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REVIEW PAPER ON STRESS & VIBRATION ANALYSIS OF COMPRESSOR BASE FRAME IN EXISTING SKID AND IT'S OPTIMIZATION

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ABSTRACT

The base frame (skid) is generally made up of the standard I- beam or C -channel sections. The frame has to withstand various forces from the compressor during operation and dead loads of all bare compressor components during lifting the whole package. Due to lifting of the skid with dead loads of all bare compressor components, the skid tends to bend. The bending can results in damage of compressor component and piping. Hence compressor base frame should be strong enough to meet the deflection and stress criteria during lifting and also, withstand the loads during compressor running. At the same time, it should be light in weight. Hence, it is essential to carry out the analysis of compressor base frame to find out stresses in existing skid and modified skid.

KEYWORDS: Base Frame, Reciprocating compressor, Static & Dynamic Loads.

INTRODUCTION

Kirloskar Pneumatics Co. Ltd is one of the largest air compressor manufacturing companies. It manufactures various types of compressors, which it supplies to the reputed firms**.**

Compressors are widely used in gas gathering, gas processing, gas storage, chemical and refining applications. Most of the larger high speed compressor models are mounted on Base frames. Compressors are mounted on the Base frame to carry its weight, to maintain its alignment and to assist in carrying the dynamic loads which every compressor generates. Compressors base frame needs a effective design technology to ensure that the base frame as designed performs the required functions, and maintains its integrity. There is also a need to maximize the life of the compressor base frame under the loads to which it is exposed.

So the project work is related to the compressor base frame (Skid) on which high speed reciprocating compressors are mounted. High speed reciprocating compressor has been meeting a market demand in various applications. Such compressor typically range from 100 to 4700 HP, operating at a speed of 1,000 to 1,800 RPM, and are typically delivered to the side as a skid mounted packages, ready to run. The primary advantage of skid mounting is portability and ability to perform all necessary integration of engine and compressor, control system and auxiliary piping on the shop floor with access to the skilled labor and equipment.

Designing products today offers many challenges they must be stronger, lighter, safer, quieter, or using new materials. Products have to satisfy a widening range of design criteria, including environmental impacts. To keep development time and cost competitive, companies rely on simulation tools. Finite element analysis (FEA) is a powerful technique to simulate the mechanical behavior of a product. The FEA method has matured to a point where design, meshing, analysis and post-processing are highly integrated and automated. In combination with numerical optimization, the finite element analysis technique can also be used to optimize existing designs or even propose radical new designs. However, a successful application of this approach requires a seamless integration of the optimization routines into the FEA-analysis software.

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LITERATURE REVIEW

Following are the some of important reviews of diffrenet researchers and scientists in the Vibration field.

A.J. Smalley, J. S. Mandke, et al., [1] has given the idea about various loads coming on the compressor base frame and to the foundation block. Reciprocating compressors are widely used in gas gathering, gas processing, gas storage, chemical, and refining applications. Most of the larger low speed compressor models are mounted on concrete foundation blocks. Reciprocating compressors rely on the foundation to locate the compressor, to carry its weight, to maintain its alignment, and to assist in carrying the dynamic loads which every reciprocating compressor generates.

Brian C. Howes & Valerie A. Zacharias, et al.,[2] describes the origin of vertical forces, discusses their practical implications, and presents examples. It is well known that forces that forces that cause vibrations in reciprocating compressors arise from a number of sources. These include unbalanced reciprocating forces and moments, piping system pulsations, and cylinder stretch. Reliable and efficient reciprocating compressor installations will result from including the effects of all forces in the design calculations. Evidence from field trouble-shooting indicates that force mechanisms operating in the vertical direction in horizontal cylinder assemblies can cause significant vibration.

The base frame discussed by **A.M. Joshi & T.A. Jadhav, et al.,[3]** in this report was designed with conventional design practices and then analyzed statically with commercial FE software. The analysis was carried out to determine the induced stresses and the deflections at various locations on proposed frame. The gravitational loads considered during designing and analysis phase resembled the actual loading cases. The results obtained by analysis were verified with physical test results and good agreement was observed between them.

D. N. Vadiraja & A. D. Sahasrabudhe, et al., [4] have given Structural modelling of rotating pre-twisted thin-walled composite beams with embedded macro fiber composite (MFC) actuators and sensors using higher shear deformation theory (HSDT).Vibration characteristics and optimal control for a box beam configuration are discussed in the numerical examples. It is observed in the present study that, gyroscopic coupling between lagging-extension motions is found to have significant effect and cannot be neglected in the analysis. Effects of vibration suppression using MFC actuators and sensors are highlighted.

Francis C. Moon & Steven W. Shaw,[5] have stated that forced vibration of an elastic beam with non linear boundary conditions are shown to exhibit chaotic behaviour of the strange attractor type for a sinusoidal input force. The chaotic motions have a narrow bond spectrum of frequency component near the sub harmonic frequencies.

K. D. Jadhav & M.R. Dhanvijay, [6] have represents a case study of the compressor base frame on which high speed reciprocating compressors is mounted. Attempts are basically made to standardize base frame for all type of piston compressor. Also, to design deck systems with effective vibration control, which able to sustain the dynamic forces occur in compressor and motor. Secondarily, anti vibration mounts can be select and arranged as they control the vibration of motor and compressor. By using FEA tool approach is made for the investigations of critical stresses. Also, to plot the harmonic responses of the base frame for acceleration with which it vibrate. Finally compare it with the standard data.

Eberle, Kelly, et al.,[7] discusses new analysis techniques to calculate the amplitude and location of high vibrations on the module deck and to optimize the topside module design. An example is included that reviews an integrated design approach, combining the topside module structural model with the mechanical model of the compressor packages. A summary of the recommended specifications for performing dynamic analysis studies is included. Also they include examples from recent projects, including a large FPSO project where three compressor packages were mounted on the topside module.

Norm Shade, et al., [8] provides a preview of some of the Gas Machinery Research Council (GMRC) guideline's recommendations for skid and foundation design. He also gave many types foundation in this paper. Also he stated that successful design and construction of a skid and foundation system requires effective planning, coordination between the technical specialists as the design is developed, and attention to construction details throughout the construction process. Performance criteria, guidelines and design strategy have to be agreed upon prior to the start of the design.

John P. Harrell, et al., [9] has given the idea about the advantages of the skid mounted compressor. High speed reciprocating compressor has been meeting a market demand in production, processing of natural gas for many years.

Such compressor typically range from 100 to 4700 HP, operating at a speed of 1,000 to 1,800 rpm, and delivered to the site as a skid-mounted package, ready to run. The primary advantage of skid mounting is portability and the ability to perform all the necessary integration of engine and compressor, control system and auxiliary piping on the shop floor with access to the skilled labor, equipment and engineering support not always available in the field.

Reciprocating compressor generates large dynamic internal forces, both from time varying acceleration of reciprocating components and from the large piston rod forces needed to compress the gas.

The finite element approach regarding the analysis of compressor base Frame is given in the document published by **Grenald Group, et al., [10]** they carried out the vibration analysis of compressor base frame using ANSYS software and found out the natural frequencies and displacement for different load combinations. Analytically the natural frequencies, transmissibility and stiffness have been found out by doing the mathematical modeling of the structure.

The **IS standards, [11]** are referred for calculating the design strength, compressive strength and bending strength of I–beam and for dimensioning, material selection and material properties of the structure. The company has referred the IS standard for designing the base frame.
A vast amount of work has been carried out for the optimization of frame structures for different applications like chassis of car, stiffener layouts of different structure, engine base frame use for testing etc. But the few researches are carried on the optimization of compressor base frame (skid). The aim of the literature review was to get the detail about the approach of methodology adopted in carrying out design and analysis of similar kind of frame.

CONCLUSION

We have clear idea about various loads coming on the compressor base frame and to the foundation block. Reliable and efficient reciprocating compressor installations will result from including the effects of all forces in the design calculations. At the place of conventional design practices it can be analyzed statically with commercial FE software accuratly. It is observed in the present study that, gyroscopic coupling between lagging-extension motions is found to have significant effect and cannot be neglected in the analysis. FEA tool approach is made for the investigations of critical stresses. successful design and construction of a skid and foundation system requires effective planning, coordination between the technical specialists as the design is developed, and attention to construction details throughout the construction process.

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