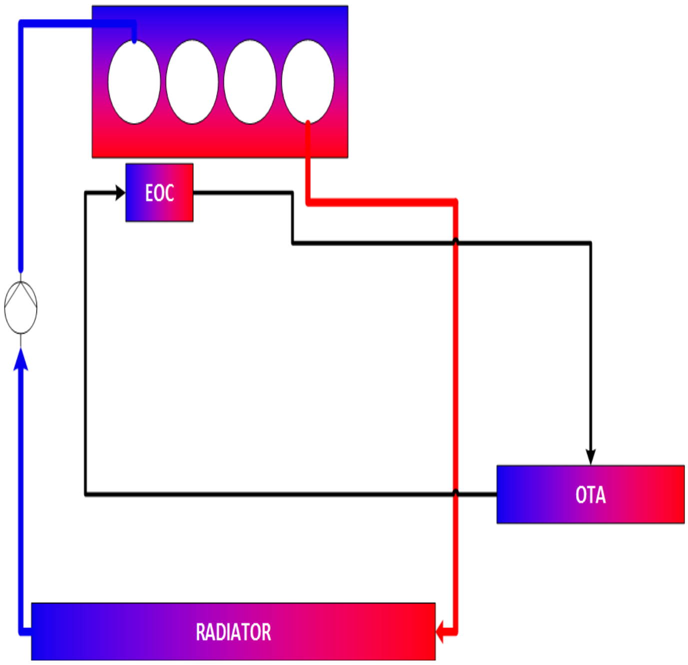
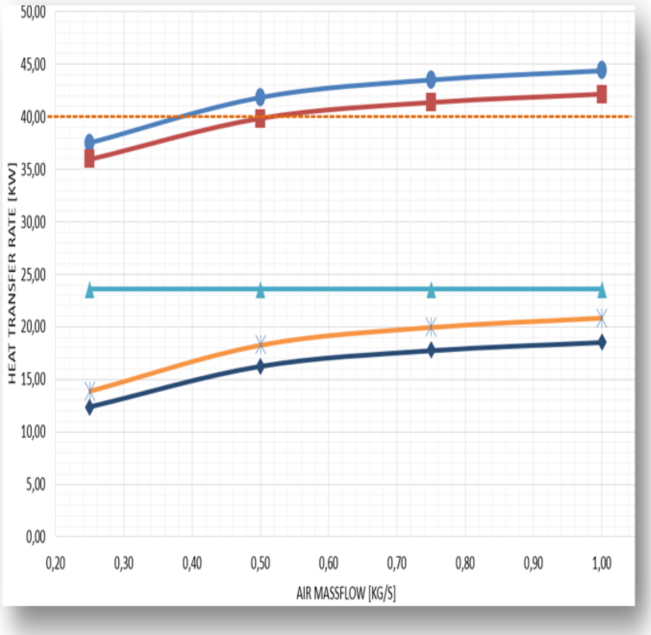


Fig 3.Schematic drawing

VII.HEAT TRANSFER OF OTA SYSTEM

Fig.4



An OTA simulation model is made with data from an oil to air heat exchanger object from an automobile supplier. OTA has the normal measurements of 270x212x26 mm (WxLxH) and a tube and fin type heat exchanger, which made out of aluminum or copper.

Some aspects have to be taken while performing this:

- There has to be space for the radiator and its tubes, and it should be easy to set in a bike.
- A good airflow gives a high air pressure in the front of the radiator which mounted. The air must also needs to be led out where there is a low air pressure present.
- The components which we used should be as low as possible in order to increase efficiency during setting or assembly, which will keep cost low as possible.

VIII.COPPER OR ALUMINIUM COIL AT RADIATOR

Copper has a thermal conductivity of 401 (W/m·K) at room temperature, while the thermal conductivity of aluminium is 237 (W/m·K) at room temperature showed in Figure 5.The values may differs with the temperature of the material. Manufacturing of a plate heat exchanger from copper would therefore most likely increase the heat transfer rate. Introducing copper components to the cooling system has not been encouraged because of the corrosion it causes to aluminum. Hydrogen has been used in coolant exchanges with copper atoms which will transfer the copper around cooling system. Aluminum is a less noble material than copper. So all the aluminum parts located in the cooling system will be affected. Galvanic corrosion will start to occur when the copper and the aluminum are in contact, and the aluminum parts will corrode. Corrosion inhibitors are added to the coolant to prevent corrosion in the cooling system. The inhibitors forms a passive layer on the surface of any metals. The inhibitors protects from corrosion from some metal atoms in the system

Mainly aluminium is used in the high performance engine because of its thermal conductivity rate,higher availability, less coat and easy to handle.

Thermal conductivities of materials vary with temperature

	k, W/m·K	
T, K	Copper	Aluminum
100	482	302
200	413	237
300	401	237
400	393	240
600	379	231
800	366	218

Fig 5

IX.CONCLUSION

A cooling system must be provide not only to prevent damage to the vital parts of the engine , but the temperature of these components must be maintained within the certain limits in order obtain maximum performance from the engine. From the analysis, the conclusion that can be made is that the high performance petrol engine almost use oil to air heat exchanger. An additional oil to air heat exchanger have the common purpose of supporting the existing plate heat exchanger when it has reached its maximum heat transfer values. The method which is used to perform this work turn out to have different levels of efficiency. This requires around three times air flow into the heat exchanger to reach the target heat transfer value.

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