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"THERMAL ANALYSIS OF A DIESEL ENGINE PISTON WITH AND WITHOUT COATING MATERIAL BY USING FEM"

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ABSTRACT

Typical, most frequently found failures of pistons used in 06 cylinder internal combustion engines. Typical piston failures caused by the poor quality of fuel, the maladjustment of the engine feed system or wrong engine operation have been discussed. The most common cause of piston failures is an incorrectly performed repair of the engine or its improper operation. Here take two material like that AL 6061 without coating and another material is Al 6061 with coating 1 mm layer of beryllium aluminium material. Here take thermal boundary condition is 40 °C and piston crown temperature put-up 450 °C and film coefficient 5eѧ-006 w/m² °C Then here find out temperature results for exiting material AL6061 is 404.44°C and when take another coated material used then find out less temperature results like 402.44 °C Then here find out heat flux results for exiting material AL6061 is 9.942 w/mm² and when take another coated material used then find out less heat flux results like 15.08 w/mm²

Key Words: *Piston Alloys, beryllium aluminium material, AL6061 , 6 cylinder , heat flux , coating, piston failures*

I. INTRODUCTION

The current design of the internal piston fire engines has contributed to improved performance and reliability of the piston-cylinder assembly components. Many research and development centers and sciences at home and abroad conduct studies aimed at increasing net energy and torque and reducing fuel consumption, while meeting EU standards for effective emissions of fire hazards [1, 2]. One of the main objectives of car manufacturers is to ensure the highest durability and reliability of the engine [7, 9]. The piston is a feature of the crankshaft assembly, which participates in the conversion of heat energy into a working machine [6, 10]. The piston head forms the moving part of the fire chamber. Piston grooves hold piston rings that enclose the cylinder working space, while individual piston pin holders have a piston pin bear-mounted on them, which transmits electrical energy to the crankshaft. The main function of the piston is to absorb the piston head-space pressure by the piston head. This force, increased by the inertia force, is transmitted to the piston, the piston pin and, through the connecting rod, to the crankshaft. The design of the piston must withstand high thermal and mechanical loads [8]. It is necessary to: - take heat from the head of the hot piston, heated by high temperature gas, to the walls of the cool cylinders, - lead the piston to the cylinder sleeve and take the pressure of the lateral piston on the cylinder bearing above, - cause very low friction loss, and - confirm the use of engine oil lubricant. The materials used for pistons in internal combustion engines include: - aluminum alloys, - alloy steels, and cast iron. The most commonly used materials for making pistons include: stainless steel, alloy steel and aluminum alloys, aluminum-silicon alloys (Al-Si) and aluminum-copper alloys (Al-Cu) These alloys are characterized by low density, being useful due to the small weight of the piston, and the large coefficient of thermal conductivity [5]. Aluminum alloys are distinguished by good posture during dispersion and mechanical efficiency (machine cutting).

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The main disadvantages of these alloys include: large coefficient of thermal elasticity, low hardness and low power indicators at high temperatures. Cast-iron pistons are rarely used. They are available in low-speed exercise engines. They are characterized by good slide structures, which maintain good mechanical properties at high temperatures, and a small coefficient of thermal expansion. The main disadvantages of using cast-iron pistons in modern high-speed engines are: the coefficient of low thermal conductivity and high magnitude leading to a large number of pistons and high inertia potential.

II. PROBLEM FORMULATION

Typical, most frequently found failures of pistons used in four-stroke internal combustion engines. Typical piston failures caused by the poor quality of fuel, the adjustment of the engine feed system or wrong engine operation have been discussed. The most common cause of piston failures is an incorrectly performed repair of the engine or its improper operation.

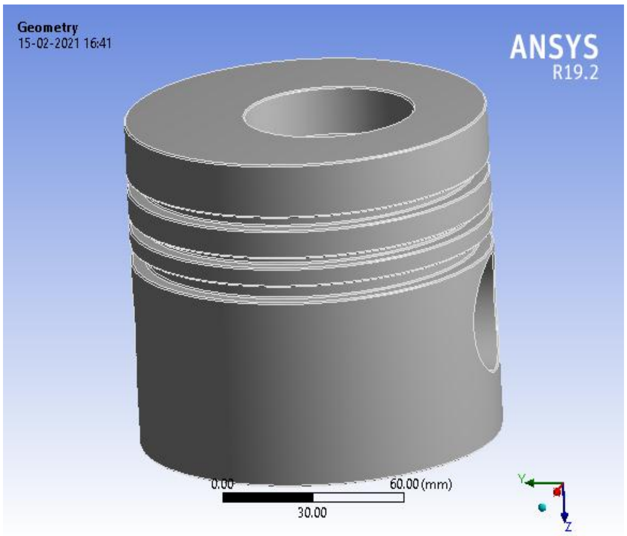
III. METHODOLOGY

FINITE ELEMENT MODEL

Establish a balanced and accurate element model that is the most important part of piston finite element analysis, thus marking the grid elements to get accurate results in the end. According to the piston structure symmetry, to facilitate calculation and reduce the workload, cut the established piston model to save 1/4 and import the model into the limited element analysis software to the piston according to good interface between modeling software and limited analytics software. During the import process, some details are left out, such as the chamfer and the snap ring of the piston pin etc. The geometric model of the piston is shown in Figure 1. The Body Structures of the Piston are shown in table1. During the production of piston model space, based on experience.

IV. MODELING & SIMULATION

4.1 ALUMINUM 6061 ALLOY MATERIALS



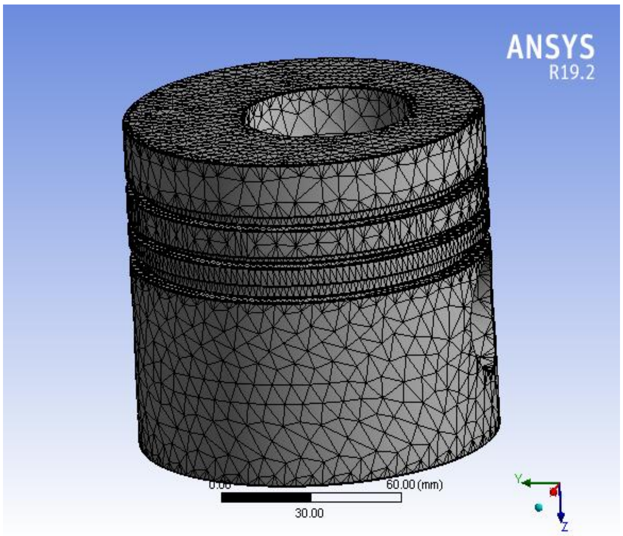


Fig.4.1 Diesel engine Al 6061 piston model import into Fig.4.2 Diesel engine Al 6061 piston meshing model

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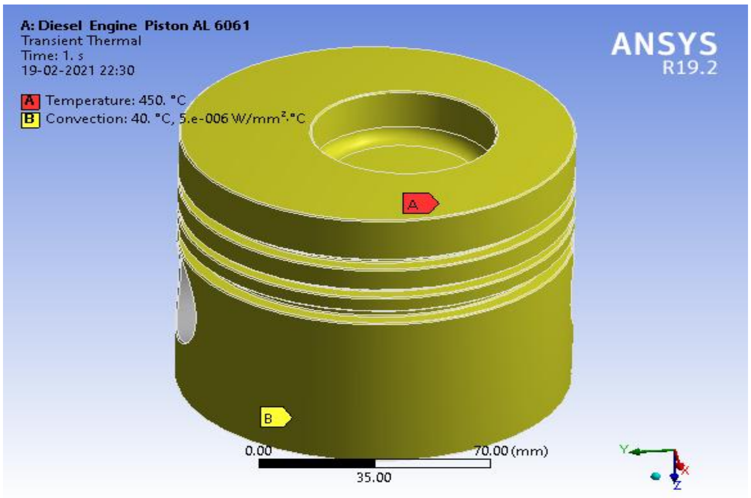

Fig.4.3 Diesel engine Al 6061 piston thermal convection boundary condition

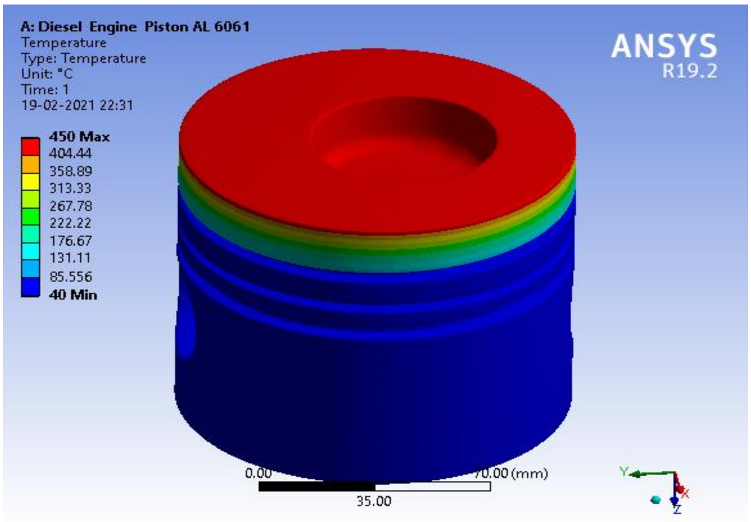

Fig.4.4 Diesel engine Al 6061 piston temperature results

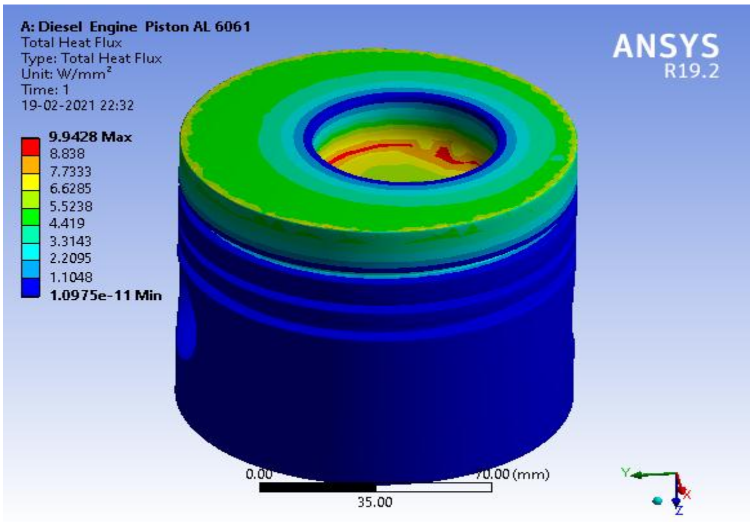

Fig.4.5 Diesel engine Al 6061 piston heat flux results

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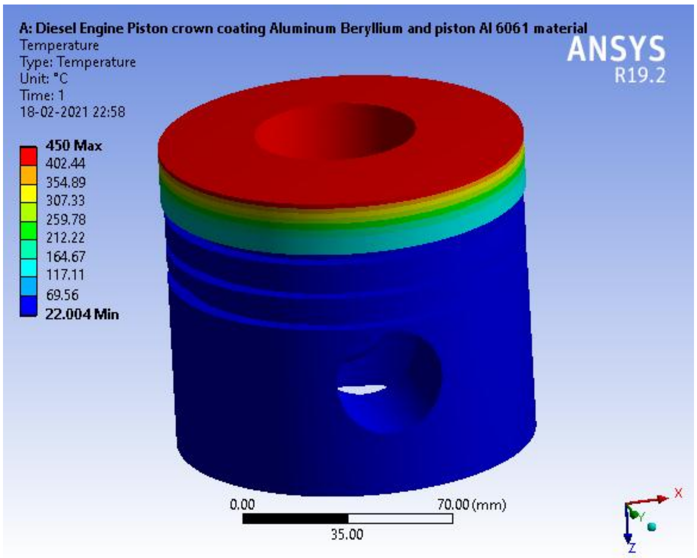

Fig.4.6 Diesel engine Aluminum Beryllium Alloy piston temperature results

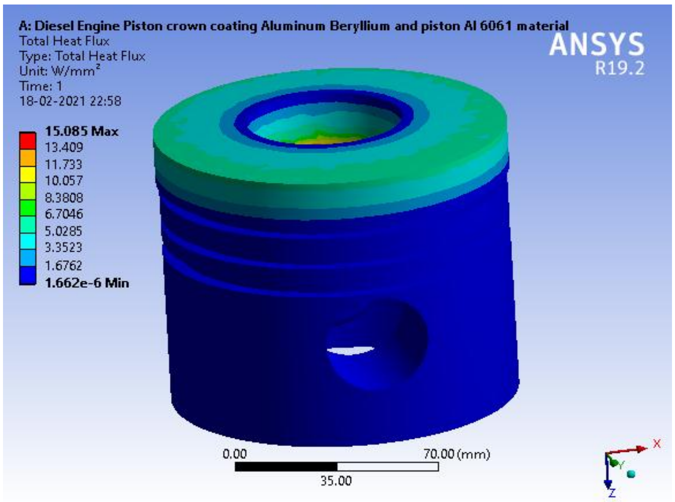

Fig.4.7 Diesel engine Aluminum Beryllium Alloy piston temperature results

V. RESULTS & DISCUSSION

Here it is cleared about diesel engine piston for 6 cylinder vehicle . here using NX software for 2D and 3D modeling purpose and simulation have performed on ANSYS workbench at thermal transient analysis platform. So here find out two results basis on thermal boundary condition. Like that temperature and heat fluxes.

Here take two material like that AL 6061 without coating and another material is Al6061 with coating 1 mm layer of beryllium aluminium material.

Here take thermal boundary condition is 40C and piston crown temperature put-up 450 C and film coefficient 5e-006 w/m²C

Then here find out temperature results for exiting material AL6061 is 404.44C and when take another coated material used then find out less temperature results like 402.44 C

Then here find out heat flux results for exiting material AL6061 is 9.942 w/mm² and when take another coated material used then find out less heat flux results like 15.08 w/mm²

So it is clear that Al 6061 with beryllium aluminium coated material is best for exiting material AL 6061 on the basis on more heat transferred and less temperature value.

So this is coated material can be used in future diesel engine piston design and minimize the piston crown damage issue by heating issue.

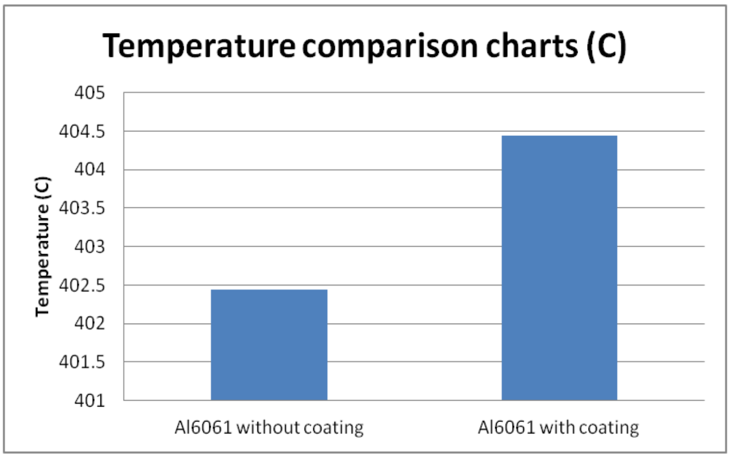

Fig. 5.1 Temperature comparison charts (C)

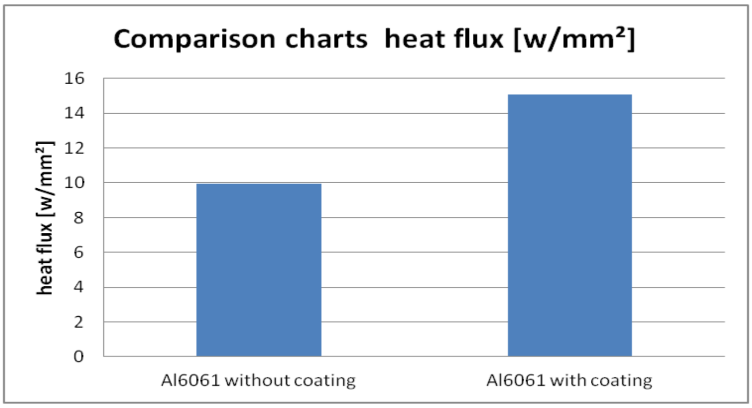

Fig 5.2 Comparison charts heat flux [w/mm²]

VI. CONCLUSION

In order to find the surrounding temperature at design stage, Thermal transient analysis is applied in the prediction of heat transfer rate.

This FEA calculation technique improves the accuracy of the piston temperature prediction and the optimization of the piston cooling is realized at the design stage.

1. The accuracy of piston temperature prediction is improved significantly.
2. By using this technique, find out heat transferred results.

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