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Pump Rebuild Report

Ingersoll-Rand 3HMTA 8 Stage Pump #1

December, 2016

POWER ZONE
EQUIPMENT, INC.

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Project Data

Customer:..... [redacted]

Customer Purchase Order Number ..... [redacted]

Customer Purchase Order Date..... 10/11/2016

Power Zone Work Order Number..... 10643

Repair Start Date..... 10/26/2016

Repair Completion Date..... 02/09/2017

Equipment..... Ingersoll-Rand 3HMTA-8 stage

Introduction

In October 2016, Power Zone Equipment received a purchase order from [redacted] for (2) IR 3HMTA 8 Stage Pump Packages. The Project required Power Zone to rebuild both 8 stage pumps and fabricate two steel bases and mount each pump with a 300 HP motor. The purchase order was issued on October 11th. Work began immediately.

Inspection by PZE technicians revealed that the first set of pumps sourced for the project were in very poor condition. The casings were damaged and one pump was de-staged to a 4 stage pump and required a switch in the shaft rotation. [redacted] conducted a brief inspection in addition and agreed the pumps were in poor condition. A second set of pumps were sourced and inspected. They were found to be in much better condition. Only physical damage spotted during initial inspection was a crack in the water jacket that required repair. Upon further review, it was noticed that the two pumps had two different impeller hydraulic types. New impellers were purchased to ensure both pumps produced the same curve. The first pump was originally completed and taken to the PZE test facility for a performance test on February 3rd. The pump bearing housing overheated when the water jacket was not in use. In order to resolve this issue, the pump returned to the rebuild bay and it was discovered that a spacer was required in the bearing drum. The rebuild was officially completed on February 9th and a successful performance test was completed that same day. The changes made to the first pump were repeated on the second pump and the rebuild of the second pump was completed on February 20th. The second pump went into testing on February 21st and was successful.

This report contains a complete description of the work performed for pump #1. The report starts with a brief overview of the pump's overall condition upon opening and examination of the case. Next, the damage found to each individual part is discussed with the corrective actions taken. Finally, a list of additional documents to reference for the pumps condition and performance is provided.

Pump Overall Condition

The first pump, labeled as Ingersoll-Rand 3HMTA #1, had been sourced from another vendor and sent to Power Zone upon [redacted]'s purchase order. When opened up, the pump looked to be in decent condition, but did exhibit minor washout in corners of the pump bearing housing. The water jacket was also cracked through and required rebuilding. All wear on the impellers and shaft were minor and only required cleaning

Primary Damage Found

Following is a list of the primary damage in the pump:

1. Water Jacket Cracked – Water jacket was severly cracked. Damaged area was excavated of bad material and rewelded shut. Jacket was air tested to ensure it was water tight.
2. Bearing Housing Cracked – The bearing housing was cracked in the area for water cooling. Bearing housing was sealed with weld and tested to ensure it did not leak.

3. Pump Casing Corners Washed Out – Corners of the casing located around the bearing housings were washed out. The corners were filled with weld of similar meteal and machined flat.

Pump Condition / Repairs Made

Impellers

Damage Found:

The impellers found in pump #1 were in great condition but were rusted. They did not require any physical repairs but needed to be blasted to get rid of all the surface rust. The O.D. of the impeller's wear ring were slightly large. Picutres of the impellers original conditions on the shaft can be seen below.

Figure 1: Original Impeller Condition on Pump Shaft

Figure 2: Original Impeller Condition on Shaft

Figure 3: Original Impeller Condition on Shaft

Figure 4: Original Impeller Condition on Shaft

Repairs Made:

All impellers were blasted to remove all surface rust. Eye rings on a number of the impellers were machined down to fit the diffusers accordingly. Pictures of the impellers after completion are seen below.

Figure 5: Impellers Sand Blasted

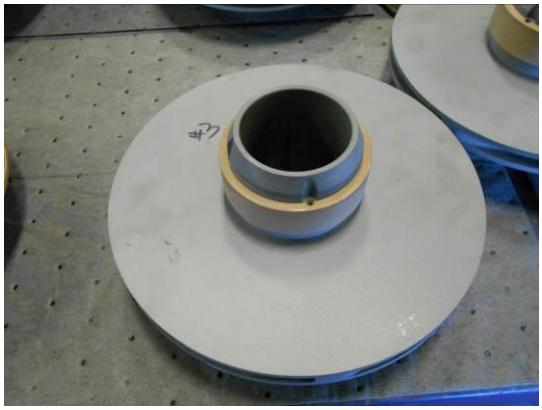

Figure 6: Impeller #3 Close Up

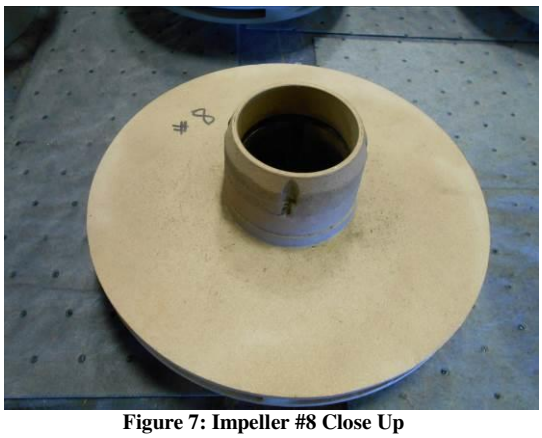

Figure 7: Impeller #8 Close Up

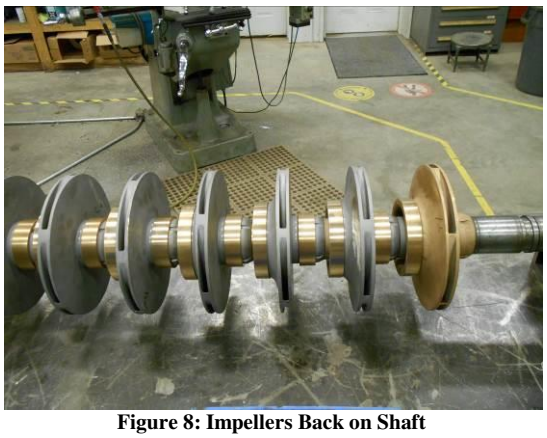

Figure 8: Impellers Back on Shaft

Impeller Description:

Impeller Stage	Suction Style	Diameter	Impeller Make, Model or S/N
1st	Single Suction	9-5/8”	3HMTA3EX5
2nd	Single Suction	9-5/8”	3HMTA3FX6
3rd	Single Suction	9-5/8”	3HMTA3FX6
4th	Single Suction	9-5/8”	3HMTA3FX6
5th	Single Suction	9-5/8”	3HMTA3FX6
6th	Single Suction	9-5/8”	3HMTA3FX6
7th	Single Suction	9-5/8”	3HMTA3FX6
8th	Single Suction	9-5/8”	3HMTA3FX7

Diffusers

Damage Found:

Diffussers were rusted from sitting in the pump for so long but were in great condition otherwise. The hub rings for the diffusers were found to be too large and were scrapped.

Figure 9: Original Diffuser on Shaft, Front View

Figure 10: Original Diffuser Condition Side View

Repairs Made:

Diffusers were blasted and cleaned to a near white metal finish. While shipping (1) diffuser from pump #1 to the foundry to make an additional diffuser for the missing stage on pump #2, the diffuser cracked during transportation, requiring an additional diffuser to be made for pump #1. In addition, new hub rings were created for the diffusers with a smaller diameter I.D.

Figure 11: New Diffuser Stacked on Sand Blasted Diffusers

Figure 12: Diffusers on Shaft

Shaft

Damage Found:

The shaft was in good condition but did exhibit rust and deposites in specific areas.

Figure 13: Paint on Shaft to be Removed

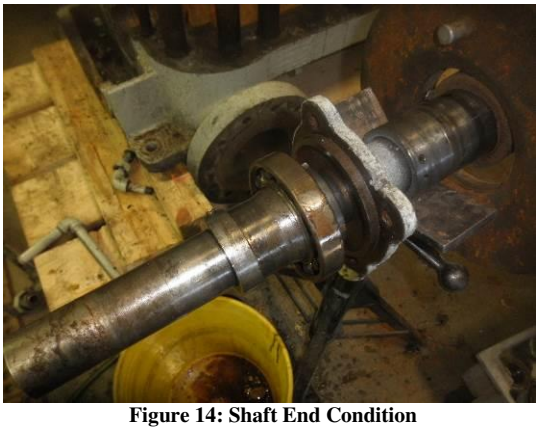

Figure 14: Shaft End Condition

Repairs Made:

Shaft was blasted and cleaned to remove all rust deposites. Runout was checked on the shaft at the thrust end seal fit, drive end seal fit and at the center of the shaft, all passing API standards.

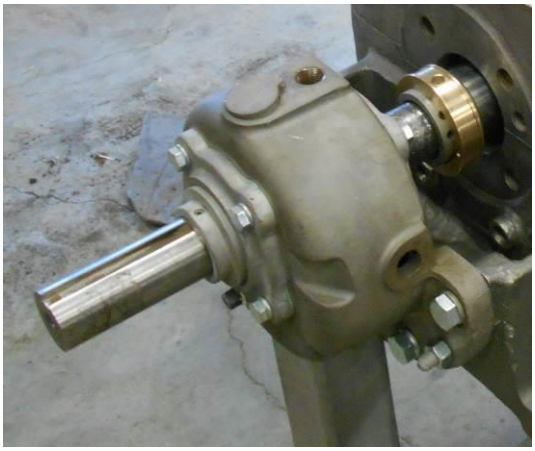

Figure 15: Drive End Shaft Repaired

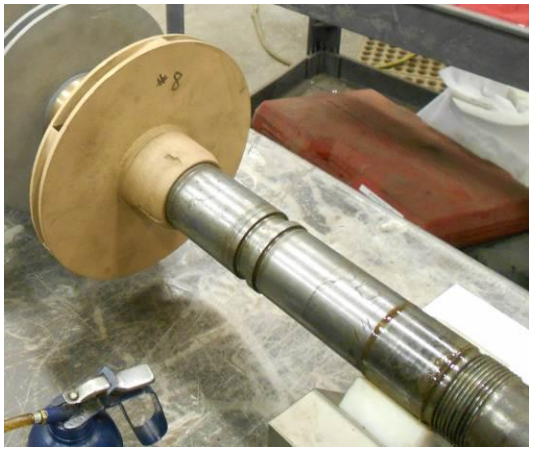

Figure 16: Thrust End Shaft Repaired

Pump Casing

Damage Found:

The pump casing was in the worst condition of all the pump parts. The water jacket was cracked and could not hold water. In addition, buildup of debris had entered into the cracks. Cleaning of the cracks was required before any welding could occur on them. Finally, corners of the pump were either chipped or worn from wash out. Pictures of the damaged areas are shown below.

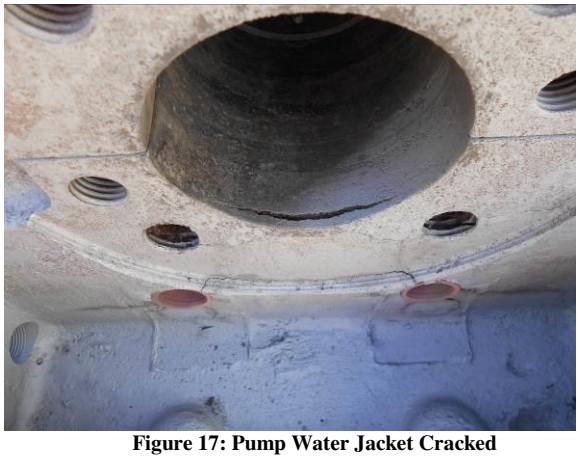

Figure 17: Pump Water Jacket Cracked

Figure 18: Debris from Cracks Cleaned Out

Figure 19: Wear out on Thrust End Left Side

Figure 20: Wear Out on Thrust End Right Side

Figure 21: Case Bottom Thrust End Left Side

Figure 22: Case Bottom Thrust End Right Side

Figure 23: Case Top Thrust End Right Side

Figure 24: Case Top Thrust End Left Side

Repairs Made:

Extensive work was completed on the water jacket. The cracks had to excavated and cleaned multiple times to get all the debris and forign material out of the pump. A plate was inserted into the excavated area and welded in place. Weld filled the remaining area and the entire jacket was tested with air to ensure it was water tight. All holes ruined from the process were redrilled and the face was machined flat. The cracks on the corners were all filled with weld and then machined flat to the original pump face. The pump casing was then sand blasted to near white finish and the external was painted high heat silver, per customers request.

Figure 25: Water Jacket Excavated and Cleaned Out

Figure 26: Water Jacket Filled Before Machining

Figure 27: Water Jacket Repaired and Machined

Figure 28: Water Jacket and Corners Repaired

Figure 29: Thrust End Bottom Corners Repaired

Figure 30: Thrust End Top Corners Repaired

Balance Drum

Damage Found:

Balance drum had surface rust and required cleaning. Otherwise, it was in good condition.

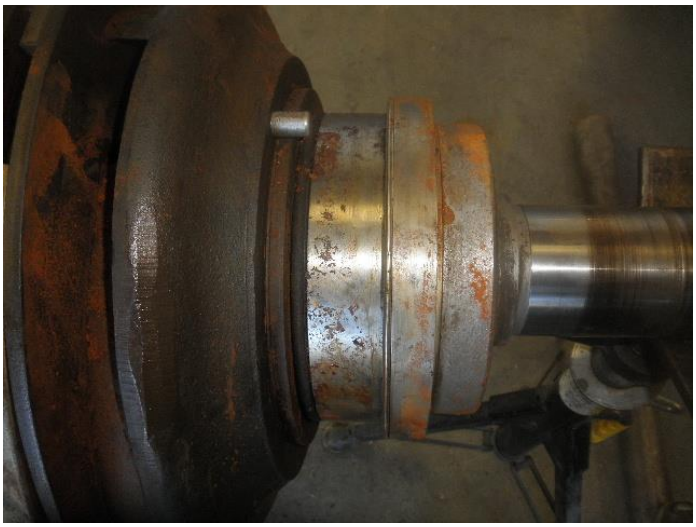

Figure 31: Balance Drum Side View

Figure 32: Balance Drum Front View

Repairs Made:

The balance drum was blasted to remove all surface rust. During testing, the thrust bearing was heating up due to excess friction. A 0.003 shim to provide additoinal clearance was added to the balance drum to increase the back thurst on the pump and reduce the bearing temperture during operation.

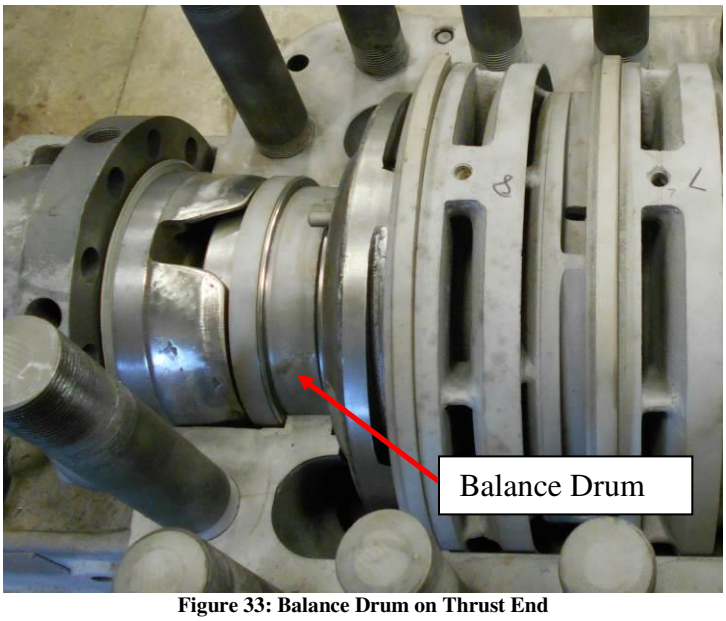

Figure 33: Balance Drum on Thrust End

Stuffing Box and Bushings

Damage Found:

The stuffing box extension exibited wear on the lip along with surface rust in areas and the bushing was too large. The drive end bushing also exibited rust and required to be blasted

Figure 34: Stuffing Box Extension with Erosion

Figure 35: Close Up of Erosion

Repairs Made:

The stuffing box extension was welded up and machined down to like new conditions. A new bushing was machined and inserted into the stuffing box extension. The drive end bushing was cleaned up an reinstalled on the pump.

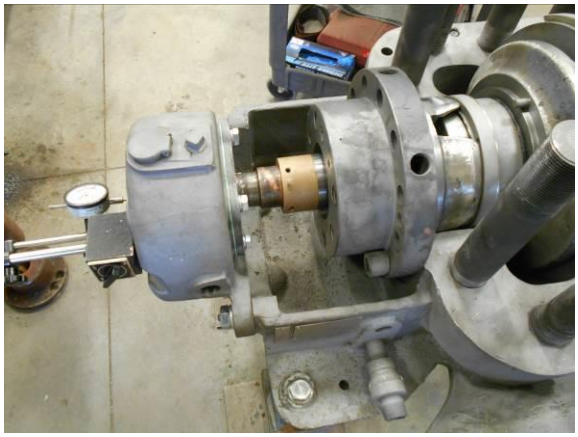

Figure 36: Stuffing Box Extension on Shaft

Figure 37: Drive End Bushing on Shaft

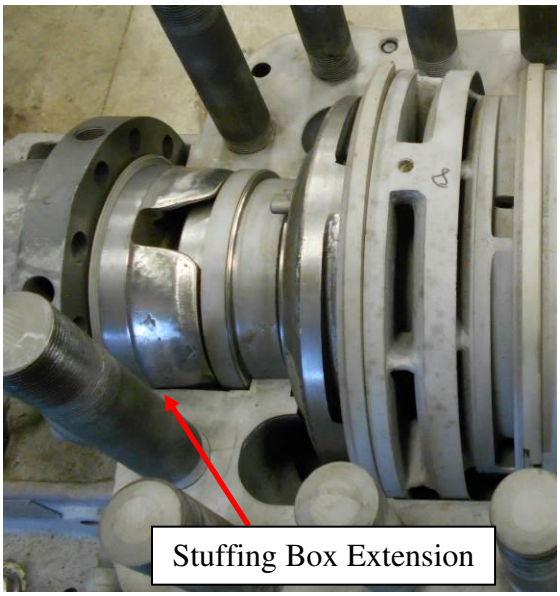

Figure 38: Stuffing Box Extension on Shaft

Packing

Damage Found:

All existing packing was worn, so it was removed and disposed of.

Figure 39: Worn Packing

Repairs Made:

New Ameri-Lon 690 9/16” packing from American Seals was used for this pump. The packing was cut on an angle using a white plastic mandrel, and installed into the pump using a 1/3 round tool.

Figure 40: 100% GFO Packing

Packing Material Desciption

Make	Material / Part #	Size
American Seals and Packing	Ameri-Lon 690	9/16”

Bearing Housings

Damage Found:

Bearing housings were in good condition, but the thrust bearing had a crack on the interior where the water jacket pushes water into the bearing housing to cool the bearings.

Figure 41: Drive End Bearing Housing

Figure 42: Crack in Bearing Housing

Repairs Made:

Bearing housing was welded closed and tested with 60 psi air to ensure it was water tight. It addition, it was cleaned up to remove all grease and surface rust.

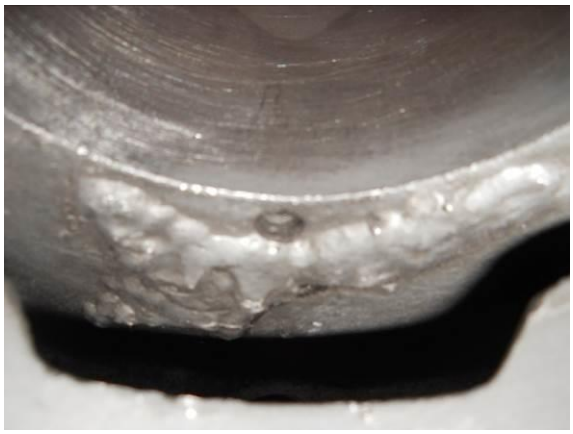

Figure 43: Bearing Housing Crack Fixed

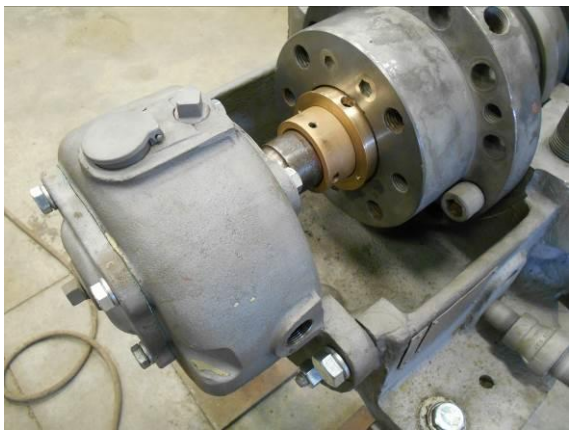

Figure 44: Thrust End Bearing Housing Cleaned and Installed

Bearings

Damage Found:

The bearings in the pump were worn and old. They were discarded and new bearings were purchased.

Figure 45: Original Drive End Bearing

Figure 46: Original Thrust End Bearing

Repairs Made:

New bearings were purchased for both the thrust end and drive end. For the thrust end, KOYO 7408DB Bearings were used and SKF 6213 Bearings were used for the drive end.

Other Information

For more information regarding this pump rebuild project, please refer to:

1. Pump Rebuild Data (showing measurements, clearances and details of the pump repair project)

2. Photos (as-received, during teardown, during assembly, during testing, and as-shipped)

3. Impeller Balance Report

4. Rotor Balance Report

5. Pump Test Report

6. Pump Curves