ANALYSIS AND OPTIMIZATION OF PISTON WITH DIFFERENT ALLOYING MATERIAL USING FEA

S.Ramkumar, D.Umapathi

Department of Mechanical Engineering, Adhi College of Engineering & Technology, Sankarapuram, Kanchipuram, Tamilnadu, India

ABSTRACT

This project contracts with the structural and thermal analysis of various aluminum alloying piston by means of finite element Analysis (FEA). The specifications used for the study of these pistons belong to four stroke engine. This project shows the procedure for analytical design of various aluminum alloying piston using specifications of four stroke engine. The results expect the maximum stress and critical region on the different aluminum alloy pistons using FEA. It is significant to find the critical area of concentrated stress aimed at suitable alterations. Static and thermal analysis is achieved by using ANSYS 16.0. The best aluminum alloy material is designated based on stress analysis results. The analysis results are used to optimize piston geometry of best aluminum alloy.

1. INTRODUCTION

1.1 Thermal Analysis and Optimization of I.C. Engine Piston

Automobile components are in excessive demand these days because of increased use of automobiles. The increased demand is due to improved performance and reduced cost of these components. R&D and testing engineers should develop critical components in shortest possible time to minimize launch time for new products. This requires understanding of new technologies and rapid absorption in the growth of new products. A piston is reciprocating IC-engines component. The component that is contained by a cylinder and is complete gas-tight by piston rings. An engine purpose is to transfer force from expanding gas in the cylinder to the crankshaft via connecting rod. As an important part in an engine, piston endures the cyclic gas pressure and the inertial forces at work, and this working condition may cause the fatigue damage of piston, such as piston side wear, piston head and crown cracks and so on. The investigations indicate that the greatest stress looks on the upper end of the piston and stress concentration is one of the mainly aim for fatigue failure. On the other hand piston overheating-seizure can only occur when something burns or scrapes away the oil film that exists between the piston and the cylinder wall.

1.2 Thermal Barrier Coating Introduction

Thermal Barrier Coating Introduction It is important to calculate the piston temperature distribution inured to control the thermal stresses and deformations within acceptable levels. Most of the internal combustion engine pistons are made for aluminum alloy materials that has thermal expansion coefficient 80% higher than the cylinder bore materials made of cast iron [Shaojun Xia, Lingen Chen, FengruiSun]. Thermal barrier coating are commonly smeared to substrates to insulate the thermal effect and allows higher working temperature. (The desire to increase thermal efficiency and reducing fuel consumptions of engine absorbing high compression ratio of particular diesel engine .coating of the engine piston is engineering application one of thermal barrier coating .the piston is a ceramic coating based on metal low thermal conductivity and good strength is predicted of enduring high temperatures them materials. one of the materials used in zirconium, which is applied by plasma-spraying technique.) The main purpose is to rise the temperature of the surface of piston crown during the extension stroke and decreasing the wall temperature and the gas to reduce heat transfer. The additional head energy in the cylinder can be converted to increase power and efficiency [Shaojun Xia, Lingen Chen, FengruiSun et al, Cerit .M, AyhanV, ParlakA, YasaraH et al, Edward H. Smith et al, MuhammetCerit, Mehmet Coban,EkremBuyukkaya, MuhammetCerit].the production of metallic combustion chamber components form thermal stresses and reduction cooling requirement. A cooling system will be reduced the cost and engine weight can be improved reliability. There are many potential benefits of fuel consumption low heat rejection and emissions as well as more life pistons, exhaust valves [Chong, M. Teodorescu V.C,Vaughanm.d, Eduardo Tomanik, Antony Raj, GnanaSagaya Raj, JawaliMaharudrappa Mallikarjuna, Venkitachalam Ganesan,Haque M.M, Sharif A,Belov N.A, EskinD.G,Avxentieva N.N]. The bond coat layer is used among the thermal barrier coating and the metal substrate. The bond coating material is an inter metallic alloy that provides high temperatures and aids in the adhesion of the thermal barrier coating layer to the substrate. The bond coat acting an important role in reducing the internal stresses which may arise between the substrate and the ceramic coating because of thermal shock. The thermal expansion coefficient of the bond coat should be between that of the thermal barrier coating and the metal substrate [Cerit .M, AyhanV, ParlakA, YasaraH, Edward H. Smith, MuhammetCerit, Mehmet Coban, EkremBuyukkaya, MuhammetCerit,]. Modeling of the piston temperature distribution is very important for the thermal stresses within acceptable levels. Computer simulations of thermal stress analyses are very useful and economically valuable for reducing the time and cost form a piston in diesel engine [Xiqun Lu, Quan Li , Wenping Zhang, Esfahanian..V Javaheri .A, Ghaffarpou.M., SinghO.P, Piston seizure investigation].There are many research papers on the temperature calculation distribution but thermal stress analyses are limited [Cerit .M, AyhanV, ParlakA, YasaraH, SilvaF.S., A. Devaraju, K. Pazhanivel]. The object of this paper is to examine the aluminum silicon temperature and stress distribution of piston by using various thicknesses of the coating materials to achieve higher diesel engine performance. Analyses have been accomplished for various conditions and uncoated piston crown and a ceramic-coated piston crown with a ceramic top coat ranging in thickness from 0.2 to 1.6 mm [Cerit .M, AyhanV, ParlakA, YasaraH].