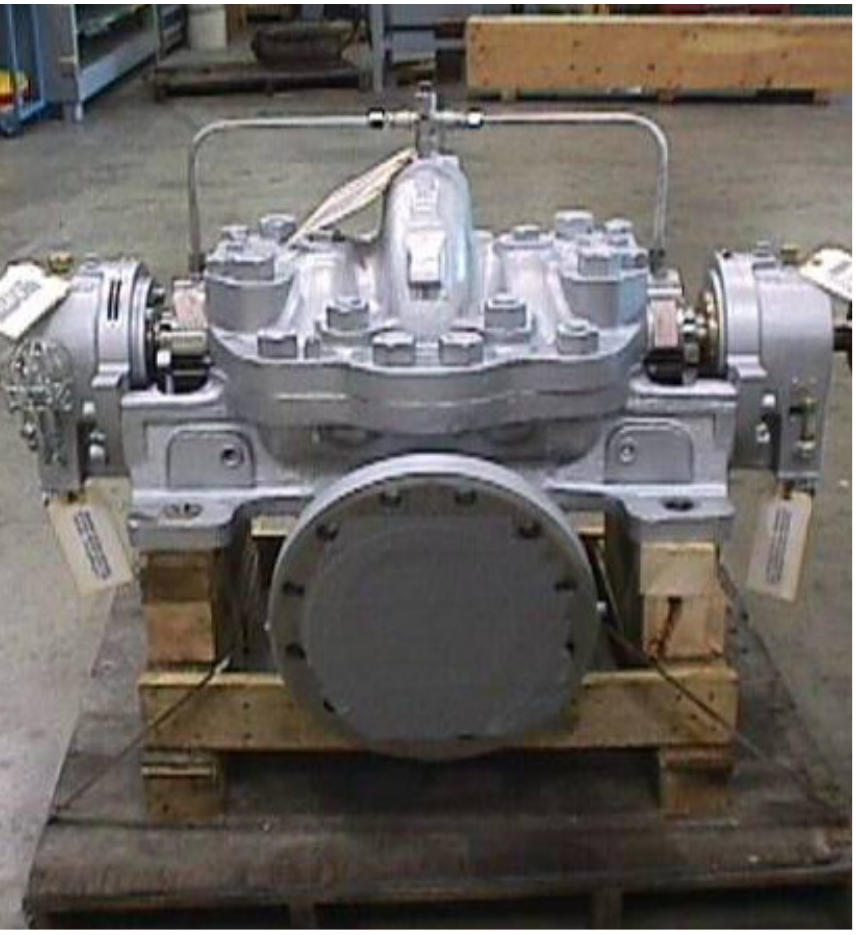
CASE STUDY

CUP-BB2 MTBR SIGNIFICANTLY IMPROVED



Ingersoll-Rand JVL - mechanical upgrade

Industry:	Industrial - paper mill
Region:	Americas
Territory:	USA
Category:	Mechanical design upgrade
API Type:	BB2

ClydeUnion Pumps Aftermarket Technical Services team has experience across a range of services on critical rotating and reciprocating equipment to improve operational safety, reliability and efficiency. The mechanical upgrade of the Ingersoll-Rand 8 JVL pumps for the industrial market is one of our success stories documented in our library of case studies. These case studies highlight the requirement from the customer, how we achieved the goal and the process we followed to deliver the improvements.

Image left: Complete pump

Situation

The project included a mechanical upgrade on an Ingersoll-Rand 8 JVL to extend the reliability and Mean Time Between Repairs (MTBR). The shaft was found sheared under the impeller fit, as indicated by rotation of continuous key by 30°. The impeller was found with a crack in the hub of the impeller at the keyway and the impeller wear rings were also rubbing 360° around. Some case damage was found from erosion and rubbing of the impeller.

Challenge

- Analysis of the rotor will help to determine the cause of failure of the shaft and impeller, and help to define the parameters for the new shaft and bearing housing
- Upgrade of old style sleeve bearings to ball-ball construction was also required to make the rotor more rigid
- Upgrade from packed pump to mechanical seals

Analysis of the pump was completed to try and 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 (see table 1 overleaf). The results show that the pump's first and second dry natural frequencies were running quite close to the x 1 and x 2 running speed. When estimating the affects of the worn packing and wear rings, the pump was operating at critical speed.

Top half of casing removed to see condition of the rotor.

ClydeUnion Pumps

Table 1 - Calculated Data

	1st Dry Natural Frequency, CPM	2nd Dry Natural Frequency, CPM	Separation Margin 1st Margin	Separation Margin 2nd Margin
Pump (as found)	2,988	8,638	-25 %	8 %
Pump (upgraded)	6,757	24,629	69 %	209 %

The new design was based on increasing the margin between the first natural frequency and the running speed. This was achieved 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 graphalloy and installed with mechanical seals. With these changes, we were able the increase margins considerably (see table 2).

Table 2 - Actual Test Data

Location + Test Condition	Natural Frequency(s), Hz	Separation Margin	
Rotor dry with coupling hub + seals	107Hz, 347Hz	60 %	159 %
Rotor dry with coupling hub, but without seals	109Hz, 428Hz	63 %	219 %
Rotor dry without coupling hub or seals	120Hz, (second mode not tested)	79 %	-

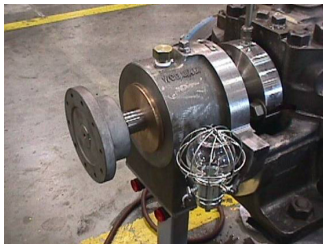
Solution

When the pump was complete, ring tests were performed on the pump to determine the natural frequencies of the various areas on the pump. The data collected showed that the pump should run with reasonable margins.

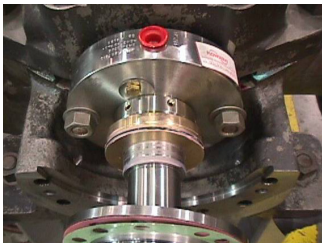
From the data above, the upgraded pump will run smoother and with less mechanical problems. The first natural frequency was increased, so that the pump will run with a larger separation margin. In all, the pump will be able to run with an extended Mean Time Between Repairs (MTBR).

The customer requested ClydeUnion Pumps upgrade all three of their pumps. All pumps are running well and have improved MTBR.

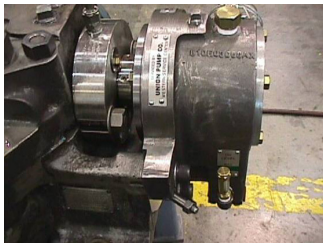
New shaft design



New bearing housings



New mechanical seals



New bearing housings

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Ref no: CS-BB2-J-I-01 Rev no: 002 UK