CASE STUDY

PUMP DESIGN UPGRADE IMPROVES MTBR FOR PAPER MILL

• Causes of impeller and shaft damage investigated
• Operational safety margins restored
• Improved MTBR

CHALLENGE

A paper mill in the USA was experiencing reliability issues with a third party pump. They appointed ClydeUnion Pumps, part of Celeros Flow Technology, to investigate the cause and propose a solution.
ClydeUnion Pumps found that the pump’s shaft was sheared under the impeller fit and there was a crack in the hub of the impeller at the keyway. The impeller wear rings were exhibiting 360° rubbing and some case damage had been caused by a combination of erosion and rubbing of the impeller.

Analysis of the pump was undertaken to determine the cause of the broken shaft under the impeller. Calculations of the first and second dry natural frequencies were done on the original pump. The results showed that the pump's first and second dry natural frequencies were running quite close to the x 1 and x 2 running speed. Factoring in the effects of the worn packing and wear rings, it was clear that the pump was operating at critical speed.

The new design was based on increasing the margin between the first natural frequency and the running speed. ClydeUnion Pumps achieved this by changing the shaft diameter, the distance between bearings, and the distance from the radial bearing and coupling. The throat bushing was also upgraded to graphite/metal alloy and installed with mechanical seals.

OUTCOMES

The upgrades resulted in a considerable increase in operating margins, verified by ring tests. The data shows that the upgraded pump will run smoother and with fewer mechanical problems, resulting in an extended Mean Time Between Repairs (MTBR).

Following this demonstration of our engineering and diagnostic expertise, the customer requested that ClydeUnion Pumps upgrade all three of their pumps.

Table 1 - Calculated Data

<table>
<thead>
<tr>
<th>LOCATION + TEST CONDITION</th>
<th>1ST DRY NATURAL FREQUENCY, CPM</th>
<th>2ND DRY NATURAL FREQUENCY, CPM</th>
<th>SEPARATION MARGIN 1ST MARGIN</th>
<th>SEPARATION MARGIN 2ND MARGIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump (as found)</td>
<td>2,988</td>
<td>8,638</td>
<td>-25 %</td>
<td>8 %</td>
</tr>
<tr>
<td>Pump (upgraded)</td>
<td>6,757</td>
<td>24,629</td>
<td>69 %</td>
<td>209 %</td>
</tr>
</tbody>
</table>

Table 2 - Actual Test Data

<table>
<thead>
<tr>
<th>LOCATION + TEST CONDITION</th>
<th>NATURAL FREQUENCY(S), HZ</th>
<th>SEPARATION MARGIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotor dry with coupling hub + seals</td>
<td>107Hz, 347Hz</td>
<td>60 % 159 %</td>
</tr>
<tr>
<td>Rotor dry with coupling hub, but without seals</td>
<td>109Hz, 428Hz</td>
<td>63 % 219 %</td>
</tr>
<tr>
<td>Rotor dry without coupling hub or seals</td>
<td>120Hz, (second mode not tested)</td>
<td>79 %</td>
</tr>
</tbody>
</table>

New shaft design

New bearing housings

New mechanical seals

New bearing housings

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