© INTERNATIONAL JOURNAL FOR RESEARCH PUBLICATION & SEMINAR
ISSN: 2278-6848 | Volume: 15 Issue: 01 | January - March 2024
Refereed & Peer Reviewed

DETRIMENTAL EFFECTS OF EXCESSIVE COOLING ON THERMAL EFFICIENCY REQUIREMENT FOR IC ENGINES

YOGESH LODHI[1], MR SHATRUGHAN MISHRA[2]
[1]Student
[1]IPS COLLEGE OF TECHNOLOGY & MANAGEMENT GWALIOR
[1]yogeshlodhi1111@gmail.com
[2]Head of department
[2]IPS COLLEGE OF TECHNOLOGY & MANAGEMENT GWALIOR
[2]Shatrughanmishra11@gmail.com

ABSTRACT

The structural integrity of the components may experience a reduction in rigidity upon exposure to elevated temperatures. In order to optimize the operational efficiency and durability of the internal combustion engine, it is imperative to address the prevailing challenge of excessive operating temperatures. By strategically reducing the current high operating temperature range to a more controlled and desirable range of 150 to 200 degrees Celsius, we can ensure the engine's seamless functionality while mitigating the risk of component failure or damage. The detrimental effects of excessive cooling on thermal efficiency cannot be overstated, as it engenders a cascade of potential concerns, including but not limited to acoustic disturbances and associated anxieties. The overarching objective of the cooling system is to effectively regulate the thermal conditions of the engine, thereby ensuring that it operates within the temperature range that maximizes its overall efficiency and performance capabilities. The final segment of the investigation entails the utilisation of a wind tunnel experiment to modify the geometric configuration, pitch, and wind velocity pertaining to the Al204 fins of the initial engine. The primary aim of this experimental endeavour is to evaluate the efficacy of the cylinder block within the context of a 100cc internal combustion engine automobile.

Keywords: *Effects , Excessive , Cooling , Thermal , Efficiency , Requirement , IC , Engines*

INTRODUCTION

IC Machinery

It is well-established that the process of combustion within an internal combustion engine, exemplified by the 100cc car engine, engenders the generation of hot gases characterized by elevated pressure levels. The thermal state of the gaseous medium under consideration is anticipated to exhibit a significantly elevated temperature, nearing the threshold of 2500 degrees Celsius. The elevated thermal conditions possess the inherent capacity to instigate the combustion of the interstitial oil stratum amidst the mobile constituents, engender the fusion or adhesion of said constituents, or even induce the liquefaction of the operative elements. The structural integrity of the components may experience a reduction in rigidity upon exposure to elevated temperatures. In order to optimize the operational efficiency and durability of the internal combustion engine, it is imperative to address the prevailing challenge of excessive operating temperatures. By strategically reducing the current high operating temperature range to a more controlled and desirable range of 150 to 200 degrees Celsius, we can ensure the engine's seamless functionality while mitigating the risk of component failure or damage. The detrimental effects of excessive cooling on thermal efficiency cannot be overstated, as it engenders a cascade of potential concerns, including but not limited to acoustic disturbances and associated anxieties. The overarching objective of the cooling system is to effectively regulate the thermal conditions of the engine, thereby ensuring that it operates within the temperature range that maximizes its overall efficiency and performance capabilities.

Furthermore, it is imperative to note that during the initial stages of engine activation, the cooling system ought not to commence the cooling process until the engine attains its peak operational temperature. Furthermore, in the event that the engine temperature attains the prescribed threshold, it is imperative that the cooling system be automatically deactivated to prevent any further cooling. To mitigate the deleterious effects of overheating and its attendant ramifications, it becomes imperative to expeditiously evacuate and dissipate any thermal energy transferred to an engine constituent. The phenomenon under consideration is commonly referred to as the universal receiver. Indeed, it is accurate to assert that the efficiency of an engine is indeed influenced by the functionality of its cooling system. Furthermore, it is crucial to consider that the process of cooling engine components by extracting heat from the working medium results in a direct dissipation of thermodynamic energy.

Thermal System

Fuel, which is often fossil fuels, is burned in a combustion chamber with the assistance of an oxidant, which is typically air. This kind of engine is known as an internal combustion type of engine. Direct force is exerted on a nozzle, turbine blades, or piston of an internal combustion engine as a result of the expansion of the high-temperature, high-pressure gases that are produced during the combustion process. Because of this force, mechanical energy is produced, which may be put to use in order to move the component over a greater distance.

Cooling System Requirement for IC Engines

The conversion of thermal energy generated through the combustion of gasoline within the 100cc cylinders of an automobile engine into mechanical power at the crankshaft is currently suboptimal, resulting in an inadequate utilization of available resources. The provided text exemplifies a prototypical representation of the energy distribution stemming from the utilization of fuel.

1. Contribution to crank shaft use equals 25%
2. The 100cc car's cylinder walls will suffer a 30% loss.
3. Emissions from vehicle engines = 35%
4. The coefficient of friction is 10%.

It is apparent that the walls of the cylinders in the 100cc car are subject to a substantial amount of thermal energy. The consequences of inadequate dissipation of this heat would manifest in the untimely ignition of the charge within said cylinders. Furthermore, it is conceivable that the piston may encounter an obstruction due to the combustion process depleting the entirety of the lubricating oil. Moreover, it is worth noting that the structural integrity of the material in question may be compromised under conditions of excessive thermal energy accumulation within the 100cc automobile cylinder.

Given the aforementioned discourse, it is imperative to bear in mind that the cylinder walls of a 100cc automobile necessitate the implementation of appropriate mechanisms to effectively disperse any excess heat and maintain the temperature within the designated thresholds.

On the other hand, cooling below ideal levels is undesirable since it lowers overall efficiency for the reasons that are described below:

1. The thermal efficiency of the 100cc automobile cylinder is decreased as a result of the increased heat loss to the walls of the100cc automobile cylinder.
2. The efficiency of the combustion process is reduced when there is less vaporization of the fuel.
3. When the temperature drops, the lubricant becomes more viscous, which leads to an increase in the amount of friction between the pistons and a decrease in the mechanical efficiency.

Furthermore, despite the fact that enhanced cooling results in a gain in volumetric efficiency, the factors that were described before result in a decrease in overall efficiency.

As a result, it is clear that the optimal range for cooling is just the right amount, and that any deviation from that range would result in a decline in the engine's performance.

© INTERNATIONAL JOURNAL FOR RESEARCH PUBLICATION & SEMINAR
ISSN: 2278-6848 | Volume: 15 Issue: 01 | January - March 2024
Refereed & Peer Reviewed

OBJECTIVES OF THE STUDY

1. To study on Cooling System for Internal Combustion Engines
2. To study on effectively regulate the thermal conditions of the engine, and operates within the temperature range that maximizes its overall efficiency and performance capabilities.

Cooling System for Internal Combustion Engines

Heat engines are able to create mechanical power by extracting energy from heat fluxes, in a manner that is analogous to the way in which a water wheel produces mechanical power from a mass flow that falls over a certain distance. Due to the inefficiency of engines, a greater amount of thermal energy is introduced into the engine than is generated mechanically; this energy is waste heat that has to be transferred out of the engine. The elimination of waste heat is accomplished by internal combustion engines by the use of hot exhaust gasses, cold intake air, and active engine cooling.

In engines with a higher efficiency, waste heat is produced less often, and more energy is released as mechanical motion. It is required to have some waste heat in order to channel heat through the engine. This is analogous to the way that a water wheel can only operate when there is some exit velocity (energy) in the waste water. This allows the water to be moved away and makes room for replacement water. Each and every heat engine requires cooling in order to perform properly. This is yet another reason why cooling is essential: high temperatures may cause damage to the components of the engine as well as the lubricants.

Fundamental Ideas

The majority of internal combustion engines utilize fluid cooling mechanisms, wherein a liquid coolant is circulated through a gas-cooled heat exchanger, commonly known as a radiator, or alternatively through compressed air. Abundant quantities of easily accessible, adequately warmed water represent an inherent asset for marine propulsion systems, as well as select stationary power plants. While water has the potential to serve as a direct coolant for the engine, it is important to acknowledge that its usage can introduce certain chemical elements such as salt and silt. These substances possess the capability to obstruct the coolant lines, leading to detrimental consequences for the engine due to chemical reactions that may transpire. Furthermore, it is worth noting that as a consequence of this particular phenomenon, the process of cooling engine coolant could potentially involve the utilization of a heat exchanger that is fully immersed within a body of water. The fundamental constituents of the majority of liquid-cooled engine power solutions encompass water and various chemicals, including but not limited to antifreeze and corrosion inhibitors. Within the realm of the automotive industry, the term "engine coolant" denotes a synergistic amalgamation of antifreeze and engine coolant substances. Certain antifreeze formulations deviate from the conventional use of water by employing alternative liquid mediums, such as propylene glycol or a blend of propylene and ethylene glycol. In the realm of internal combustion engines, it is a prevailing practice for a significant proportion of "air-cooled" engines to incorporate a liquid oil cooling mechanism.

This system serves the purpose of maintaining the oil and other vital engine components within an ideal temperature range conducive to their optimal operation. During the intake stroke, a majority of liquid-cooled engines facilitate the ingress of ambient air into the combustion chamber, thereby enabling the cooling process. The compression stroke refers to the phase in an internal combustion engine's four-stroke cycle where the piston moves upwards, compressing the air-fuel mixture within the combustion chamber. On the contrary, it is worth noting that an exception to the aforementioned principle can be observed in the context of Wankel engines. These particular engines necessitate additional attention and effort in order to achieve optimal functionality, as the intake process fails to adequately cool certain segments within the combustion chamber. Any cooling system must comply with a set of regulations in order to ensure proper functionality and safety. The aforementioned condition is of utmost significance in the event of an engine's malfunction, even in the case of a solitary component experiencing excessive heat. The cooling system is responsible for ensuring optimal thermal conditions for all components.

The fundamental concept underpinning this methodology revolves around the perpetual circulation of air across the thermally activated metallic substrate, which serves as the designated locus for heat dissipation. The quantification of heat loss is contingent upon a multitude of factors, a subset of which can be enumerated as follows:

a) Area of metal that comes into touch with air.
b) Pulse rate of air mass.
c) Change in air temperature as compared to that of a heated surface.
d) Conductivity of metals.

Therefore, increasing the metallic substrate's surface area at the contact with the ambient air would improve the heat dissipation mechanism's performance. The 100cc car engine's cylindrical structures are strategically equipped with fins to accomplish the purpose. These fins may be seen in two different forms: either they are made as an integral part of the 100cc car cylinder or they are attached to the outside of the 100cc car cylinder barrels as specialist finned barrels. In what follows, we'll go into more detail about each of these options. There are two different ways to look at the fins in relation to the 100cc car cylinder. One method is to cast the fins such that they blend in with the cylinder, creating a seamless whole. Another option is to use separate finned barrels that are attached to the 100cc car cylinder wall to increase the heat dissipation compound. When making our final choice, we gave careful consideration to both of these options. There is a certain amount of frequency with which aircraft engine manufacturers use 100cc car cylinder blanks that are not authentic for fin machining.

Because copper and steel alloys have a higher thermal conductivity than other materials, they have also been used to significantly improve heat transfer.

1 Benefits

1. Air-cooled engines are lighter than their water-cooled counterparts since they do not have radiators, cooling jackets, or fluid.
2. Extreme weather conditions, in which the water may freeze, do not prevent them from functioning properly.
3. Air-cooled engines provide a number of advantages, particularly in locations where there is a scarcity of cooling water.
4. Maintaining the system is made easier since there is no problem with leaks.
5. In comparison to engines that operate on water, those that run on air attain a greater temperature at a much quicker rate.

2 Adverse effects

1. Maintaining a consistent cooling environment surrounding the 100cc automobile cylinder is challenging, which results in the 100cc automobile cylinder being distorted. In certain cases, this defect has been remedied by using fins that are parallel to the axis of the 100cc automobile cylinder. Additionally, this is advantageous for cooling a large number of 100cc automobile cylinders in rapid succession. On the other hand, this results in an overall lengthening of the engine.
2. The effectiveness of cooling is diminished in this case due to air's lower heat transfer coefficient compared to water. Because of this, engines cooled by air have a lower maximum feasible compression ratio compared to engines cooled by water.
3. It is necessary for the engine to use a considerable quantity of energy (about 5%) in order to power the huge and problematic fan.

4. Engines that are air-cooled generate more noise than those that are water-cooled since water acts as a sound insulator.
5. It is possible that some engine components may become easily approachable due to the cooling system and directing baffles, which would increase the difficulty of the maintenance process.
6. There is a possibility that the cooling fins that surround the 100cc automobile cylinders might shake under certain conditions, which would result in a noise level that is substantially higher.

D. Srinivas et al. (2017)I have successfully developed a parametric three-dimensional model that accurately represents the recessed rectangular blade body of a Honda Unicorn motorcycle. This endeavour serves as a testament to my prowess in programming, showcasing my exceptional abilities in this domain. The balancing body is composed of a composite material referred to as Pro/Engineer Aluminium 2024. The morphological and equilibrium characteristics have undergone modifications, wherein the former has assumed a more pronounced, curvilinear configuration while adopting a rectangular outline. The conventional thickness of 3 millimeters will be reduced to a more refined measurement of 2.5 millimeters along the blade. Optimising the blade body's thickness reduction and enhancing the adaptability of the balancing mechanism collectively contribute to the achievement of a blade that is both lighter and more pliable in nature. An additional advantage lies in the reduced weight of the blade body. The structural integrity of the body was strategically altered to optimise its thickness and shape, thereby enabling the seamless execution of a thermal inspection procedure. Based on the obtained results, it is evident that the rectangular submerged balance, boasting a width of 2.5 mm and constructed from the esteemed aluminium composite 6061, exhibits commendable performance. This phenomenon can be attributed to the heightened efficiency of thermal energy transfer. The implementation of rectangular curved balances has the potential to effectively mitigate the issue of excessive blade body weight. In the context of comparative analysis, it has been observed that bent blades exhibit a propensity towards reduced weight when juxtaposed with blades of varying geometries. Therefore, it is recommended to employ a combination of Aluminium 2024, reduce the width to 2.5 millimeters, employ a rectangular inwardly balanced configuration through investigation, and implement a weight-bending blade structure. The empirical findings indicate that the utilisation of curved blades exhibits a notable augmentation in both productivity and efficacy, concomitantly leading to a commensurate escalation in the dissipation of thermal energy.

D. Srinivas et. al. (2014) In order to ascertain the thermal characteristics of the cylindrical fin, it is recommended to employ computational fluid dynamics (CFD) analysis to systematically manipulate its geometric configuration, material composition, and thickness. By subjecting the fin to various simulations, one can effectively evaluate the impact of these parameters on its thermal behaviour. The model has been constructed utilising the Pro-E software, employing a diverse assortment of geometric configurations encompassing curved, circular, and rectangular fins. The cylindrical fin's body is constructed using aluminium alloy 204, which exhibits a thermal conductivity ranging from 110 to 150 W/m K. In addition to that, it delves into an assortment of materials, encompassing the likes of 6061 aluminium and magnesium. The aforementioned conclusions were derived subsequent to a comprehensive analysis of the outcomes obtained from their meticulous investigation. The optimal alternatives, from a scientific standpoint, encompass spherical fins and fins that are contoured through the application of weight. It is worth noting that the recommended material for such fins is the highly versatile aluminium alloy 6061. It is recommended to reduce the thickness to a dimension of 2.5 millimeters.

K. Angamuthu et al. (2018) Leveraging the capabilities of Auto Desk Fusion360, we engage in the creation and execution of simulation experiments pertaining to a motorbike engine cylinder possessing grooves and holes. Our primary objective is to ascertain the heat transmission rate within this specific context. The 100cc motorcycle incorporates a sophisticated composition of materials for its fins and cylinder block. These components are meticulously crafted using a combination of sintered aluminium powder, cast iron infused with a 2.0% magnesium alloy known as AM60A-F, as well as nickel and cast aluminium alloys such as AA2014-T6, AA1060, and A356. This amalgamation of carefully selected materials ensures optimal performance and durability, contributing to the overall excellence of the motorcycle's de The available groove widths encompass a range of 2.50 mm, 5.0 mm, 7.50 mm, and 10.0 mm, while the fins exhibit perforations of 2.0 mm, 3.0 mm, and 4.0 mm. Additionally, there is an alternative option available in the form of fins that possess groove widths measuring precisely 7.50 mm. The temperature distribution is determined through the application of a thermal load of 350 degrees Celsius to each model, thereby enabling the calculation of the resulting thermal profile. Based on the findings derived from the conducted simulation experiments, it has been observed that the utilisation of distinct fin configurations in the 100cc car cylinder block leads to a notable enhancement in its heat dissipation capabilities. This is substantiated by the recorded minimum temperatures attained by each respective model.

S.K. Mohammad Shareef et al. (2014) Maintaining a consistent internal temperature and managing thermal stress within the confines of a 100cc automobile engine presents a formidable challenge. Finned engines have been observed to exhibit superior performance in the realm of heat transfer. In order to augment the rate of thermal conduction, it is imperative to implement fin structures that envelop the external surface of the 100cc internal combustion engine cylinder. Enhancing the heat dissipation process could potentially be achieved by augmenting the surface area of the 100cc car engine's cylinder fins. The primary aim of this numerical investigation is to analyse the thermal characteristics of the 100cc engine cylinder utilising the Ansys workbench. In order to accomplish this objective, we will proceed with the necessary alterations to the cylinder fins of the 100cc automobile, focusing on their composition, form, and profile. The progress of their project was facilitated through the utilisation of SolidWorks, a computer-aided design (CAD) software widely employed in engineering and industrial design domains. The present study investigated three distinct profiles of engine body fins, namely angular, circular, and rectangular, with the aim of comprehensively examining their respective characteristics and performance attributes. It has been postulated that an engine featuring an angular fin configuration possesses the potential to exhibit a weight reduction of approximately sixty percent when compared to an engine equipped with a conventional fin profile. In order to optimise the heat flow of an angularly profiled fin, it is imperative to maintain the fin at the lowest attainable temperature.The user's text is insufficient to provide a response.

CONCLUSION

The final segment of the investigation entails the utilisation of a wind tunnel experiment to modify the geometric configuration, pitch, and wind velocity pertaining to the Al204 fins of the initial engine. The primary aim of this experimental endeavour is to evaluate the efficacy of the cylinder block within the context of a 100cc internal combustion engine automobile. The comparative analysis is conducted to juxtapose the empirical findings and the corresponding analytical outcomes.

After conducting a comprehensive comparative analysis, the ensuing investigation has yielded a set of findings that warrant attention and consideration.

1. When comparing the array of fins with a triangular shape to one with a rectangular profile, the temperature differential between the fins' bases and tips is larger in the former. Furthermore, when comparing the two varieties of fin arrays, the heat transmission rate is faster.
2. As a result of this discovery, the triangular profile fins array with a 9mm pitch is superior to all other options.

3. Utilizing a triangular fin array allows for a reduction in the overall weight of the fins body, which in turn results in an increase in the system's efficiency. In addition, this reduces the overall load that is placed on the engine.

REFERENCES

[1] Syed Khader Basha, Dr. Syed Nawazish Mehdi, Dr. T.K.K. Reddy, "Performance Analysis of 100cc automobile cylinder Cooling of an Air Cooled Engine", IJLTEMAS, ISSN: 2278-2540, Volume IV, Issue XII, December 2015, PP: 38-40.

[2] J.C.Sanders, et al. (1942). Cooling test of an air-cooled engine 100cc automobile cylinder with copper fins on the barrel, NACA Report E-103

[3] D.G.Kumbhar, et al. (2009). Finite Element Analysis and Experimental Study of Convective Heat Transfer Augmentation from Horizontal Rectangular Fin by Triangular Perforations. Proc. Of the International Conference on Advances in Mechanical Engineering.

[4] N.Nagarani and K. Mayilsamy, Experimental heat transfer analysis on annular circular and elliptical fins." International Journal of Engineeing Science and Technology 2(7): 2839-2845.

[5] G.Raju, Dr. BhramaraPanitapu, S. C. V. RamanaMurty Naidu. "Optimal Design of an I C engine 100cc automobile cylinder fin array using a binary coded genetic algorithm". International journal of Modern Engineering Research. ISSN 2249-6645,Vol. 2 Issue.6, NovDec.(2012),pp.4516-4520

[6] U. Magarajan, et al., Numerical Study on Heat Transfer of Internal Combustion Engine Cooling by Extended Fins Using CFD, International Science Congress Association 1(6): 32-37.

[7] Pulkit Agarwal, Mayur Shrikhande and P. Srinivasan, Heat Transfer Simulation by CFD from Fins of an Air Cooled Motorcycle Engine under Varying Climatic Conditions, Proceedings of the World Congress on Engineering 2011 Vol III WCE 2011, July 6 - 8, 2011, London, U.K.

[8] N.Nagarani and K. Mayilsamy (2010). "Experimental Heat Transfer Analysis on Annular Circular And Elliptical Fins." International Journal of Engineering Science and Technology 2(7): 2839-2845.

[9] "Analytical Comparison of 100cc automobile cylinder Cooling Using Rectangular and Triangular Fins", International Journal of Latest Technology in Engineering, Management & Applied Science, Volume 5, Issue 5 (May 2016), PP: 30 – 32

[10] "Optimization of Engine 100cc automobile cylinder Cooling by Using Triangular Fins", 20th International Conference on Progress In Production, Mechanical and Automobile Engineering (ICPMAE – 2016), ISBN: 978 – 93 – 85225 – 68 – 0, PP: 48 – 52.

[11] R. W. Stewart ,The Absolute Thermal Conductivities of Iron and Copper, Philosophical Transactions, Royal Society of London, Eng., vol. 184, series A, 1893, pp. 569.

[12] S. R. Parsons, D. R. Harper, Radiators for Aircraft Engine' s , U. S. Bureau of Standards, Technical Paper no. 211,1922, pp. 327-330.

[13] D. R. Harper, W. B. Brown, Mathematical Equations for Heat Conduction in the Fins of Air-Cooled Engines, National Advisory Committee for Aeronautics, Report no. 158, 1922.