EFFECT OF HIGH ENGINE TEMPERATURE ON PERFORMANCE AND CHARACTERISTICS OF IC ENGINE

Suresh konda[1], P.SaiSrikanth Goud[2], M.Narsimha[3], V.Rupesh Goud[4], T.Chandra Shekar[5]

[1]*Assistant professor, Mechanical engineering, NNRG, Telangana, India*
[2] *Student, Mechanical Engineering, NNRG, Telangana, India*
[3] *Student, Mechanical Engineering, NNRG, Telangana, India*
[4] *Student, Mechanical Engineering, NNRG, Telangana, India*
[5]*Student, Mechanical Engineering, NNRG, Telangana, India*

ABSTRACT

In Present technology era IC engine is primary source for vehicular propulsions so, the study and analysis of IC engine is significant and it has huge platform to research and this work brings the picture of effects which will evolve in running a engine at unwanted high temperatures , as the engine running at high temperatures the following difficulties may arise like evaporation of lubricant oil ,harmful unwanted emission, variation of volumetric efficiency, variations of metallurgical properties of engine components etc. Among the above problems variation of volumetric efficiency and variation of metallurgical properties of engine components are the working stock.

Keywords: - *High temperatures , Volumetric efficiency, Metallurgical properties, and Lubricant oil etc..*

1. INTRODUCTION

We have two types of engines, the spark ignition engine (SI) and the compression ignition engine (CI). Both have there merits and demerits, Heat transfer in IC engines is a serious problem, since you need high temperatures to combust the fuel. But you also need to keep the temperature at a controllable level in order to operate the engine safely. Once the temperature in the engine has reached intolerable values the engine block and components may suffer damage. Therefore it is essential to have a heat removal process which will maintain the engine at a safe operating condition. There components in the engine that suffer more from high temperature than others. Therefore, A water jacket or air through fins are the two ways that reduce the temperature in the engine. The components with the highest temperature are Spark plug, the piston face, exhaust valve and a port. The problems with these components are that they are not only the hottest components, but they are also difficult to cool. They are difficult to cool because, there location in the engine does not permit them for proper heat transfer. The design of engine is such that there is not much space for water jet to cool of the components .The spark plug is located in the middle and fastened to chamber. There is no water flow that will aid in the reduction of the temperature.

Taking in to account that as the engine warms up components expands with heat, the engine is designed in such away that, at optimum operating temperature, components will expand to optimum size. If an optimum temperature is not achieved then expansion will be either excessive or insufficient and can cause complications in running efficiency of the engine [1].Surface temperature may have to limited to temperatures as low as 130 °C [2]

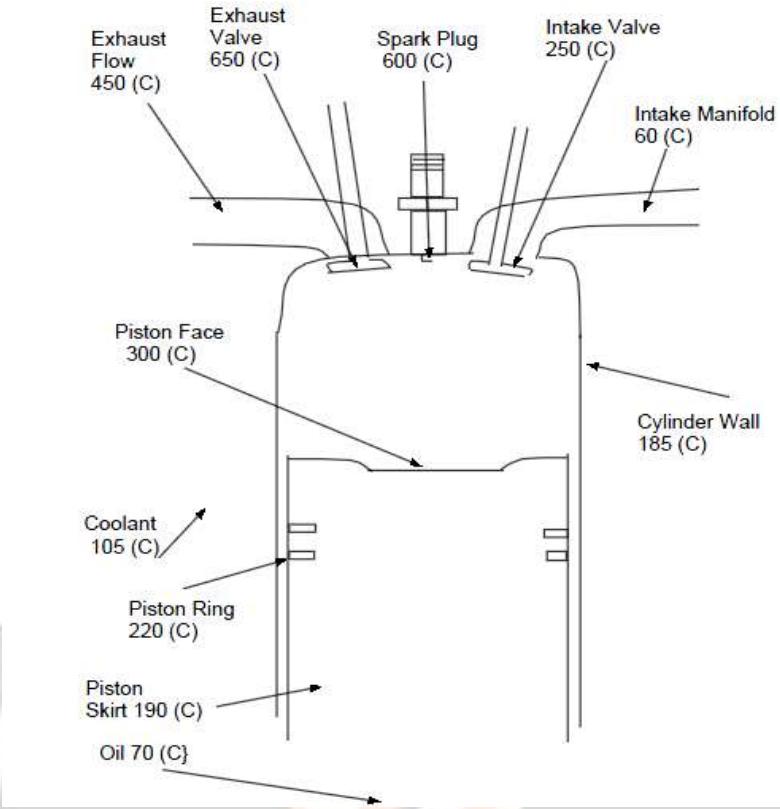

Fig: 1 Temperatures of engine components

1.1 Effect on lubricant

All engines require some form of lubrication and this provided by the oil .This oil is require to carry out numerous different tasks, when the engine is in operation ,the primary function being to lubricate all the components by reducing friction or preventing or reducing metal to metal contact[2]. The most prominent factor is due to change in temperature during machinery operation. A lubricant viscosity will decrease with an increase in temperature and will decrease in temperature reduction. These oils are designed to function in an optimal way at the normal operating temperature range of the engine. As the general rule of thumb, an engine operating temperature should be approximately 10□C to 15□C and above the cooling water temperature [3]. Keeping this in mind, the sump operating temperature of engine oil should not exceed under normal conditions. Another general rule that can be applied to the operating viscosity of engine oil is that, if the operating viscosity of oil goes below 10mm2/s then the oil is too thin to lubricate [4].

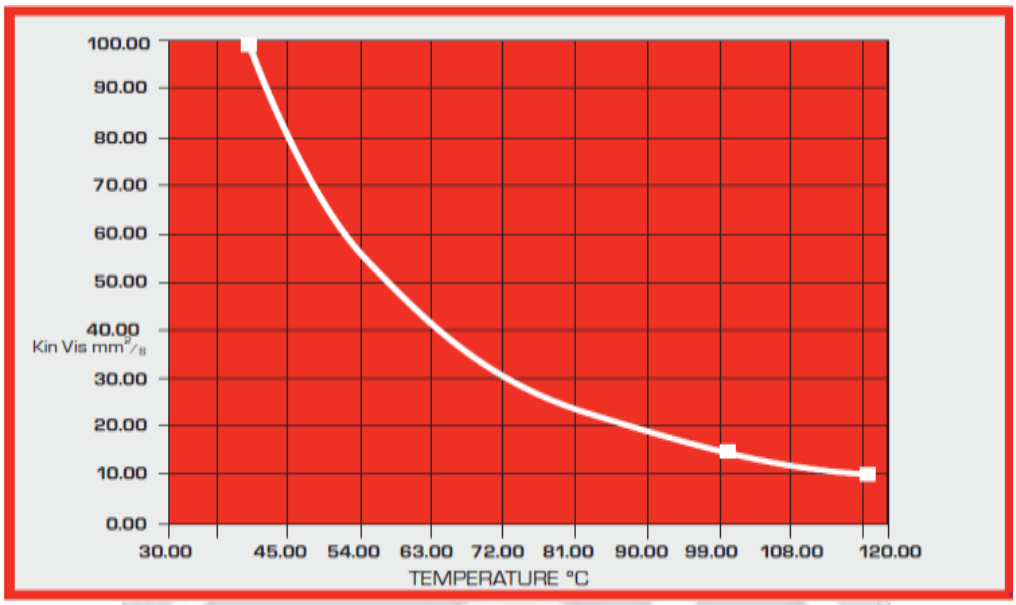

Fig: 2 (Viscosity of lubricant vs Engine temperature) [4]

2. Effect on Engine components

The temperature in the combustion chamber of engine goes up to 2700k, and the material used in the engine cannot withstand this. Further, this high temperature destroys the lubricants properties l, of the oil film on the cylinder walls, at the same time, thermal stress will be developed there by destroying the cylinder, head and piston. As the internal combustion engine valves are precision engine components. They open and close as and when needed. The

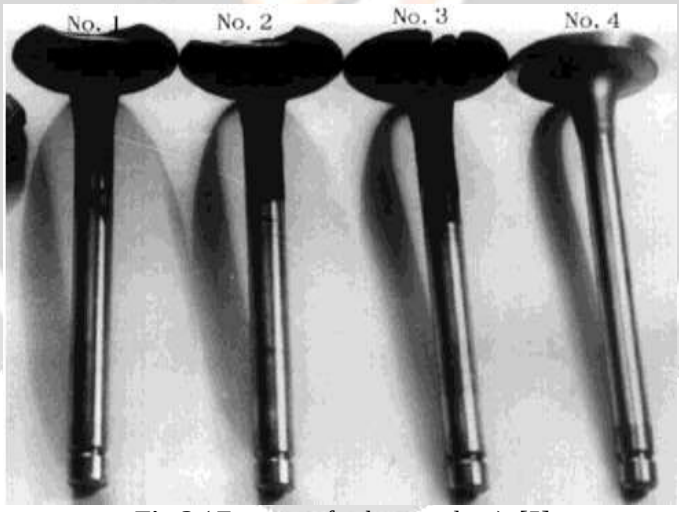

Fig:3 (Fracture of exhaust valves) [5]

Fresh charge (air - fuel mixture in spark ignition engines and air alone in compression ignition engines) is induced through inlet valves and the products of combustion get discharged to atmosphere through exhaust valves. They are also used to seal the working space inside the cylinder against the manifolds [5]

As the main heating part in the engine, piston works for a long time high temperature and high load environment (maximum gas pressure reaches almost 13 MPa). The piston has the characteristics of large heating area and poor heat dissipation, so the thermal load is the most serious problem [6]. In actual work, there are many failure modes due to thermal stress. Structural design of the piston has a very important influence on the reliability, emission, economy and life of the engine. Under the high temperature condition, the piston is subjected to periodic heat load which can cause surface cracking, corrosion, wear and even structural damage under abnormal temperature or burning condition [7]. As it can be concluded it is very necessary to analyze thermal stress of the piston [8].

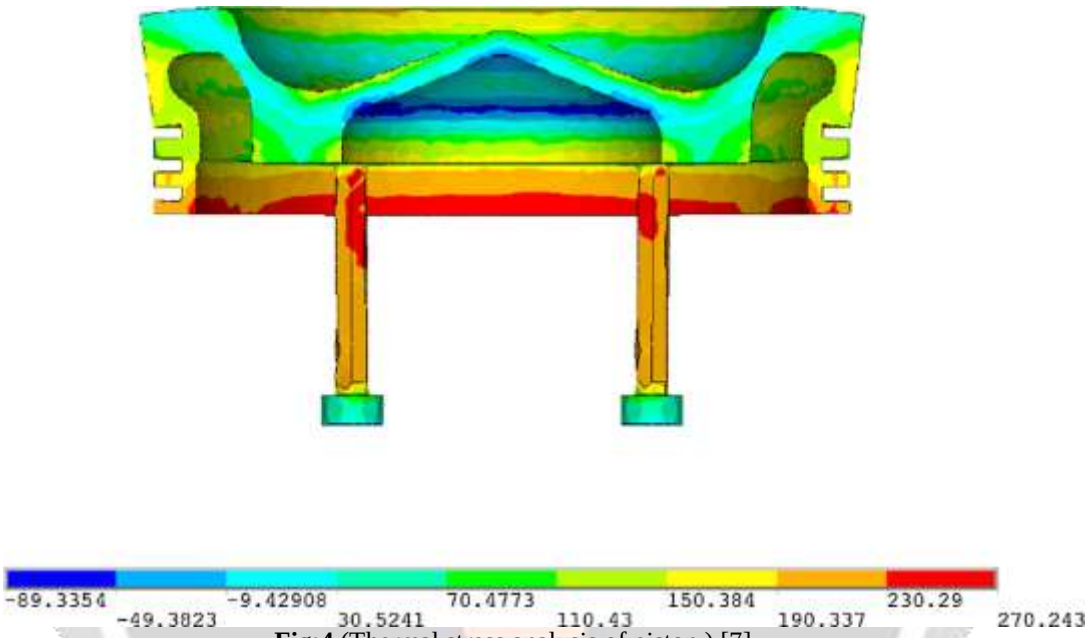

Fig:4 (Thermal stress analysis of piston) [7]

2.1 Effect on emissions

Over recent past years, stringent emission legislations have been imposed on NOx, smoke and particulate emissions emitted from automotive diesel engines world wide. Diesel engines are by low f characterized fuel consumption and very low CO emissions [9]. However, the NOx emissions from diesel engines still remain high. Hence, in order to meet the environmental legislations, it is highly desirable to reduce the amount of NOx in the exhaust gas. In diesel engines, NOx formation is a highly temperature-dependent phenomenon takes place when the temperature in the combustion chamber exceeds 2000 K [10]. Therefore, in order to reduce NOx emissions in the exhaust, it is necessary to keep peak combustion temperatures under control. Formation of NOx is almost absent at temperatures below 2000 K. Hence any technique, that can keep the instantaneous local temperature in the combustion chamber below 2000 K, will be able to reduce NOx formation.

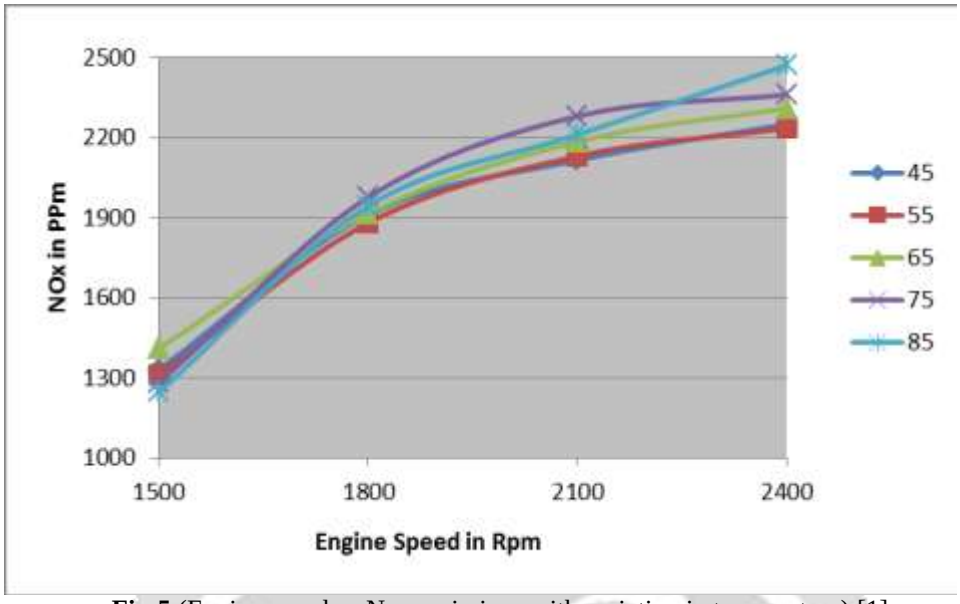

Fig:5 (Engine speed vs Nox emissions with variation in temperature) [1]

2.2 Effect on engine performance:

The high temperature in the combustion chamber of engine not only effects the components but also effects the efficiency and brake Power. The brake Power of engine decreases at high temperatures and speeds [8].

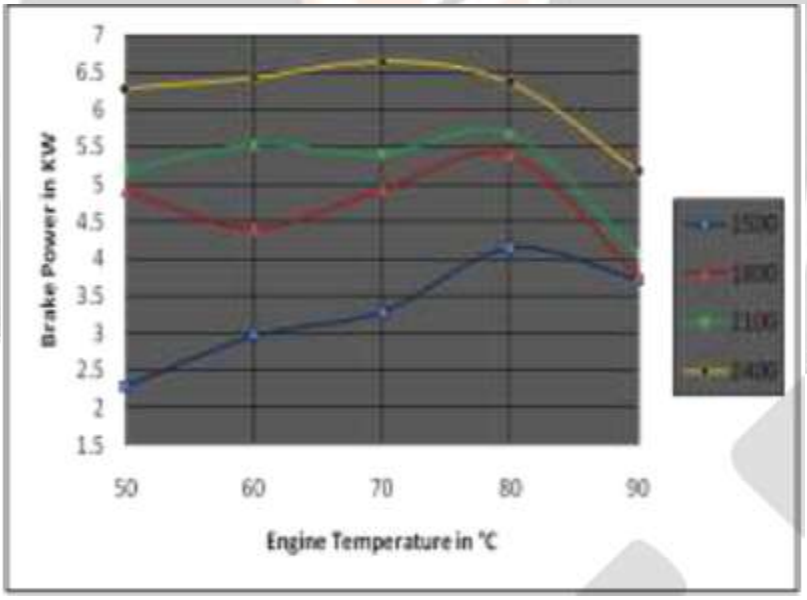

Fig:6 (Brake power vs Engine temperature) [8]

The previous research's on knock has revealed that increase in cylinder temperatures increase the tendency of an engine to knock. Increasing the jacket temperature decreased the value of the compression ratio at which knock occurred [11].

3. Effect on volumetric efficiency:

Mass flow rate of air may decrease due to increase in engine temperature; this may lead to decrease in volumetric efficiency. As we know that the air densities decrease by the increase in the temperatures, Due to high temperatures in the engine the components such as the inlet manifold get heated to high temperatures, this high temperature inlet

manifold raise the temperature of charge air passing through it . The mass of air induced into the engine decreases, this can be explained

$$M=\alpha v$$

Mass is directly proportional to the density and volume , the volume of the engine is constant ,so when temperature increases the air density decreases and which results in the decrease in the mass of air supplied.

Volumetric efficiency:

$$\eta_v\ (\%) = \frac{\text{Mass of air consumed}}{\text{mass of flow of air to fill swept volume at atmospheric conditions}}$$

$$\eta_v(\%) = \frac{AirFlow(Kg/Hr)}{\pi/4 \times D^2 L(m^3) \times N(RPM)/n \times NoofCyl \times AirDen(Kg/m^3) \times 60} \times 100$$

Where n= 1 for 2 stroke engine and n= 2 for 4 stroke engine.

As we know the mass of air supplied decrease, so the volumetric efficiency also decreases.

4. CONCLUSIONS

As the temperature of the combustion chamber in the engine increases above 2000k, the viscosity of lubricant decreases below 10mm2/s, this may lead to insufficient lubrication of components and high temperature may lead to decrease in brake power. Nox emissions increases due to high temperatures in combustion chamber and also the components in the engine get damaged and lose their properties due to thermal stresses induced by the temperatures.

The volumetric efficiency decreases with increase in engine temperatures.

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