47TH TURBOMACHINERY & 34TH PUMP SYMPOSIA
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IMPROVED RELIABILITY OF WASTE WATER PUMP

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Mar 16 – Present: Machinery Engineer (SHARQ: A SABIC AFFILIATE)
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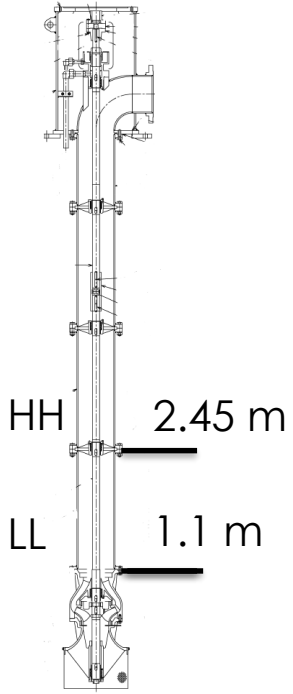
Introduction

- Nine vertical sump pumps are used to transport Industrial Waste Water (IWW) from the processing plant to outside of the manufacturing complex.
- One normally running while two on stand-by.
- The pumps are self-lubricated by the pumped media (API VS2, 6m Long, 75KW of Power).
- Material Class is API I-1

Existing Industrial waste water Pump

Operating conditions:

- Suction Press. : 1.03 kg/cm2A
- Head : 25 m
- Capacity : 500 m3/h
- Liquid : Waste Water
- Lubrication : Self. Lubricated
- Sump Depth : 6.42 m
- Pump length : 6.3 m
- Min. Submergence: 0.7 m



PROBLEM STATEMENT

- Frequent pumps failures(Once/Year).
- High Spare Parts Cost (130K USD/overhaul).
- High Labor Cost
- IWW Pumps consumed ~ 30% of budget in 2015

FAILURE HISTORY

- Three IWW Ponds are available, each having three pumps.
- A new overhauled pump cannot last more than a year since commissioning in 2006.
- Spare consumption is very high since spares are interchangeable.
- The three pump were never all healthy at the same time.
- Dewatering portable diesel pumps were used during failure of all pumps.

OVSERVATIONS: WASTE WATER POND SCREEN MESH & BLOCKED STRAINER

- The ponds receives foreign items both from upstream processes & atmosphere.
- This leads eventually to blockage of suction strainer.
- 3M pond cleaning and impeller cleaning was not sufficient to eliminate failures

WORN OUT SLEEVE BEARINGS

- The sleeve bearing are severely worn out with a completely wiped out silicon carbide coating.
- This leads to the bearing housing being twisted and separated from the outer ring.

CORRODED IMPELLER

- These are photos of three different impellers at different failures.
- Severe corrosion can be observed with significant thickness reduction.
- Sometimes the impeller is disintegrated into two pieces.

IDENTIFIED ROOT CAUSES

a. Strainer Blockage:

This blocks the pumped water leading to a lack of lubrication for the bearings, as well as impeller cavitation.

b. Material incompatibility:

After Lab Sample Analysis with consultation with Metallurgy specialists. It was concluded that severe corrosion was taken place due high dissolved oxygen content accompanied by high flow.

INVESTIGATION TEAM RECOMMENDATIONS

1. To upgrade the pump material to a minimum of API S-8 Material Class.

Pump Parts	Material Class		
	Existing	Proposed Option 1	Proposed option 2
	I-1	S-6	S-8
Casing	Cast Iron	Carbon Steel	Carbon Steel
Inner Casing Parts	Cast Iron	12% CR	316 AUS
Shaft	Carbon Steel	AISI 4140	316 AUS
Impeller	Cast Iron	12% CR	316 AUS

INVESTIGATION TEAM RECOMMENDATIONS

2. To re-design the pump suction strainer to 1.2m by 1.2m cage. This is introduced to minimize chances of blockage hence pump cavitation.

PUMP MATERIAL CLASS UPGRADE

- Budgetary offer was received for the upgrading the materials by OEM.
- The cost was significant (150K USD) for the upgrade.
- Although installation of the cage strainer & with material class upgrade would technically resolve the problem, the material upgrade is expensive (150K USD) & the spare parts cost are still high.

NEW PUMP DESIGN PROPOSAL

- An idea for a new pump design was proposed.
- The drive was to overcome the existing design deficiencies specifically:
  - Self-lubrication by dirty process.
  - Modification cost + spare parts cost.
  - Prolonged down time and man-hours for MTC.

NEW PUMP DESIGN SELECTION

- Many options by a variety of OEMs were explored.
- The majority offered similar construction design and did not offer any superiority in design nor cost.
- A company specialised in the mining industry was approached and were able to offer a 500 m3/h 6m suction lift self-priming pump.

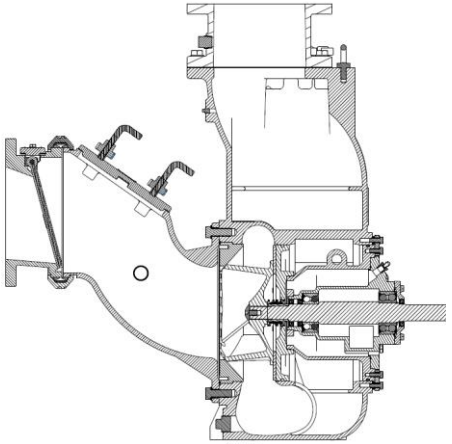
Selected Self-Priming Pump

Operating conditions:

- Suction Press. : 0.00 kg/cm2A
- Head : 28 m
- Capacity : 500 m3/h
- Liquid : Waste Water
- Lubrication : Oil

Material of Construction

- Casing : Ductile Iron
- Impeller : Hi Chrome 27%
- Wear plate : Hi Chrome 27%
- Shaft :17-PH SST



Selected Self-Priming Pump

Advantages:

- Easy maintenance (smaller and easily maintainable at site).
- Upgraded material suitable for the process
- Project capital cost less than cost of material upgrade of the existing pump

SPARE PARTS COST COMPARISON

EXISTING PUMP			NEW PUMP		
Description	**QTY**	**Cost**	**Description**	**QTY**	**Cost**
Impeller	1	$ 18K	Impeller	1	$ 3K
Upper Shaft	1	$ 5.3K	Shaft	1	$ 4K
Lower Shaft	1	$ 5K	Mechanical Seal	1	$ 0.7K
Sleeve Bearings	5	$ 80K	Anti-fric. Bearing	1	$ 2K
Shaft Sleeve	5	$ 30K	Rear Wear Plate	1	$ 2.3K
Bearing Holder	3	$ 3K			
Suction Bowl	1	$ 17K			
Wear Ring	2	$ 2K			

NEW DESIGN VS EXISTING DESIGN

- Project Capital Cost including piping …etc (40K USD) VS Existing Pump Cost (150K USD for only the pump)
- Cheap Spare Cost (12K USD) VS Existing Pumps Spares (130K USD)
- Easy to maintain in-site (20 hrs) vs Has to be lifted by crane and shifted to workshop consuming huge man-hours (100 hrs)
- Material is compatible to the pumped media (Hi-Chrome) VS Incompatible materials to the pumped media (Cast Iron).
- Ability to pump sludge and up to 7.5cm particles VS Sensitive to solid foreign particles.

APPROVED DESIGN

- Two pumps were commissioned in Jan 2017
- The two pump are running healthy
- Purchase order has been granted to upgrade the remaining pumps.

PIPING & CAGE FABRICATION

NEW PUMP SUCTION LINE

NEW PUMP INSTALLATION

Conclusion

The old pump design was found to be inadequate to for the unit function.

The new pump was tried for over a year successfully with **zero** breakdowns/corrective maintenance.

Maintenance cost average reduction per year from 300K USD/Year to simple negligible cost of lubrication

Other troublesome vertical sump pumps are being upgraded with a similar self-priming (15 total)

Lessons learned

- Avoid settling for half solutions
- Try to pursuit solutions in different dimensions (i.e. Mining industry in this case)
- Always keep in mind cost of spare parts cost and maintainability during design selection
- Self-priming pumps are far less expensive, reliable and maintainable than Vertical sump pumps.