Repair is an Opportunity to Improve Pump Performance

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Often all that is needed to improve a pump's reliability and performance is to provide a high quality inspection and repair. Over time a pump may have been repaired by more than one service provider with varying levels of engineering and technical experience. Tolerances may have been opened up, fits and concentricities may have been lost and materials may have been changed, all of which contribute to reduced performance, loss of reliability and more frequent repairs.

This article highlights the opportunity seized by a coal-fired power station to upgrade a Westinghouse Vertical Pump during the repair process.

Background:

The Power Plant's Unit #4 "Alpha" Circulating Water Pump was scheduled for repair and in the process of removal, the sister pump #4 "Bravo", exhibited severe vibration and failed in a manner which was believed to have been a result of a broken shaft. The Alpha pump was put back into service and the Bravo pump removed and sent to the repair facility for inspection and emergency repair.

Observed Pump Condition:

The general condition of the Bravo pump when received at the repair facility was much worse than anticipated with the top column flange broken about half way around. The entire pump had been hanging from this broken joint leaving a gap of ¼" to ½" at the opening. The keyed coupling (internal to the pump) used to join its two shafts was broken in several pieces, the shaft journals were severely worn to one side and the impeller vanes & suction bell liner surface were also severely worn as expected, considering the significant pump damage.

Column pipe upper flange as-received

Close-up of the broken pipe

Close-up of the broken pipe flange

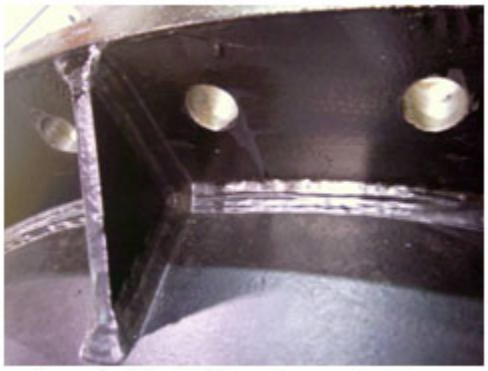
Destroyed shaft coupling and hardware

After disassembly of the pump, it was also observed that the shaft enclosing tubes had spun in their fits due to not being fitted with any anti-rotation mechanism. This rotation caused damage to the 'O'-ring fit areas at both ends of the enclosing tube assembly resulting in loss of proper flush water supply to the pump bearings below the packing box. Another issue observed during inspection was that part-to-part alignment of major pump components utilized dowel pins, which are very difficult, if not impossible, to verify.

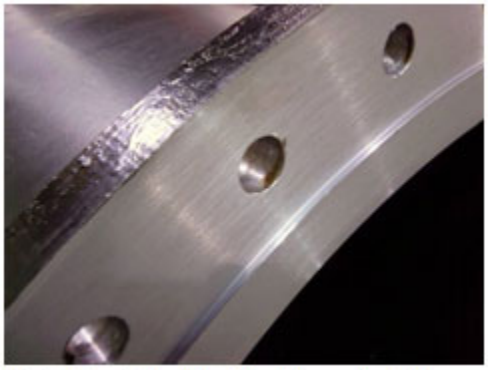
Opportunity for Improvement:

While the typical repair scope of bearing, wear ring and small part replacement was employed, several issues identified in the previous paragraph were corrected with improvement to the design as follows:

- The column pipe repair included replacing the entire upper flange, adding reinforcing gussets to the flanges on both ends, excavating defective flange & pipe seams and full-welding to restore integrity and improve overall strength.



Gusset added to the column pipe flanges



Typical register fits added throughout the pump

- Register fits were machined into each component as part of the repair process with minimum clearance to assure proper alignment.
- The impeller vanes were reestablished to the proper length and also to consistent vane lengths. This was done instead of merely de-burring the worn edges to restore pump performance and also to eliminate hydraulic imbalance. It required an extensive amount of welding to the sealing surface of the vanes and precision machining of the impeller and suction bell for proper fit; this tolerance has a significant effect on the pump efficiency. NDE of the impeller during inspection revealed minor cracks, which were also repaired.
- The repair plan required the replacement of both shafts, which presented another opportunity. The service center upgraded the shafts by manufacturing them in a stronger, more durable material for the pump's application. The service center also manufactured a new coupling assembly to include an upgraded coupling design in addition to new shaft coupling hardware. The upgrades to the shafts included maintaining full size shaft diameter through the coupling assembly (the existing shafts were turned-down) and machining proper radii into all corners and keyways. The shaft coupling upgraded design consisted of a larger coupling outside diameter, heavier thrust rings (instead of the existing thin-walled clam-shell type), improved bolting and two keys 180 deg. apart on opposite ends for balance & strength.

New shafts and shaft coupling components during and after assembly

- Enclosing tube 'O'-ring fit areas on both ends were restored and the enclosing tube assembly was fitted with an anti-rotation device.
- Pump fasteners were replaced with an upgraded and more durable material to resist corrosion and fatigue.

Lessons Learned:

While there are "typical" repair items such as bearing and wear ring replacement, shaft journal repair and impeller balancing, the unexpected issues can really cause the most frustration. Proper inspection will reveal other issues which may not be so obvious, and coordination with a qualified service provider can provide real opportunities for improvement of your pumps. Improvement of pump reliability, durability and performance provides greater Mean Time Between Repairs (MTBR), which is becoming the main focus of most pump users.

Make sure to work with a qualified pump service provider who can offer a thorough inspection, in-house engineering support and review, and an experienced work force dedicated to providing a quality product. Taking the time to review the current operating conditions in relation to the pump's original design specifications can lead to engineering recommendations for improving the pump's performance and extending its life.