CONSIDERATIONS OF CONNECTING ROD, PISTON AND GUDGEON PIN IN RECIPROCATING AIR COMPRESSOR

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Abstract

A compressor is a machine providing air at high pressure and work is done on the gas by external agency. The process of compressing of air requires that work should be done upon it. The air compressor is a device that converts power into kinetic energy by compressing and pressurizing air there are two types of methods for air compression are positive displacement or negative displacement. Reciprocating compressors is a positive displacement type are used in some of the most critical and expensive systems at a production facility, and deserve special attention. Gas transmission pipelines, petrochemical plants, refineries and many other industries all depend on this type of equipment. Due to many factors, including but not limited to the quality of the initial specific at ion/design, adequacy of maintenance practices and operational factors, industrial facilities can expect widely varying lifecycle costs and reliability.

Keywords*: Connecting rod, Air compressor, Piston, Modeling, Analysis*

1. INTRODUCTION

The various definitions of The Energy consumption of air compressor in the improving efficiency of the reciprocating compressor to improve the compressors performance that can be improves the electric motor efficiency, internal losses system effects, speed variation and interaction of valve stress and compressor performance. To improve the heat transfer in reciprocating compressor using element methods. Reciprocating compressor is one of the most popular machine uses in the industries. Compressors can be classified according to the pressure delivered:

1. Low-pressure air compressors (LPACs), which have a discharge pressure of 150 psi or less

2. Medium-pressure compressors which have a discharge pressure of 151 psi to 1,000 psi

3. High-pressure air compressors (HPACs), which have a discharge pressure above 1,000 psi They can also be classified according to the design and principle of operation:

1. Rotary-screw compressor

2. Turbo compressor

A. Displacement Type There are numerous methods of air compression, divided into either positive displacement or roto-dynamic types.

B. Positive Displacement Positive-displacement compressors work by forcing air into a chamber whose volume is decreased to compress the air. Once the maximum pressure is reached, a port or valve opens and air is discharged into the outlet system from the compression chamber.

C. Dynamic Displacement Dynamic displacement air compressors include centrifugal compressors and axial

compressors. In these types, a rotating component imparts its kinetic energy to the air which is eventually converted into pressure energy. These use centrifugal force generated by a spinning impeller to accelerate and then decelerate captured air, which pressurizes it.

However, the fault diagnosis of reciprocating compressors is one of the most widely used, but utilize it for machinery protection. It also explains that there are really load limits based on the running gear (moving parts such as pistons, rods, crosshead, crank throw, etc.) as well as load limits based on the stationary components (frame, crosshead guide, etc.). The basic kinematics and forces mechanism m will be reviewed to least understood reciprocating still a difficult task however, the term "rod load" is I compressor descriptors in industry. Typical end users know users, analysts, OEMs, etc. "Rod that rod load is don't general have a good developed and how to provide a better understanding of the various definitions that are used.

2. LITERATURE REVIEW

The heat transfer carried out in reciprocating compressor which was leading to loss of volumetric efficiency B.G. Shivaprasad stated that Regenerative heating of the gas in the absence of any heat source is considered to be one of the primary contributors to suction gas heating. The experiments conducted to measure the cylinder wall heat transfer rate in order to verify earlier imperial models used for prediction, and to assess the capacity loss resulting from regenerative heating. Heinz P Bloch and John J.Hoefner worked on the Development of a Double acting free piston expander for power recovery in transcritical CO2 cycle

[1]. Senegal developed new method of thermodynamic computation for a reciprocating computer simulation by Si – Yieng

[2]. W. Norman Shadeetal. suggest optimization and revitalization techniques on compressors used in air drilling, air procession and air separation etc. and emphasis on the fact that virtually any size model can be considered for improvements, A. Al masi worked on reciprocating compressor design and manufacturing with respect to performance, reliability and cost. And suggested methods for optimum reciprocating compressor. A P. Budagyan and P.I. Plastinin devoted on design and optimization on reciprocating compressors and minutely studied the effect of temperature variation on the overall performance of the reciprocating compressors and cooling of compressors

[3]. Today, connecting rods are best known through their use in internal combustion piston engines, such as automotive engines. These are of a distinctly different design from earlier forms of connecting rods, used in steam engines and steam locomotives.

3. BOUNDARY CONDITIONS

Axial stress developed and fixed constraints on the CR are the real time boundary conditions which are seen in Eco Boost Mustang Engine. Axial Stress- Axial stresses are developed due to the

- Combustion Chamber pressure (CC)
- Inertia Force Combustion chamber pressure (CC) - High value of axial

stresses is developed due to compressive pressure developed inside the combustion chamber due to the combustion of fuel [5].

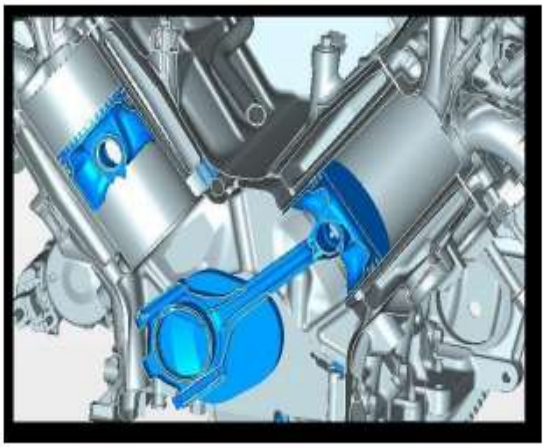

Figure 1. Piston- Combustion chamber and piston connecting rod

A. MESH AND MESH SENSITIVITY

Solving a complex body to find the results of stress and fatigue life without using Finite element analysis is tedious and takes a lot of man hours and often results in human errors in solving complex equations. In 1943 an efficient way to solve complex problems related to a component was introduced by R. Courant [13]. He discretized the whole component into small elements, this process of breaking down the body is called meshing. This small elements are solved individually for solutions. Then solution of each individual element is summed up to get a final solution. One should understand that the obtained solution are not exact, but are approximate solutions which Engineers can trust. Mesh- A very fine mesh was created at the critical areas like fillet region and edges of the CR. These are the sections in the CR where there is probability of max. stress concentration. Mesh connections are created in the assembly for connectivity while mesh operation is performed and make assembly a single model for analysis results.

B. Mesh sensitivity analysis

The purpose of conducting this analysis is to get accurate output solution. In this thesis, it is carried out to fin exact stress and fatigue plots. The relationship between input value and output values are understood using mesh sensitivity analysis. Output results were studied for different input element sizes from 8mm to 2 mm (element size).

4. CAE ANALYSISFOR FS AND AA

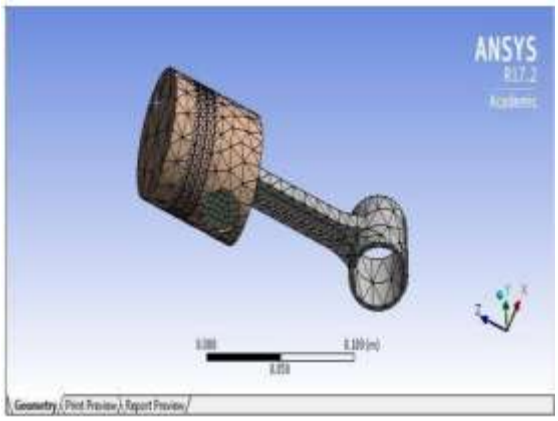

Figure No 2: Connecting Rod Meshing Model

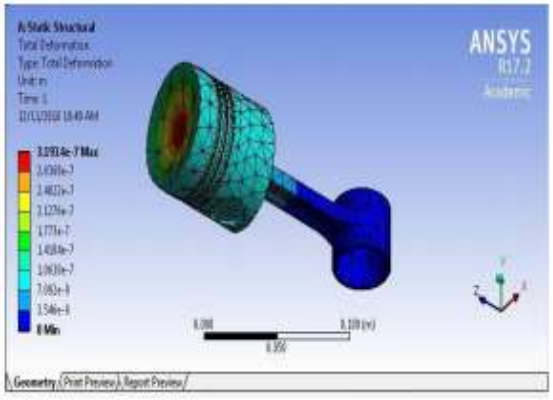

Figure 3: Total Deformation

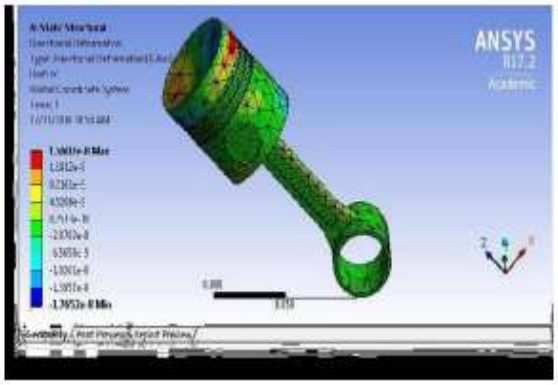

Figure 4: Directional Deformation (x axis)

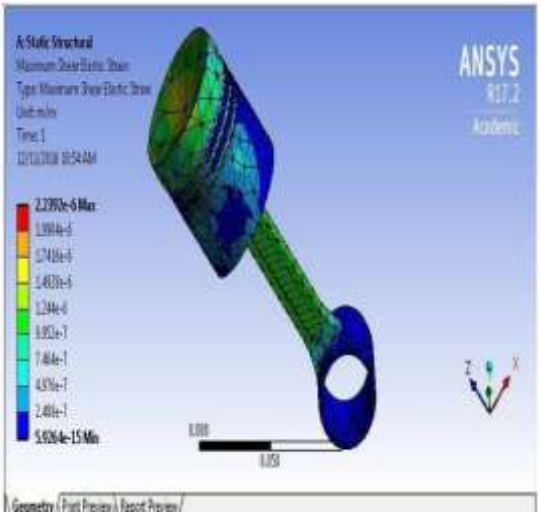

Figure 5: Maximum Shear Elastic Strains

When the connecting rod is applied repeated cyclic loads, like pressure and inertia force, the material begins to weaken, this is known as fatigue. When the material is subjected to repeat cyclic loading there will be progressive and localized structural damage . The stress developed will be always less than the yield stress and ultimate stress, however due to repeated loading; the material will fail from generations of crack to brittle material like failure. This type of failure generation is very hard to identify since the connecting rod is not visible to naked eyes and it is inside the engine cylinder. This type of failure is called ―throwing a rod‖ and the whole engine ceases, which leads to irreparable engine. According to survey it says 90% of the connecting rod failure is due to the fatigue. In this thesis, fatigue analysis is carried out to see if the connecting rod fulfills infinite life requirement, also if the connecting rod fails, further analysis is carried out to find value of the stress for which the life of the CR increases to infinite and giving FOS of value 2.

1. Minimum life of the CR is 504 cycles only.

2. CR is at high risk of failure as the min. life of the component is 504 cycles only.

3. It is the responsibility of the Engineer to redesign the CR to give fatigue life of 10E6 cycles.

In general practice for steel material, CR is designed for infinite cycles. Fatigue redesign for forged steel connecting rod

5. CONCLUSION

- Aluminum7075 weights three times less than Forged Steel; this material Connecting Rod is mainly used in aerospace application.
- Forged Steel has very high stress handling capacity without yielding.
- Deformation is Forged Steel is less compared to Aluminum7075.
- Also with application of 17.7 MPa pressure and 1000 N inertia force, Forged Steel has better values of stress, deformation, FOS, and fatigue life, which is better than Aluminum7075.
- Aluminum7075 has no infinite life and fails at 10E8 cycles; Forged Steel has infinite fatigue life.

- Also from manufacturing point of view Manufacturing Forged Steel is easier when compared to CNC manufacturing of . Material thickness for Aluminum7075 is thicker when compared to Forged Steel, for same value of Boundary Condition. As the thickness of the Connecting Rod increases, Connecting Rod comes in contact with the engine block and crankshaft.

- By considering all the above factors, one can conclude that Forged Steel is better material than Aluminum7075 in terms of stress handling, manufacturability and cost.

- Forged Steel is the best material to be used as a Connecting Rod material for Ford Eco Boost Mustang.

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