

Design and Manufacturing of BS6 Engine Cooling System

Ihab Jilani¹ Ronak Oswal² Rahul Suryavanshi³ Amit Waghmode⁴ Prof. Mukesh. M. Mane⁵
^{1,2,3,4,5}Suman Ramesh Tulsiani Technical Campus, India

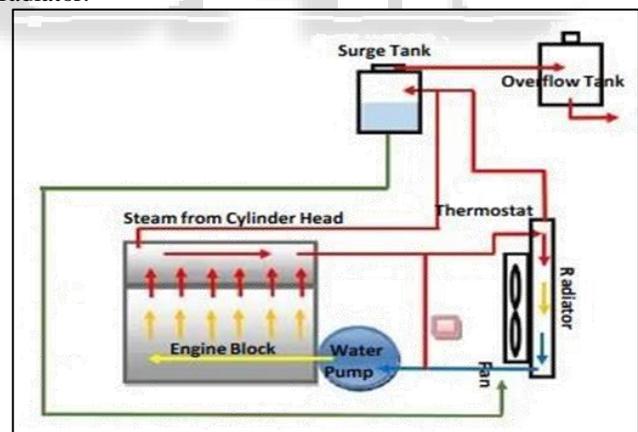
Abstract— The rapid growth of automotive industry in India is facing challenges of degradation in the quality of surrounding environment. To improve the current status of exhaust emissions from automobiles Government of India decided to implement Bharat Stage VI (BS-VI) norms from April 2020 in 15 major cities. Due to skipping of BS-V, Indian original equipment manufacturers (OEMs) are now facing a big challenge of confirming these norms. Sustainable mobility is the only solution for this which includes improvements in existing engine technology and fuels. This report explains in brief about various means of sustainable mobility namely usage of alternate fuels, advanced combustion methods, engine downsizing, onboard diagnostics, use of after-treatment devices, electric and hybrid vehicles. Hydrogen which is the best fuel among all fuels, but not a better option because of safety issues. Hence to meet BS-VI emission limits advanced combustion methods, downsizing of engine and application of after-treatment devices could be the possible options that engine manufacturers have. This report briefly explains key features of BS-VI and possible options to satisfy BS-VI limits. Finally, the current status of efforts taken by Indian OEMs to meet those norms is mentioned.

Keywords: Bharat stage VI, fuel, energy, engine cooling system

I. INTRODUCTION

As per World health organization (WHO) India has greatest number of most polluted cities (30 in top in terms of particulate matter (PM). Air pollution is fifth cause of death India. Currently in capital city Delhi vehicles are contributing around 59%, 50% and 18% of overall emissions of CO, HC and NO_x respectively. To address this serious issue on 19th Feb 2016 Ministry of road transport and highway, India issued notification of Bharat stage VI (BS-VI) which will be implemented from 1st April 2020. In BS-VI modified mass emission standards and type approval requirement, compulsory usage of OBD in all kinds of vehicle, improved durability levels and requirements of fuel compatible with BS-VI are some noteworthy points. In about seven months, India will fully adopt the stricter BS6 emission norms a transition that can be termed as the biggest technological leap the country's auto industry has taken towards clean air. The shift, by skipping BS5, has not only happened in record time – around three and a half years – but also under great pressure, as both the oil companies and the auto industry worked relentlessly to prepare in time for the challenging deadline of April 2020. However, not all automakers have managed to make this transition fast enough, resulting in many models and powertrains being phased out. It has also entailed a significant cost, one that will inevitably be passed on to the consumer. Naturally, the talk surrounding the shift has raised many questions and left many car buyers flummoxed. But we'll break it down and tell what you need to know.

In an automobile where usually internal combustion engine is used the power is generated by igniting air and fuel in a combustion chamber. This energy is not utilized completely it is wasted in the form of heat and exhaust gases, if this excess heat is not removed from the engine it results in the overheating of the engine which affects a lot on the engine performance as well as on the engine life. Usually small capacity engine uses air to cool the engine in this case fins are provided on the engine. But in case of high-performance engine, air is not enough for cooling, so a liquid cooling system has to be used which uses a radiator, cooling fan, a pump and a thermostat. In this liquid cooling system, liquid is used for reducing the temperature of engine this liquid usually being (specialized coolants) but here we are designing a Liquid cooling system for a FSAE race car where we have to follow certain rules and regulation which includes compulsory use of distilled water as coolant, so we need to design our radiator accordingly also as we are talking about a race car the design of the radiator is of the main concern as it has to be compact, light in weight and as the engine is going to be used at its maximum capacity the cooling system should be very efficient. These automotive radiators are mostly made up of thin aluminum fins and flattened aluminum tubes. The coolant flows from engine to inlet port of the radiator then it is circulated in radiator tube and undergoes heat transfer by conducting heat from fin to air flowing through radiator and then it goes back to engine through outlet port of the radiator.



II. PROBLEM STATEMENT

The main aim of adapting BS6 engine over BS4 engine is to minimize and reduce the gases emission and to drop the pollution level. As we all are aware about that BS4 engine is going to be banned by April 2020.

A vital difference between BS6 and the outgoing BS4 fuel is that the BS6 fuel contains 5 times fewer sulphur traces (10 parts per million) compared to BS4 (50 ppm). NO_x (Nitrogen Oxide) level will be brought down by a staggering 70% for Diesel engine and 25% for Petrol Engines.

III. OBJECTIVE

- To minimize the emission level
- To increase the engine performance and efficiency
- To lower the grade of Sulphur content in the fuel
- To cut down on N₂O (Nitrous Oxide) emissions by more than 70%

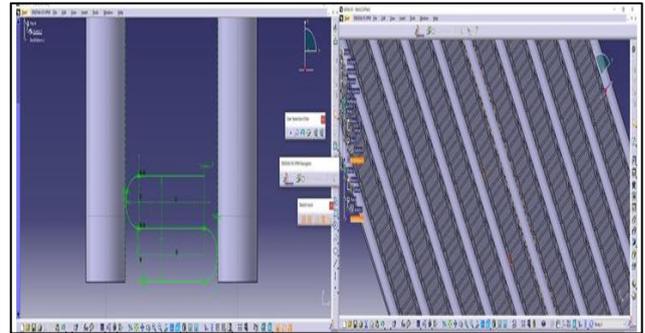
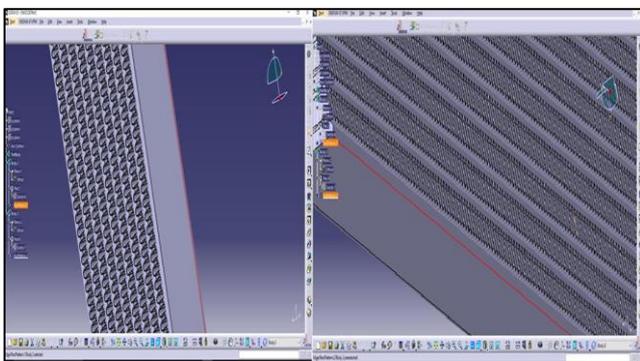
IV. SCOPE

- 1) BS-VI will definitely going to bring drastic change in automotive market in India.
- 2) We will get more fuel efficient and very low emission producing vehicles in near future. Downsizing and down speeding will yield smaller and powerful engines.
- 3) Indian driving speeds are less than European driving speeds, hence it is difficult to achieve temperature which is necessary to operate particulate filter. Hence domestic tire-I and tire-II suppliers have great opportunity to innovate new engine technology and emission control technology suitable to Indian driving conditions.
- 4) To achieve emission limits specified in BS-VI ample amount of engine electronics will required. This will enhance business of domestic and MNC automotive electronic suppliers. Vendors and engineering solution providing companies for Eco testing, fuel system testing and emission testing are also going to benefit a lot.
- 5) Through all these efforts people can ensure significant reduction in air pollution from automobiles. This will bring remarkable improvement in air quality in highly populated cities as automobiles are main source of air pollution in cities.

V. MODIFICATIONS IN FINS

Here we have some changes in the thickness of the fins so that we can get large surface area for the mounting of the fins as the surface area increase the number of fins also increased which is directly proportional to the rate of heat transfer through the fins our main aim to increase the rate of heat transfer which we have accomplished through this there is huge difference in the rate of heat transfer after the modification of the fins.

VI. DESIGNING OF FINS



VII. BS 6 EMISSION NORMS

Engine Type	Mass of exhaust gas	BS4 Limit	BS6 Limit	Percentage Decrease
PETROL	CO (in mg/km)	1000	1000	Nil
	HC (in mg/km)	100	100	Nil
	Nox (in mg/km)	80	60	2.50%
	PM (in mg/km)	.	4.5	
Diesel	CO (in mg/km)	500	500	Nil
	HC+Nox (in mg/km)	300	170	43%
	Nox (in mg/km)	250	80	68%
	PM (in mg/km)	25	4.5	82%

VIII. LITERATURE REVIEW

Rafal Krakowski [1] The original cooling system operating at elevated pressure coolant was developed, built and tested. With an average overpressure 0.3 MPa in the cooling system, due to evaporation of cooling water, the water temperature at the outlet of the cylinder head, was achieved at 120°C. A result of research the cooling system operation, which was increased pressure of the coolant, in terms of the possibility of obtaining an elevated coolant temperature and the effects of the working conditions of the system on this temperature level was verified. It was observed, that it was possible to maintain the pressure in the system and thus temperature of the liquid at the assumed level for a longer period of time. Cooling intensity was changing by adjusting flow water pump, coolant flow switching between small and large cooling system and fan starting mounted on the radiators

John Chastain [2] The introduction of advanced thermal management system concepts in spark ignition engines can improve the cooling system component power consumption. A traditional waxbased thermostat, mechanical water pump, and mechanical/electrical radiator fan were replaced with computer controlled components whose operation is not directly dependent on the crankshaft motion. These servomotor driven cooling components can quickly respond to the vehicle's operating conditions and provide an opportunity for pre-emptive cooling based on anticipated engine load by decoupling the mechanical cooling components. This shaft decoupling dramatically reduced the cooling system power consumption. Finally, future work should address the design of better control strategies to unify the operation and accuracy of the smart cooling system

Nayan Mirgal [3] BS-VI will definitely going to bring drastic change in automotive market in India. We will get more fuel efficient and very low emission producing vehicles in near future. Downsizing and down speeding will

yield smaller and powerful engines. Diesel vehicles will get more expensive as they required more after treatment to stay clean. This will attract OEMs towards alternative fuels and hybrid technologies. Indian driving speeds are less than European driving speeds, hence it is difficult to achieve temperature which is necessary to operate particulate filter. Hence domestic tire-I and tire-II suppliers have great opportunity to innovate new engine technology and emission control technology suitable to Indian driving conditions. To achieve emission limits specified in BS-VI ample amount of engine electronics will required. This will enhance business of domestic and MNC automotive electronic suppliers. Vendors and engineering solution providing companies for Eco testing, fuel system testing and emission testing are also going to benefit a lot. Through all these efforts people can ensure significant reduction in air pollution from automobiles. This will bring remarkable improvement in air quality in highly populated cities as automobiles are main source of air pollution in cities

Marco Antonio Iskandar [4] The results described in the specialized technical literature, as well as experience in the MWM International Motores and tests made in the context of this work, allow us to predict that the use of a cooling system with electronically controlled engine, tends to reduce both energy consumption, the temperature of the cylinder wall and the temperature fluctuations in order to reduce the thermal stresses and stabilizing the temperature of the oil film that reduces friction in the sliding components. The improvement in fuel economy is also obtained by reducing the power supplied to engine accessories. Moreover, experimental results found in literature and observed in tests already conducted, show that NO_x can be reduced by controlling the temperature of engine coolant, and which additionally show a reduction of CO and HC. More investigation about this control system is in course and will be reported later.

Wamei Lin and Bengt Sunden [2] About 70 % fuel energy in vehicles is lost to the cooling systems, which include the engine cooling system, the exhaust gas, other frictional components (i.e., brake rotor), and so on. To find out opportunities to reduce the fuel consumption and carbon dioxide emission in vehicles, a literature survey concerning different cooling systems was carried out. Some important/useful results are shown as follows: Engine cooling system keeps the engine work at an optimized temperature with minimized fuel consumption. A radiator is the most important component in the engine cooling system. Compactness, low pressure drop, low cost and new material should be considered in the radiator design. In 10-20 years, the combustion process still will be the major method for generating power in vehicles. Even though EGR has a little effect on reducing the fuel consumption, it plays an important role in reducing emissions

IX. CONCLUSION

We have design and work on BS6 Engine cooling system and studied the various aspects of cooling system of engine. As far as our work is completed we have come to know that BSVI engine is going to bring drastic change in automobile market in India. We are still working on the various

alteration on the cooling system of BSVI engine for our model Z101.

Thus we have developed “BSVI engine cooling system” which is going to change the automobile sector and it will consider as an innovation which is further going to help in reducing emission and increase performance and efficiency of the engines

REFERENCES

- [1] Rafal Krakowski, INTERNAL COMBUSTION ENGINE COOLING SYSTEM WITH ELEVATED COOLANT TEMPERATURE RESEARCH ON THE MODEL TEST STAND, Journal of KONES Powertrain and Transport, Vol. 20, No. 4 2013
- [2] Lin, Wamei; Sundén, Bengt, Vehicle Cooling Systems for Reducing Fuel Consumption and Carbon Dioxide: Literature Survey, 2010
- [3] Marco Antonio Iskandar, Alberto Adade Filho, Design and analysis of a cooling control system of a diesel engine, to reduce emissions and fuel consumption, ABCM Symposium Series in Mechatronics- Vol. 5, 2012
- [4] Nayan Mirgal, Indian Automotive Industry towards Bharat Stage-VI Emission Norms: A Technical Review, International Journal of Engineering Research And Advanced Technology (IJERAT), Vol.3 (11) Nov -2017