THE STRESS OF SLIDING VANES IN A ROTARY COMPRESSOR

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ABSTRACT
A rotary sliding vane compressor was redesigned with extended rods on both edges of each vane and guide slots on both cover plates to improve its performance. The governing equations were derived to obtain loads acting on vanes and the stress of vanes. The finite element method is used with a generated computer program to determine the stress of vanes based on the calculated loads and the measured loads acting on the vanes. The results were compared and show good agreement with those obtained by using an existing software IDEAS.

1. INTRODUCTION
Sliding vane rotary compressors have been used in many applications due to advantages of the light weight, compact size and simple mechanism. A rotary compressor with a stator, a rotor with ten sliding vanes was designed.

The cross sections of the stator and the rotor are elliptical and circular, respectively. Ten sliding vanes are inserted into ten slots of the rotor. When the rotor rotates inside the stator, vanes slide along the stator inner contour and slide outward due to the centrifugal force and inward due to the constraint of the stator inner contour. Vanes impact on the stator inner contour during starting up and shutting down operations or low rotor rotational speeds. Friction power loss is high due to friction between vanes and other components. The prototype of the compressor was built. Noise level was high during operation and vanes were damaged.

The compressor was redesigned with extended rods on both edges of each vane and guide slots on both cover plates as shown in Figs. 1 and 2. These extended rods were inserted into the guider slots to control the motion of vanes and to reduce compact and friction between vanes and the stator. The schematic drawing of the compressor is shown in Fig. 2.

Although analyses in various aspects were studied for this compressor [1-5], the stress of vanes with extended rods was not investigated, and the extended rod of the vane was bended. Therefore, the purpose of this study is to analyze the stress of vanes and to improve the performance of the compressor.

2. METHOD OF APPROACH
With the assumed polytropic process during compression, the governing equations were derived to obtain loads acting on vanes and the stress of vanes. The finite element method is used with a generated computer program to determine the stress of vanes based on the calculated loads and the measured loads acting on the vanes.

3. RESULTS AND DISCUSSION
The angular location is measured from the horizontal axis. The stress versus the angular location of the vane is
determined. With the rotor rotational speed of 1000 rpm, the contour plots of the Von Mises stress are generated for vanes at various critical locations. The calculated maximum Von Mises stress of 2.58 MPa occurs at the root of the extended rod. This result is comparable with the maximum Von Mises stress of 2.84 MPa obtained by using IDEAS software as shown in Fig. 3. The deviation is about 9.2% as shown in Fig. 4. Using the loads obtained from experiment measurement, the calculated result of the maximum Von Mises stress is 2.32 MPa that is even smaller than 2.58 MPa. When the rotor rotational speed increases to 2000 rpm, the maximum Von Mises stress of vanes increases to 4.52 MPa, and it is reduced significantly compared with the vane maximum Von Mises stress of 5.12 MPa in the previous compressor without extended rods. The maximum Von Mises stresses of vanes at various locations are shown in Table 1.

![Figure 3. Maximum Von Mises stress vs. location of vane.](image)

![Figure 4. Deviation between FEM and IDEAS simulation.](image)

<table>
<thead>
<tr>
<th>method</th>
<th>θ</th>
<th>maximum Von Mises stress (unit: kg/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDEAS</td>
<td>60°</td>
<td>0.85</td>
</tr>
<tr>
<td>FEM calculated</td>
<td>60°</td>
<td>0.93</td>
</tr>
<tr>
<td></td>
<td>120°</td>
<td>1.42</td>
</tr>
<tr>
<td></td>
<td>180°</td>
<td>2.84</td>
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<tr>
<td></td>
<td>120°</td>
<td>1.25</td>
</tr>
<tr>
<td></td>
<td>180°</td>
<td>2.58</td>
</tr>
</tbody>
</table>

4. CONCLUSION

The maximum Von Mises stress of vanes with the extended rods is smaller than that of the previous vanes without the extended rods. Therefore, it is expected that the life of the vanes and the redesigned compressor should be improved.

ACKNOWLEDGEMENTS

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