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DESIGN AND ANALYSIS OF SUPPLY PIPELINE FOR SCREW COMPRESSOR

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ABSTRACT

A typical piping system consists of combination of pipes and various fitting components like bends, Tees etc. In manufacturing plants, piping systems are continuously present and transport air or gas to the plants. The screw compressor piping systems are subjected to various types of loading due to Weight, Pressure, Temperature, wind etc. causing possible failure modes, based on type of loading, as plastic, rupture, fatigue, creep etc. In addition, pipe exhibits different geometric characteristics at fittings which have notable effect on the flexibility of the piping system. Such a piping layout design depends mainly on stress analysis and displacement. The present paper analyses the presence and effect of hangers and extending joints on CAESAR-II pipe layout/routing. Main aim of piping stress analysis is to provide adequate flexibility for absorbing thermal expansion, code compliance for stresses and displacement incurred in piping system. This in turn has influence on stress concentration at fittings and the loads produced due to it. This thesis attempts to explain basic concepts of flexibility, stress intensification factors and their concerns provided in ASME B31.3 codes.

Keywords*: ASME B31.3, CAESAR II, Piping, Screw Compressor, Stress Analysis.*

I.INTRODUCTION

The use of screw compressors in industry is widespread since they have replaced the traditional reciprocating compressor in a large range of applications such as air compression, refrigerant compression and particularly supercharging in the automotive industry. Nowadays, due to global environmental issues, energy conservation has become a very important problem. Screw compressor supply piping play a major role in industries. Piping system is the heart of any process plant. Piping stress analysis is a method which is highly reciprocal with piping layout and support. Piping layout design depends mainly on stress analysis and flexibility. It will vary with respect to pipe geometrical properties, pressure, temperature, and supports. The piping supports are designed based on the selected locations, types and the applied loads. The discussion is heavily weighted to the stress analysis of piping systems in thermal power plants, since this type of piping has the most stringent requirements. Piping system comprises of pipes, fittings like elbows, tees, reducers, sockets, half couplings, unions, flanges and valves. These all are used to transfer the fluid from one point to another through straight pipes, changing the direction with most economical means- elbow, branching through tees. In this paper, the design and analysis of the piping system is done by using CAESAR II Software. For design of piping systems, selection of proper material for construction and to detail out the material specifications like length, Diameter, wall thickness, temperature, pressure, elastic modulus, poissions ratio, pipe density, fluid density, etc., knowledge of codes and standards is essential. There are many type of piping standard available, they are ASME, ANSI, BIS, ISO, ASME B31, CSI, etc. Of these standards ASME B31 is used in this paper.

- ASME B31.1 - Power Piping
- ASME B31.2 - Fuel Gas Piping
- ASME B31.3 - Process Piping
- ASME B31.4 - Liquid Piping
- ASME B31.5 - Refrigeration Piping
- ASME B31.8 - Gas Distribution and Transportation
- ASME B31.9 - Building Service Piping

II.PIPING LAYOUT & ROUTING

In the piping system various failure modes is to affect the overall function of the piping layout. Mainly the pipe engineer is to consider the stress analysis according to the piping codes. It depends upon the material, supports and loads. The piping layout is very important for the installing of pipe in the sites. It shows the piping in the plan view and gives all the information required for preparation of isometric drawings. Pipe Routing is always decided based on the Equipment layout. The best possible pipe routing is achieved by knowing the process flow and the above criterion for layout.

Pipe Data:

- Pipe Material - A 106 grade B
- Pipe Nominal Diameter - 12.70mm
- Operating Pressure - 600KPa
- Operating Temperature - 36^{0}C

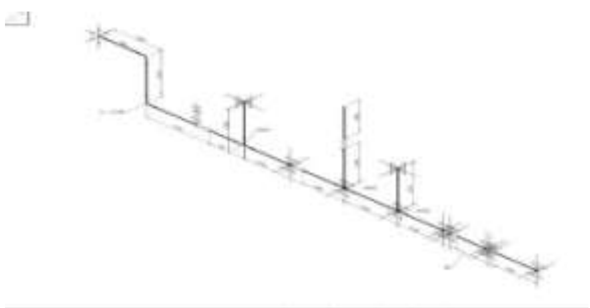

Figure1: Isometric view of piping system to be designed

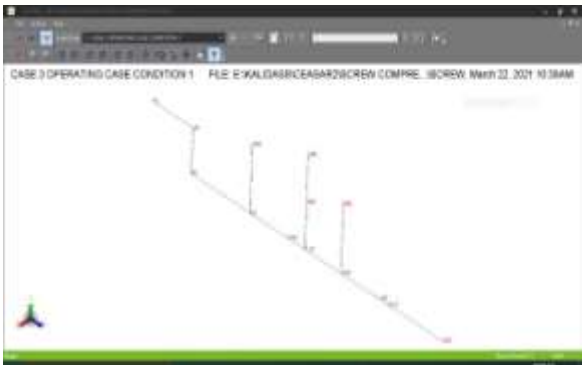

Figure 2: 3D view of supply pipeline of screw compressor

III.METHODOLOGY

The Methodology of design procedure is to find a piping configuration and size within the constraints, the design parameters which are safe and economical. The steps in pipeline design are as follows:

1. The determination of the problem.
2. The determination of a preliminary pipe route.
3. Structural analysis.
4. The stress analysis is performed in pipe configuration until compliance with the code is achieved.
5. Support and anchor design based on reaction found in the structural analysis.

IV.STRESS ANALYSIS

Piping stress analysis is a term applied to calculations, which address the static and dynamic loading resulting from the effects of gravity, temperature changes, internal and external pressures. Stress analysis for this piping system is

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CODE STRESS CHECK PASSED      : LOADCASE 14 (EXP) L14=L3-L7
Highest Stresses: (   KPa     ) LOADCASE 14 (EXP) L14=L3-L7
Ratio (%):                     10.9       @Node     38
Code Stress:                22490.6       Allowable Stress:     206842.7
Axial Stress:                3198.2       @Node     20
Bending Stress:             19292.4       @Node     38
Torsion Stress:                 0.0       @Node     39
Hoop Stress:                    0.0       @Node     20
Max Stress Intensity:       22490.6       @Node     38
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V.DISPLACEMENT ANALYSIS

Node	DX mm.	DY mm.	DZ mm.	RX deg.	RY deg.	RZ deg.
10	0.000	-0.000	-0.000	0.0000	-0.0000	-0.0000
20	0.031	-2.156	0.000	0.0000	-0.0000	0.2555
30	0.033	-1.648	0.000	0.0000	-0.0000	0.3279
38	0.036	-0.388	0.000	0.0000	-0.0000	0.4735
39	0.083	-0.274	0.000	0.0000	-0.0000	0.4887
40	0.200	-0.226	0.000	0.0000	-0.0000	0.4915
48	9.097	-0.227	0.000	-0.0000	-0.0000	0.0830
49	9.116	-0.219	0.000	-0.0000	-0.0000	0.0805
50	9.124	-0.200	0.000	-0.0000	-0.0000	0.0781

Node	DX mm.	DY mm.	DZ mm.	RX deg.	RY deg.	RZ deg.
60	9.124	0.001	0.000	-0.0000	0.0000	0.0222
70	9.124	0.039	0.000	-0.0000	0.0000	0.0222
80	9.124	0.144	0.000	-0.0000	0.0000	0.0380
90	9.124	0.079	0.000	-0.0000	0.0000	-0.0266
100	9.124	0.033	0.000	-0.0000	0.0000	-0.0266
110	9.124	-0.428	0.000	-0.0000	0.0000	-0.0224
120	9.124	-0.140	0.000	-0.0000	0.0000	0.0541
130	9.124	0.213	0.000	-0.0000	0.0000	-0.0187
140	9.124	0.180	0.000	-0.0000	0.0000	-0.0187
150	9.124	0.000	0.000	-0.0000	0.0000	-0.0216
160	0.000	0.144	0.000	-0.0000	0.0000	0.2424
170	9.906	-0.428	0.000	-0.0000	0.0000	-0.0224
180	9.946	-0.428	0.000	-0.0000	0.0000	-0.0224
190	10.728	-0.428	-0.000	-0.0000	0.0000	-0.0224
200	0.000	-0.140	-0.000	-0.0000	0.0000	0.2343
210	9.124	-0.000	-0.000	-0.0000	-0.0000	0.0000
220	9.124	0.000	0.000	-0.0000	0.0000	-0.0000

VI.CONCLUSION

The analytical results of this piping layout describe the stress analysis and displacement analysis of piping system in the screw compressor is found to be good and economically value. The analysis of a piping system using CAESER-II software gives more accurate and precise results. Thus, the objective of this paper was attained.

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