Analysis of Air Compressor Cylinder by varying different Configuration of Fins

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Abstract

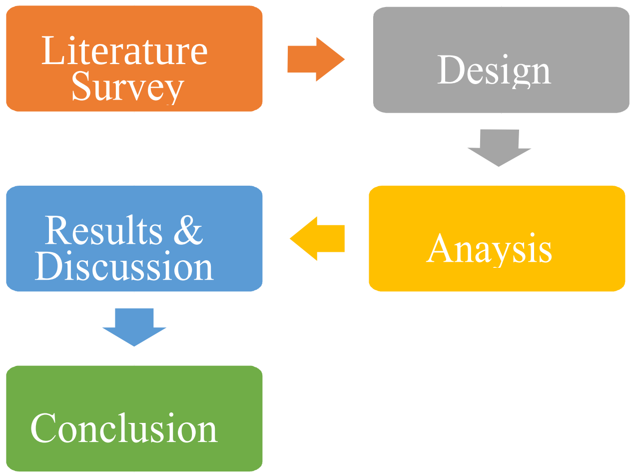
The vast majority of air compressors are either of the kind that use reciprocating pistons or rotary vane screws. Centrifugal compressors are often used for extremely large applications, such as the provision of high-pressure clean air to fill gas cylinders and the production of a significant quantity of moderate pressure air to operate pneumatic tools. Heat may be created in an air compressor in two different ways: first, heat can be produced when friction occurs, and second, heat can be produced when air is compressed under high pressure. Hence, the heat will be released into the atmosphere through the fins. As engineers, the primary question that piques our attention is determining the degree to which certain extended surfaces or fin configurations have the potential to increase the rate at which heat is transferred from a surface to the fluid that is around it.

Before we can calculate the rate of heat transfer that is associated with a fin, we need to first know how the temperature varies throughout the length of the fin. Within the scope of this project, we manipulated the geometrical forms of the fins in order to do an analysis and pick the most efficient cooling fin. The finite element method, sometimes known as FEM, is a significant numerical tool that is frequently used in engineering assessments. In this study, it was determined that analysis was best performed on specimens with rectangular, triangular, or no fins at all. Analyze the many factors, such as the heat transfer rate via the fin, the efficiency and efficacy of the fins, and the heat transfer modes of free and forced convection.

Introduction

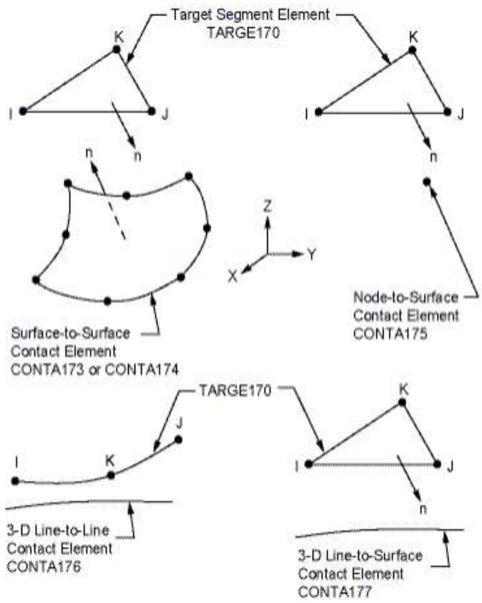
The majority of today's internal combustion engines are cooled by a closed circuit that circulates a liquid coolant through channels in the engine block and cylinder head, where the coolant is responsible for absorbing heat, and then to a heat exchanger or radiator, where the coolant is responsible for releasing heat into the air. This type of cooling system is considered to be the most efficient method of cooling an internal combustion engine. This sort of cooling system is the one that is utilized in internal combustion engines more often than any other type (or raw water, in the case of marine engines). In spite of the fact that the liquid itself is not involved in the process of cooling the device, we nevertheless refer to it as being water-cooled even if it does not engage in the process. This is a result of the use of the liquid-coolant circuit. On the other hand, an air-cooled engine will dissipate all of the heat that it creates by exchanging it with the air that is immediately around it. (Direct Cooled Engine) This is often made possible by the use of metal fins that cover the outside of the cylinder head as well as the cylinders themselves. These fins increase the surface area of the engine that the air can make contact with, which is an essential component for the engine to have so that it can function well. Efficient cooling that makes use of a significant quantity of air can be accomplished in one of two ways: either by forcibly feeding air with the assistance of a fan and shroud, or by simply letting natural air flow with fins that are well-designed and angled in the appropriate directions. Both of these methods are described in more detail below. Each of these approaches are broken out in further depth down below. Both of these ways of approaching the problem are valid alternatives. A significant portion of the heat that is produced by combustion engines—approximately 44 percent—is expelled through the exhaust rather than being absorbed by either a liquid cooling system or the metal fins of an air-cooled engine.

Methodology

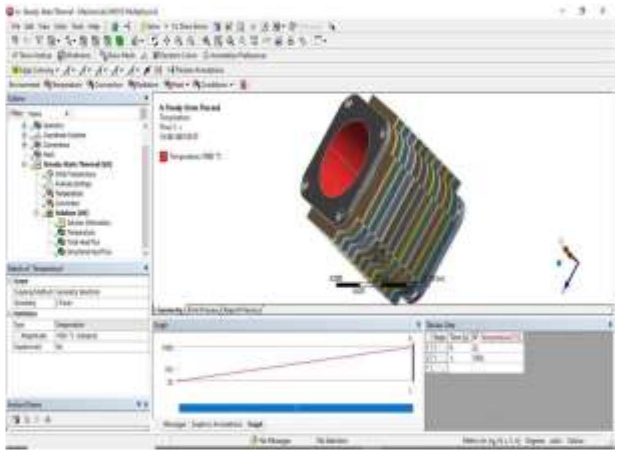


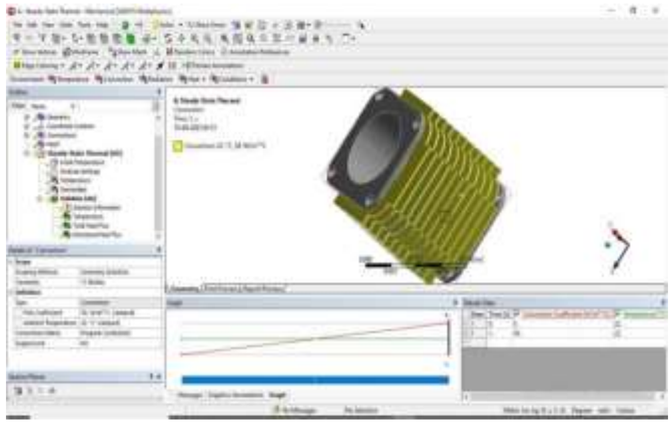
This is the case even though liquid cooling systems are more efficient than aircooled engines at removing heat. Despite the fact that both of these kinds of cooling systems are put to use, this remains the situation (the latter of which only absorbs 12 percent). About eight percent of the total heat energy is transferred into the oil, which, despite its primary purpose of lubrication, also plays a part in the process of heat dissipation by acting as a cooler. This transfer of heat occurs when the oil is heated to a temperature that is higher than its normal operating temperature. When the oil is brought to a temperature that is greater than its typical working temperature, a process known as heat transfer will take place. The movement of thermal energy from one location to another as a direct result of a temperature gradient is an example of the phenomenon known as heat transfer. Heat may be transmitted from one site to another by radiation, convection, and conduction. These are the three methods by that heat can be transferred. A fin is a little appendage or component that is linked to a body or structure that is considerably bigger in size. Fins are often seen on fish and other marine organisms. The kind of cross-sectional area will determine the specific form that may be given to straight fins, however, there is a large variety of possible forms that can be given to these types of fins. The cylindrical fin, the trapezoidal fin, the parabolic fin, the rectangular fin, and the triangular fin are only a few examples of the many shapes that come under this category. Quantifying the effectiveness of the fin may be done using a variety of various metrics, all of which are available. Its efficacy, its heat resistance, and its efficiency are only few of the measures that make up these qualities. There are a few areas where you could discover uses for triangle-shaped fins, including radiators in space, air cooling systems in spacecraft, and cylinders of air-cooled compressors and cylinders. In their evaluations, a large number of writers placed a substantial amount of stress on the usefulness of fins. In his research, Thirumaleshwar provides an outline of the several possible routes that heat might go. He provided in-depth information on extended surfaces, which included boundary conditions and analysis, among other things, among his contributions. The book that Arora and his co-authors wrote explains the triangular fins that are seen on some fish. In addition to this, they performed data analysis and provided extensive information on the boundary conditions of the triangular fins. The author of Incropera's book provided a link for triangular fins, which may be found in the book. He spoke about the two-dimensional study of the fins that was a component of the process of heat transmission. In their study, Mahesh and his colleagues discussed the various diverse applications that may be built using either triangular or rectangular fins. They noted that both shapes have their advantages and disadvantages. Kumar et al.

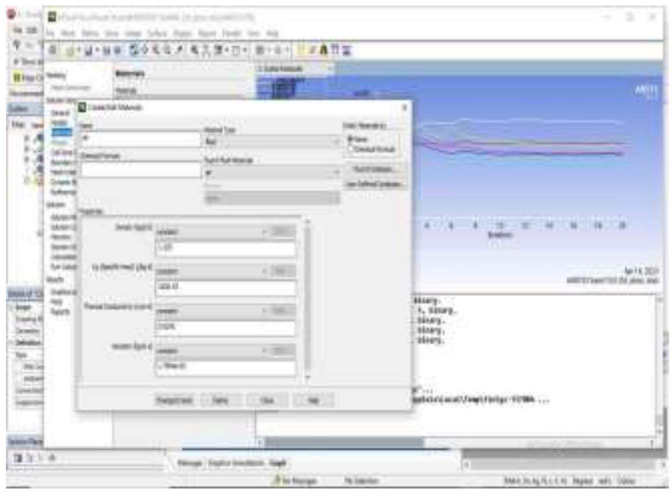
The findings of an experimental study that projected the performance of a heated triangular fin array housed within a vertically oriented and air-filled rectangular enclosure were reported by the authors in their paper. They examined the impacts of a variety of influencing characteristics for their broad ranges and analyzed the results.



Under constant heat flux boundary conditions at the heated and cooled sides of the enclosure, these parameters included the Rayleigh number 295214 Ra 773410, fin spacing, 25 mm S 100 mm, and fin height 12.5 mm L 37.5 mm. Also, they investigated the impacts of the Rayleigh number 295214 Ra 773410, which was used. They made the discovery that the Nusselt number is correlated, on the basis of real data, with a range of other elements that have an effect on the outcome. The provided information in his work on the use of modified Bessel functions in the study of extended surface heat transfer. Moreover, differential equations were derived from the foundations of conduction and convection heat transfer in order to construct them. In the course of their research, Rahim and his coworkers explored the mechanism by which heat is conducted through a wall that has triangular fins that are at least partly submerged inside its volume. We solved each component's linked heat diffusion equations numerically by using an iterative finite volume approach. This method is responsible for the component's overall control. They present the findings of their inquiry, which contain both quantitative and qualitative data, in the essay that they have written for the assignment. It has been discovered that the fin-root may serve the wall in the capacity of both a heat washbasin and a heat source at the same time. This is something that can be accomplished by serving both functions simultaneously. The finding that the fin-root may fulfil both functions simultaneously opened the door for the investigation that led to this discovery.







Literature Survey

"Experimental and Numerical Investigation of Heat Transfer Enhancement in Wavy Fin Heat Exchangers Used in Air Compressors" by P. Kantharaj et al. (2018) - This article discusses the use of wavy fin heat exchangers for air compressors and presents both experimental and numerical results on their performance.

"Thermal Analysis of Air Compressor Fins with Different Geometries" by H. T. Uysal and E. Yılmaz (2016) - This article investigates the effect of different fin geometries on the thermal performance of air compressor fins using numerical simulations.

"Performance Analysis of a Finned Tube Heat Exchanger for Air Compressor Applications" by M. A. Alhazmy et al. (2015) - This article presents an experimental study on the performance of a finned tube heat exchanger used in air compressors.

"Experimental Investigation of Heat Transfer and Pressure Drop in Wavy Fin and Flat Tube Heat Exchangers for Air Compressors" by S. A. Khan et al. (2014) - This article presents experimental results on the performance of wavy fin and flat tube heat exchangers for air compressors.

"Heat Transfer and Flow Characteristics of an Air-Cooled Heat Exchanger with Louvered Fins" by S. S. Yi et al. (2013) - This article investigates the thermal performance of an air-cooled heat exchanger with louvered fins using numerical simulations and experimental measurements.

"A Review on Heat Transfer Enhancement Using Dimpled Fins" by S. V. S. S. S. Prasad et al. (2020) - This article provides an overview of heat transfer enhancement techniques using dimpled fins, which could be applied to air compressor fins as well.

"Numerical Investigation of Heat Transfer Enhancement in Plate Fin Heat Exchanger with Perforated Rectangular Fins" by R. D. Bhangale et al. (2019) - This article presents numerical results on the performance of plate fin heat exchangers with perforated rectangular fins, which could be used in air compressors.

"An Experimental Study of Heat Transfer and Pressure Drop Characteristics of Wavy Fin-and-Tube Heat Exchangers for Air-Conditioning Applications" by S. Y. Lee et al. (2018) - This article presents experimental results on the thermal performance of wavy fin-andtube heat exchangers, which could be adapted for use in air compressors.

"Experimental Investigation of Heat Transfer and Pressure Drop Characteristics of Plate-Fin Heat Exchanger with Inverted Triangle Fins for Automotive Intercooler Applications" by S. S. Kim et al. (2017) - This article reports on an experimental study of the thermal performance of plate-fin heat exchangers with inverted triangle fins, which could be useful for air compressors in automotive applications.

"Heat Transfer and Pressure Drop in Lanced and Wavy Fin Compact Heat Exchangers" by D. Li et al. (2015) - This article investigates the thermal performance of lanced and wavy fin compact heat exchangers, which could be applied to air compressors.

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