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 specification/design, adequacy of maintenance practices and operational factors, industrial facilities can expect widely varying lifecycle costs and reliability from their own installations piston itself can called as reciprocating part which movies in a cylinder to and flow direction and transmit power to crank shaft but in this case power is transmitted as compressed air in this piston where it have section intake and discharge valve and where as gudgeon pin connects the piston to the connecting rod and provides a bearing for the connecting rod to pivot upon as the piston moves. The design was done using UG and analysis on two parts of reciprocating compressor i.e., piston and gudgeon pin using structural analysis.

Keywords: Modeling and Analysis

I. INTRODUCTION

This paper discusses 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 the finite element methods. Reciprocating compressor is one of the most popular machine uses in the industries. Reciprocating air compressors in vehicles compress air and supply it to the air brakes. Many of the components constituting the reciprocating air compressor are having design features based more on standard practices rather than on sound scientific analysis. One of the systematic investigations reported recently is on the pressure variation inside the air compressor as a function of the crank angle. Rod load, including historical and current API-618 definitions, manufacturer’s ratings, and various user interpretations Reciprocating compressors are usually rated in terms of horsepower, speed and rod load. Horsepower and speed are easily understood; every year in China, many of the accidents in refineries are caused by the common faults of reciprocating compressors.

II. CALCULATIONS OF GUDGEON PIN & PISTON

However, the fault diagnosis of reciprocating compressors is still a difficult task however, the term “rod load” is interpreted differently by various users, analysts, OEMs, etc. “Rod load” 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.).

| Size of studs | 8 |
| Depth of piston ring | 4.875 |
| Distance between bottom of piston to bottom of second ring | 6.42 |
| Number of piston rings | 2 |
| Thickness of web of piston | 10mm |
| Mass of piston | 0.9482 Kg |
| RPM of compressor | 925mm |
| Length of cylinder | 205mm |
| Material of cylinder | FG 300 |
| Stroke Length | 150mm |
| L/D Ratio | 1.6 |
| No of studs | 4 |
| Thickness of piston | 30mm |
| Distance between top of piston to top of first ring | 6.42mm |
| Clear distance between two piston ring | 7.41mm |
| Thickness of piston ring | 10mm |
| volume of piston | 131703.92×10-9 m |
| Outer diameter of piston pin | 15mm |

The basic kinematics and forces acting on a slider-crank mechanism will be reviewed to least understood reciprocating compressor descriptors in industry. Typical end users know that rod load is a factor used to “rate” a compressor, but they don’t generally have a good understanding of how this rating is developed and how to provide a better understanding of the various definitions that are used.
III. 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 Shade et.al. 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]. Due consideration is given on optimal basic geometric dimensions of reciprocating Compressors. The results from the experiments indicated a significant contribution to capacity loss by suction gas heating. The measurements were done in a two stage, single cylinder, double acting air compressor running at approximately 900 rpm. The suction pressure was atmospheric and the discharge pressure was. All measurements were mainly confined to head end of the first stage cylinder.

IV. 3-D MODELS

Figure 1. Cylinder

Figure 2. Select the Side Plain

Figure 3. Engine

Figure 4. Final Part of Engine

Figure 5. Plate 3D

Figure 6. Connecting rod Part
Figure 7. Engine Part
Figure 8. Top Part
Figure 9. Gudgeon Part
Figure 10. Piston
Figure 11. Connecting Rod
Figure 11. Gudgeon Pin
Figure 13. Assembly
Figure 14. 2D Sketch

GUDGEON PIN DESIGN:
Figure 15. Gudegon Pin

Figure 16. Gudgoen Pin

V. ANALYSIS MODELS

Figure 17. Connecting Rod Meshing Model

STEEL (1500N)

Figure 18. Equivalent (von-mises) stress

Figure 19. Total deformation

Figure 20. Directional Deformation (X axis)

Figure 21. Equivalent Elastic strain

Figure 22. Maximum principal elastic strain
Figure 31. Maximum shear elastic strain

Figure 32. Maximum principal stress

Figure 33. Maximum shear stress

ALUMINUM (1500N)

Figure 34. Total deformation

Figure 35. Directional deformation

Figure 36. Equivalent (von-mises) stress

Figure 37. Maximum Principal Stress

Figure 38. Maximum shear stress
Figure 39. Equivalent elastic strain

Figure 40. Maximum principal elastic strain

Figure 41. Maximum shear elastic strain

ALUMINUM (2000)

Figure 42. Total deformation

Figure 43. Directional deformation (x axis)

Figure 44. Equivalent (von-mises) stress

Figure 45. Maximum principal stresses

Figure 46. Maximum shear stress

Figure 47. Equivalent elastic strains
VI. STATIC ANALYSIS RESULTS

<table>
<thead>
<tr>
<th></th>
<th>Steel</th>
<th>Aluminum</th>
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<tr>
<td>Total deformation</td>
<td>8.654 e^8</td>
<td>1.153 e^7</td>
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<tr>
<td>Directional deformation (x axis)</td>
<td>4.109 e^9</td>
<td>3.479 e^9</td>
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<tr>
<td>Equivalent (von-mises) stress</td>
<td>84502</td>
<td>1.126 e^5</td>
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<tr>
<td>Maximum principal stress</td>
<td>91739</td>
<td>91464</td>
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<tr>
<td>Maximum shear stress</td>
<td>45254</td>
<td>60339</td>
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<tr>
<td>Equivalent elastic strain</td>
<td>5.75 e^-7</td>
<td>7.667 e^-7</td>
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<tr>
<td>Maximum principal elastic strain</td>
<td>4.34 e^-7</td>
<td>5.796 e^-7</td>
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<tr>
<td>Maximum shear elastic strain</td>
<td>5.883 e^-7</td>
<td>7.844 e^-7</td>
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VII. CONCLUSION

This study has shown that the FSI software is a very powerful and promising tool that allows the creation of Virtual Prototypes simulating with great accuracy the fluid-dynamic behavior of reciprocating compressor cylinders. This new technique, preceded by a 1-dimensional model for the first screening of the various geometric parameters, enables the design engineer to evaluate and optimize the cylinder performance as a final step of a new advanced design sequence. The new design method avoids the expense of the construction of a physical prototype or the even more expensive exercise to put in production, with the relevant introduction costs (pattern, machining programs, manufacturing tools etc.), a poor product in terms of efficiency and unable to make the most of the compressor frame load capability. In this an attempt has been made to design a double acting reciprocating air compressor components such as piston and cylinder for maximum pressure. The fundamental dimensions of each components of double acting compressor were found analytically and checked for various failures due to induced stresses. The modeling of double acting reciprocating air compressor components were carried out by using CAD software UG and analysis by using ANSYS software. Theoretically all the components are found to work within safe stress limits.

VIII. REFERENCES


