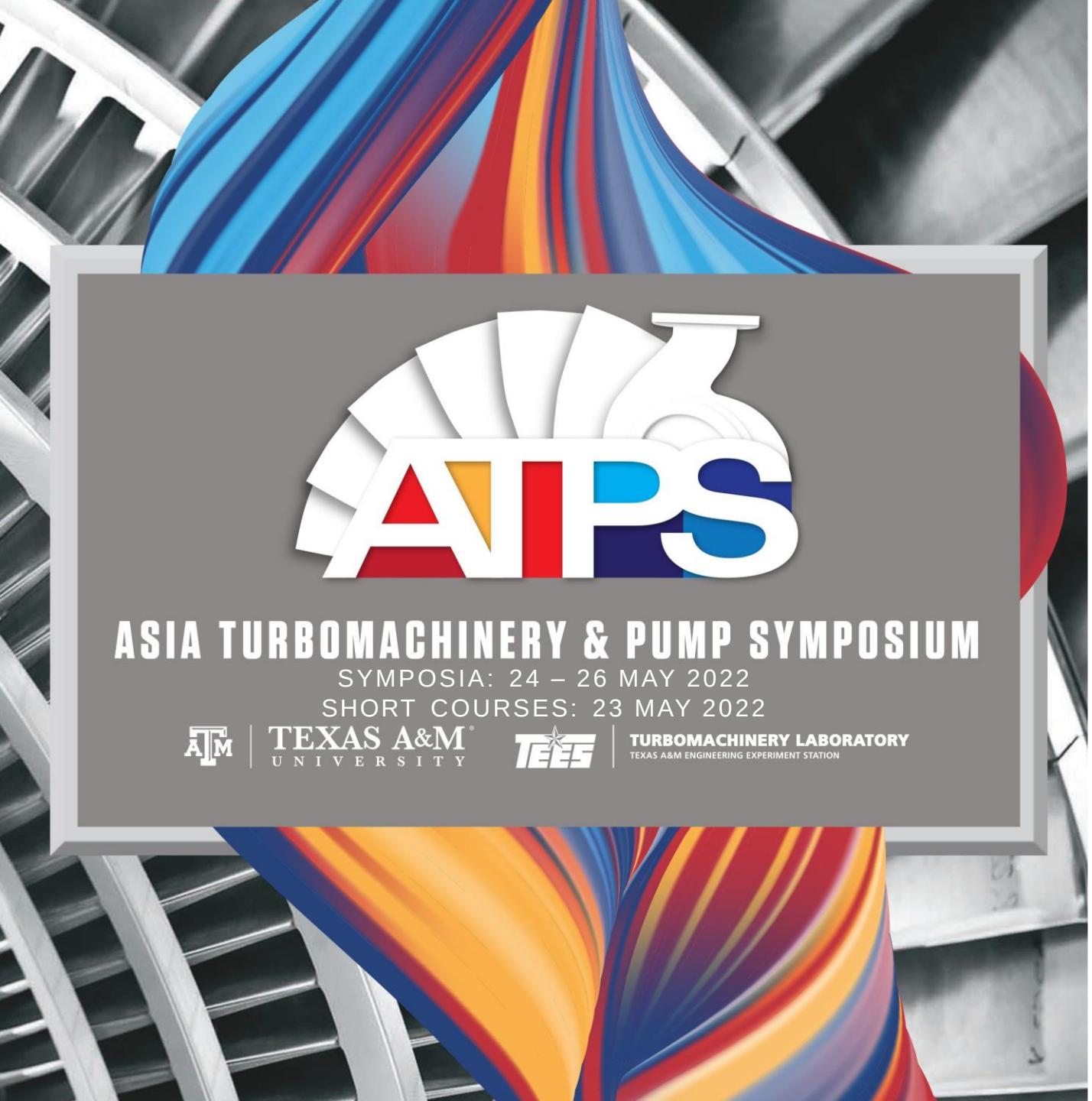


Offline Chemical Wash for Internal Fouled Multistage Pump

Tinagaran – ExxonMobil
Ng Wei Sing– ExxonMobil

ExxonMobil

Author

Tinagaran Puvanasan Machinery Engineer	Tinagaran is a Machinery Engineer in ExxonMobil Singapore and has 5 years of rotating equipment experience in refining and petrochemical industry. Tinagaran holds a Bachelors degree in Mechanical Engineering from Nanyang Technological University, Singapore.	
Ng Wei Sing Lead Machinery Engineer	Ng Wei Sing is a Lead Machinery Engineer in ExxonMobil Singapore and has 9 years of rotating equipment experience in refining and petrochemical industry. Ng Wei Sing has a Postgraduate Doctoral degree in Mechanical Engineering from University of Leeds	

Abstract

High pressure lean amine pump performance dropped within a span of about 1 month due to internal fouling. Fouling was caused by accumulation of iron sulphide. To address the fouling, pump would have been to taken out of service for a full overhaul, resulting in extended downtime and high cost of repair.

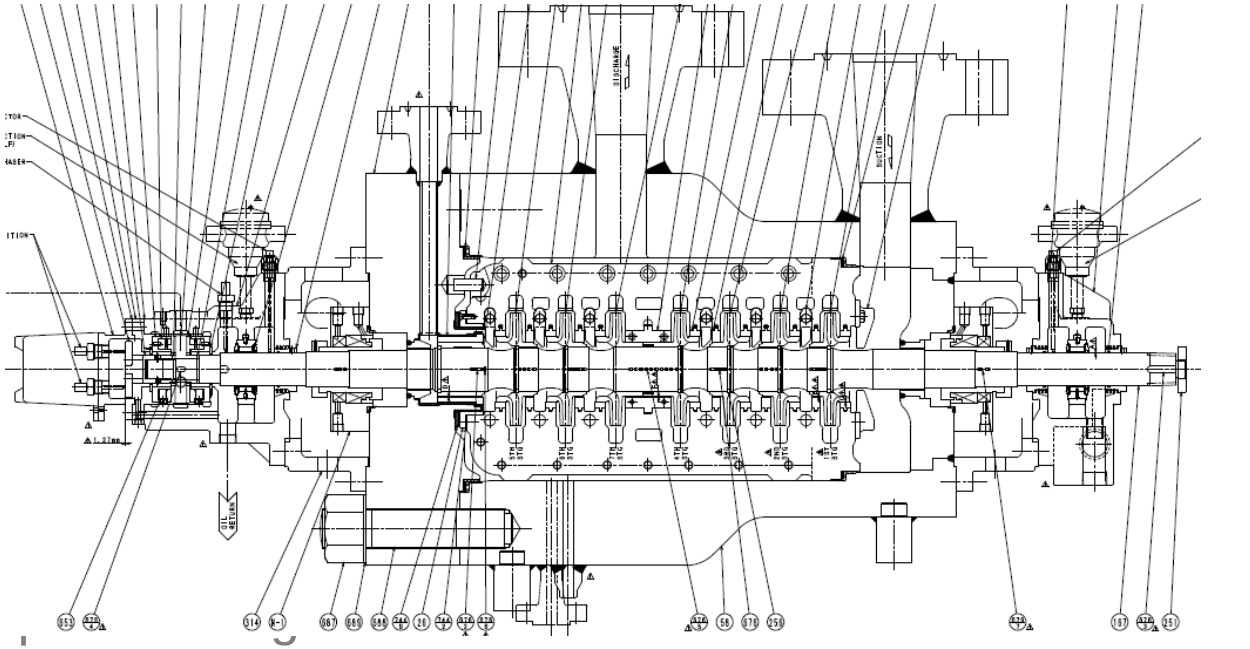
Offline chemical wash with 1% EDTA (Ethylenediaminetetraacetic) solution pursued as an alternative to the pump overhaul. Prior to commencing with the chemical wash, material compatibility of pumps/mechanical seals wetted parts, and process fluid flow path were considered as part of the technical evaluation.

The chemical wash skid comprised of an external circulation tank and air operated diaphragm pump. Skid was connected to the pump via flexible hoses. During chemical wash, samples were regularly collected at the circulation outlet to check for appearance in order to determine progress of the chemical wash in removing the foulants.

Pump performance recovered upon completion of the chemical wash.

Background

Type: Seven stage centrifugal pump
Service: Lean amine
Rated flow: 110.5 m3/hr
Differential Pressure: 19,311 kPag
Pumping Temperature: 52°C



Motor power: 900 kW
Shaft speed: 6,559 rpm

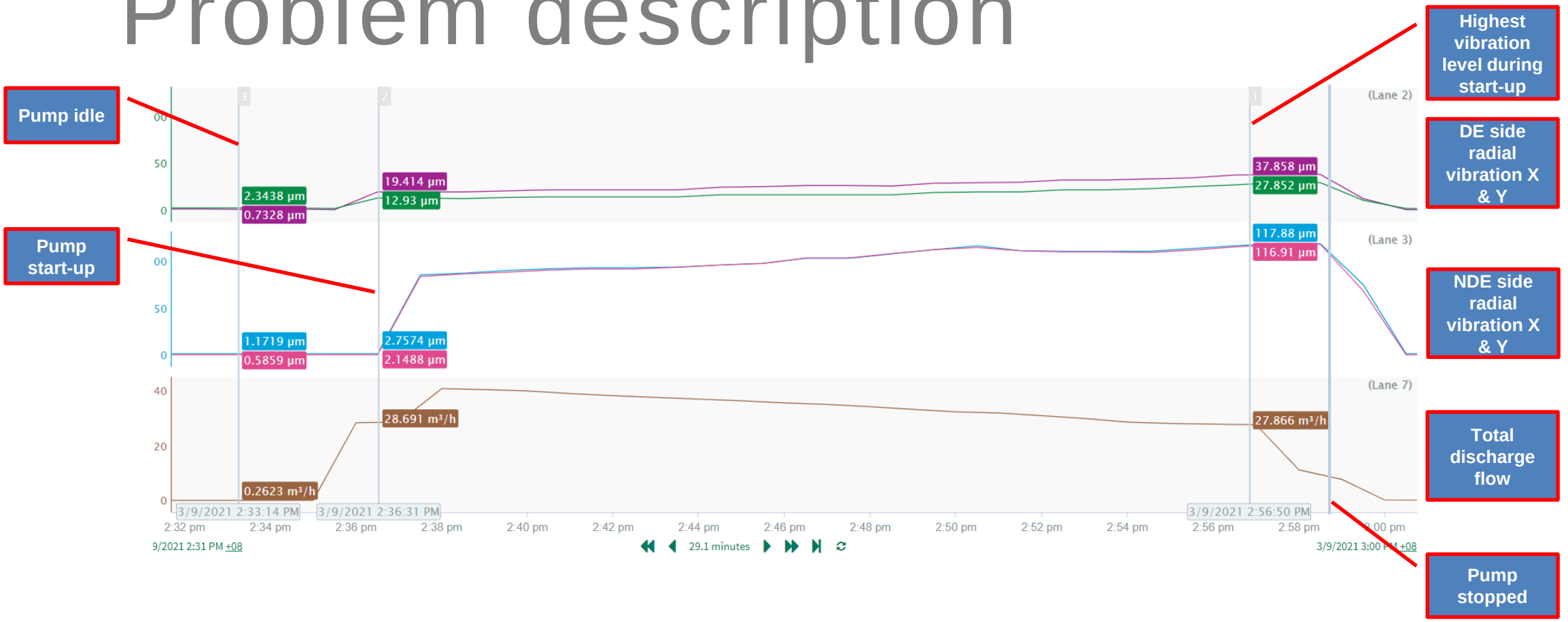
DE/NDE radial bearing: 6 pads tilting ,
Thrust bearing: 12 pads tilting pad bearing

Mechanical seal: Single seal with API seal flush plan 11

Problem description

1. High pressure lean amine pump failed to deliver during start-up (ie. During switchover from in-operation B pump to standby A pump)
2. Even with the discharge valves fully open, pump flowrate and discharge pressure dropped below pump performance curve. Discharge pressure was 23,200 kPag vs 21,500 kPag and flowrate dropped to below MCSF of 35 m3/hr.
3. Bearings radial vibration also increased and pump overheated.
4. Pump switch-over aborted to prevent any further damage to the equipment.

Problem description

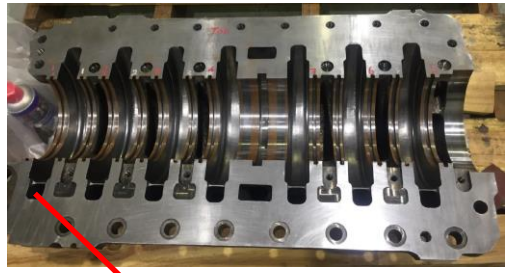


Analysis

1. As part of the troubleshooting, pump suction strainer was checked and it was <5% plugged.
2. Pump was deemed not able to deliver because pump flow path was partially blocked. The following potential blocked paths were evaluated/checked:
    a) Dropped suction valve gate. – **Low probability.** Suction pressure remained stable
    b) Dropped discharge valve gate. – **Low probability.** Discharge pressure was supposed to be higher for a blocked discharge scenario. However, discharge pressure was lower than pump performance curve
    c) Jammed shut discharge check valve – **Low probability.** Same basis as dropped discharge valve gate.
    d) Foreign material choking suction impeller eye/pump internal flow passage (internal fouling) – **High probability.** Discharge pressure was lower compared to pump performance curve.

Analysis

1. Presence of foreign material was also causing failures in upstream pumps and circuit.
2. Foulants from the lean amine circuit were collected and analyzed by Process Engineers. Based on lab test results, foulants are deemed as iron sulphide sludge.
3. As such, pump's failure to deliver was concluded as due to accumulation of iron sulphide sludge in the internal flow passage, partially blocking the flow.
4. Accumulation of iron sulphide sludge occurred when pump was on standby (~ 1month) whilst packed with lean amine fluid.
5. Partially blocked internal flow passage cause the total flow through the pump to drop below the pump MCSF (minimum continuous stable flow).
6. With total flow below MCSF, radial vibration increases.



Pump internal volute flow passage partially blocked by iron sulphide sludge

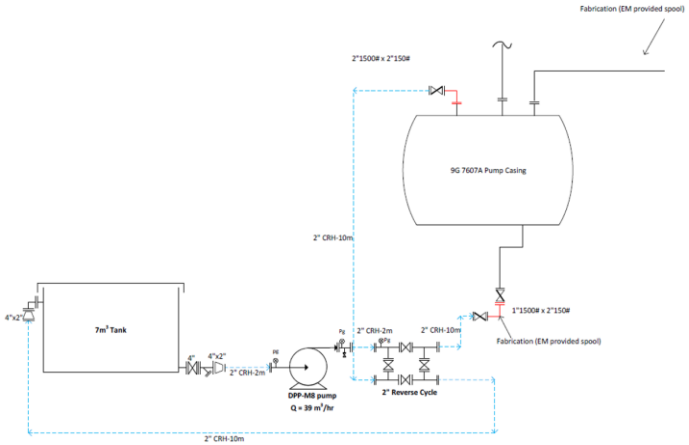
Iron sulphide sludge observed on upstream cartridge filters

Mitigation

1. Process Engineers were consulted for ideas on using chemical medium to dissolve the iron sulphide sludge.
2. 1% EDTA (Ethylenediaminetetraacetic) solution was proposed for the offline chemical wash. Previously, similar chemical was used to dissolve iron sulphide/hydrocarbon foulants in pump suction strainer of sour water service bottom pumps.
3. Prior to the chemical wash, material compatibility of pump and mechanical seal wetted parts were evaluated. Following parameters were part of the evaluation:
    1. flowrate
    2. pressure
    3. pH of the chemicals
4. For an effective chemical wash, process fluid flow path from suction to discharge nozzle was also considered for the tie-in of the chemical wash skid.

Mitigation

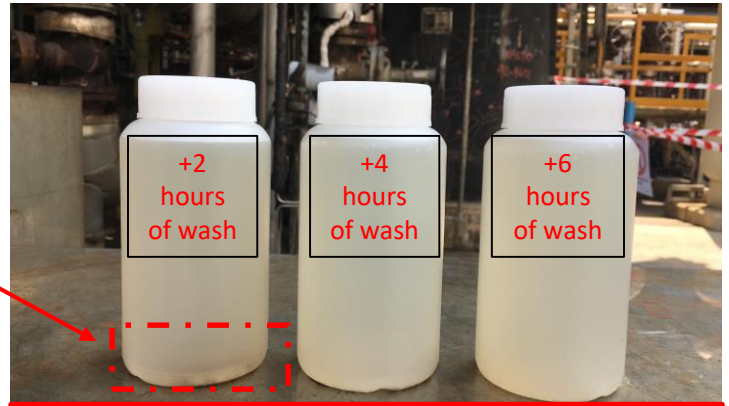
1. Chemical wash skid consists of external circulation tank and air operated diaphragm pump.
2. Skid was connected to the pump via flexible hose connected to the suction strainer flange and pump casing drain.
3. Chemical flow from the suction nozzle, through the 1st to 7th stage impellers before flowing out of the pump casing drain.
4. The dissolved foulants were then collected in the circulation tank.
5. Pump shaft was manually rotated every hour to ensure the foulants around internal rotating parts are evenly removed.
6. Samples were then collected at the circulation outlet 2 hourly and checked for appearance to assess remaining foulants in pump.



Result

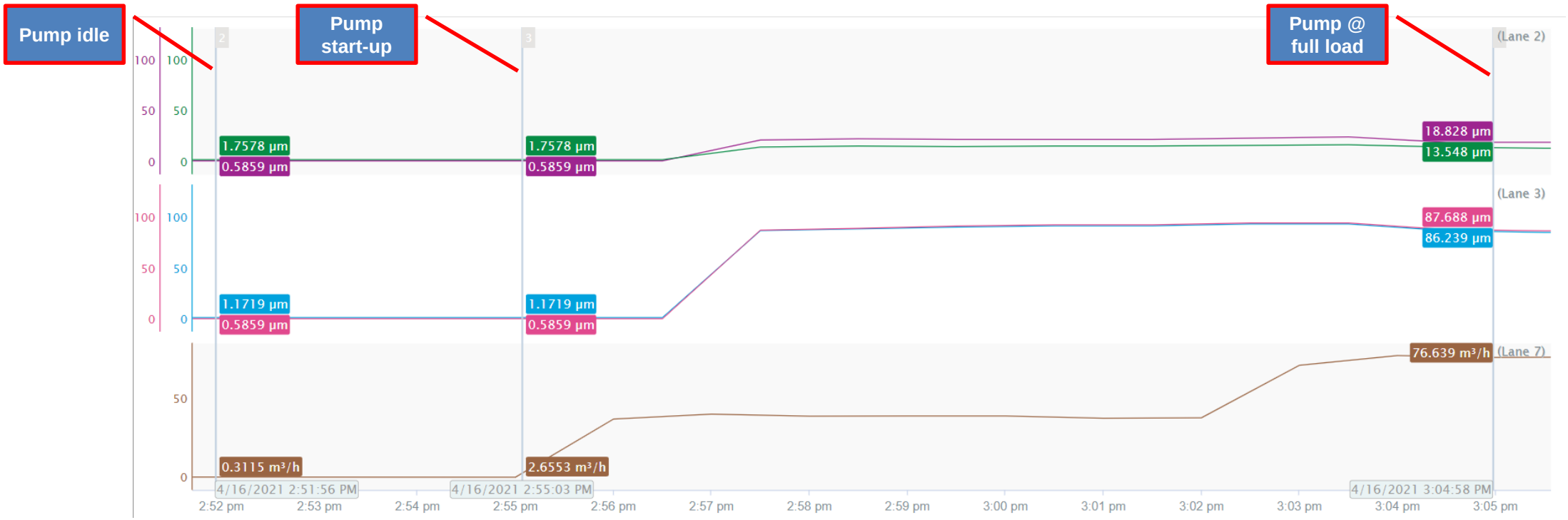
1. Appearance of samples collected at the circulation outlet improved through out the chemical wash. Lesser sediments were also observed in the liquids. Liquid clarity improved.
2. Pump performance recovered upon completion of the chemical wash. Pump discharge pressure and flowrate was as per performance curve.
3. High vibration or pump overheating was not observed during the pump start-up.

1st sample collected with the sediments



Samples collected at the circulation outlet

Result



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Key learnings

1. Lean amine is a relatively clean liquid. However, foreign materials such as iron suplhide could be formed gradually over many years due to foaming within lean amine circuit when unit upset.
2. Chemical wash with 1% EDTA solution has proven to be successful in columns. The learnings from these applications were then applied to pumps in lean amine service.
3. The offline chemical wash has been successful in washing away iron sulphide accumulation within the pump, avoiding high cost overhaul and long downtime.
4. To enhance the effectiveness of the chemical wash, it is paramount to have a good understanding of the process fluid flow path within the pump. This helps to maximize the exposure of the internals to the chemical.