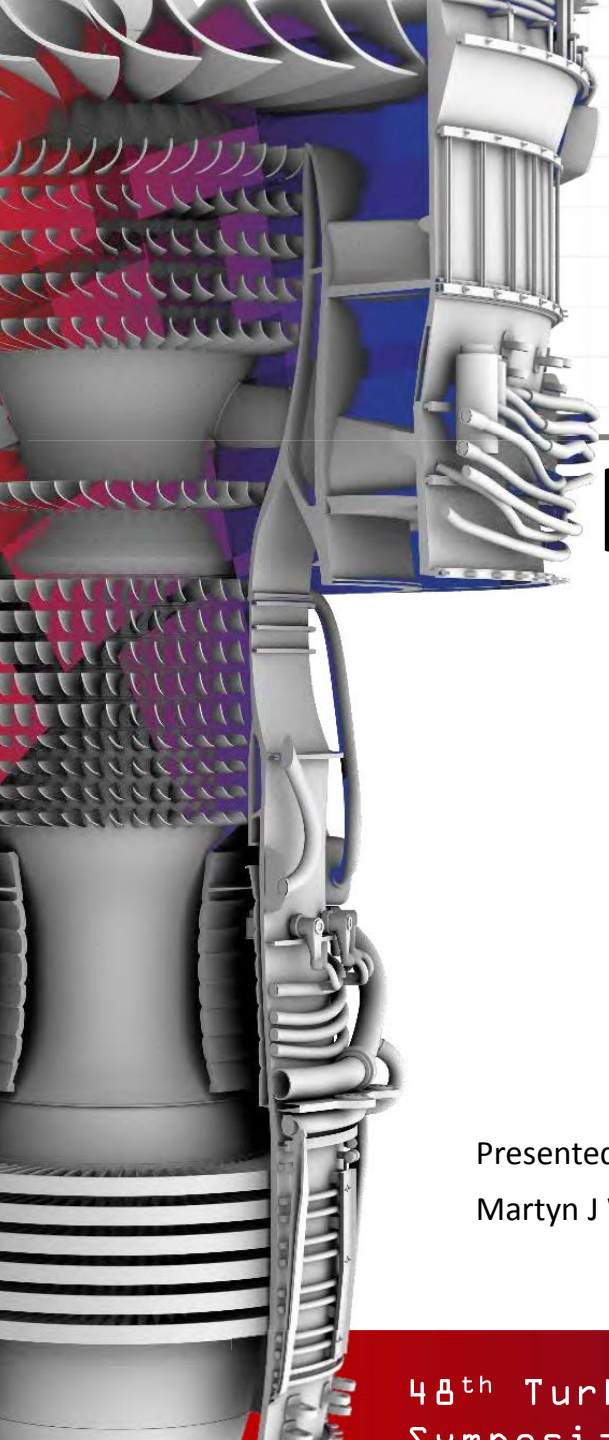


TURBOMACHINERY & PUMP SYMPOSIA

Hydrogen recycle gas compressor fouling mitigation using higher suction temperature.

Presented by

Martyn J Williams AMiEAust C Eng A NER (Snr Machinery Engineer @ BP Refinery Kwinana Western Australia)

Biography: Marty Williams AMiEAust , C Eng A

- 1976 – 1981 Started out as Apprentice Mechanical Fitter 1st class Machinist at Shell UK oil at Stanlow refinery in the UK.
- 1981 – 1985 Mechanical fitter (Machinery) at the Stanlow facility
- 1985 – 1990 Machinery Supervisory role at the Stanlow facility
- 1990 – 2000 Machinery Supervisor / Reliability Engineer at BP Refinery in Kwinana Western Australia.
- 2000 – 2013 Machinery Engineer at BP Refinery
- 2013 to present Snr Machinery Engineer at BP Refinery Kwinana.
- 2014 Attained Chartered Engineer status.

The compressor

- Manufactured in 2004 and commissioned on a Hydrotreater in 2005.
- 7 stage centrifugal barrel compressor. (rotor speed 15,000 rpm)
- Driven by a 1.8 Mw electric motor. (1500 rpm)
- Gas seals with intermediate labyrinth.
- No proprietary surge control system is installed.
- On going issues with chloride contamination since commissioning.
- Since being installed the compressor has been stripped to clean 6 times also 3 gas seal failures due to chloride contamination
- March 2017 - February 2019 longest continuous run since being commissioned in 2005. Two hot strips carried out. Gas seal contamination issue still present, however not as bad.

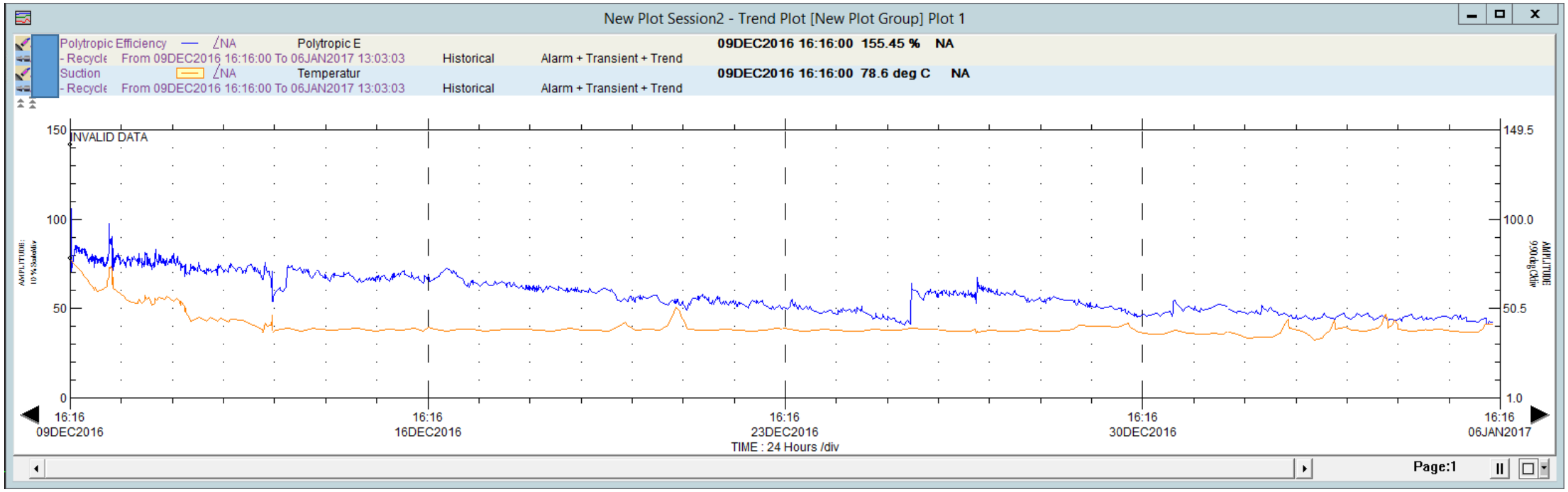
The compressor set-up and lead up to the problem

- When the compressor gas composition was specified to the various prospective vendors chloride contamination was not identified as a potential gas contaminant of any concern.
- Compressor had a full string test prior to delivery, performance right on theoretical curve. Installed and commissioned without any issues.
- Due to the very small drop off in efficiency over a long period of time (12 to 18 months) the chlorides problem was not identified until the seal gas supply flow from the compressor casing port started to drop off for no real apparent reason. Low seal gas flow was the first symptom of a problem.
- No proprietary compressor surge controller installed and the compressor performance was initially not monitored, there was seen to be no need.

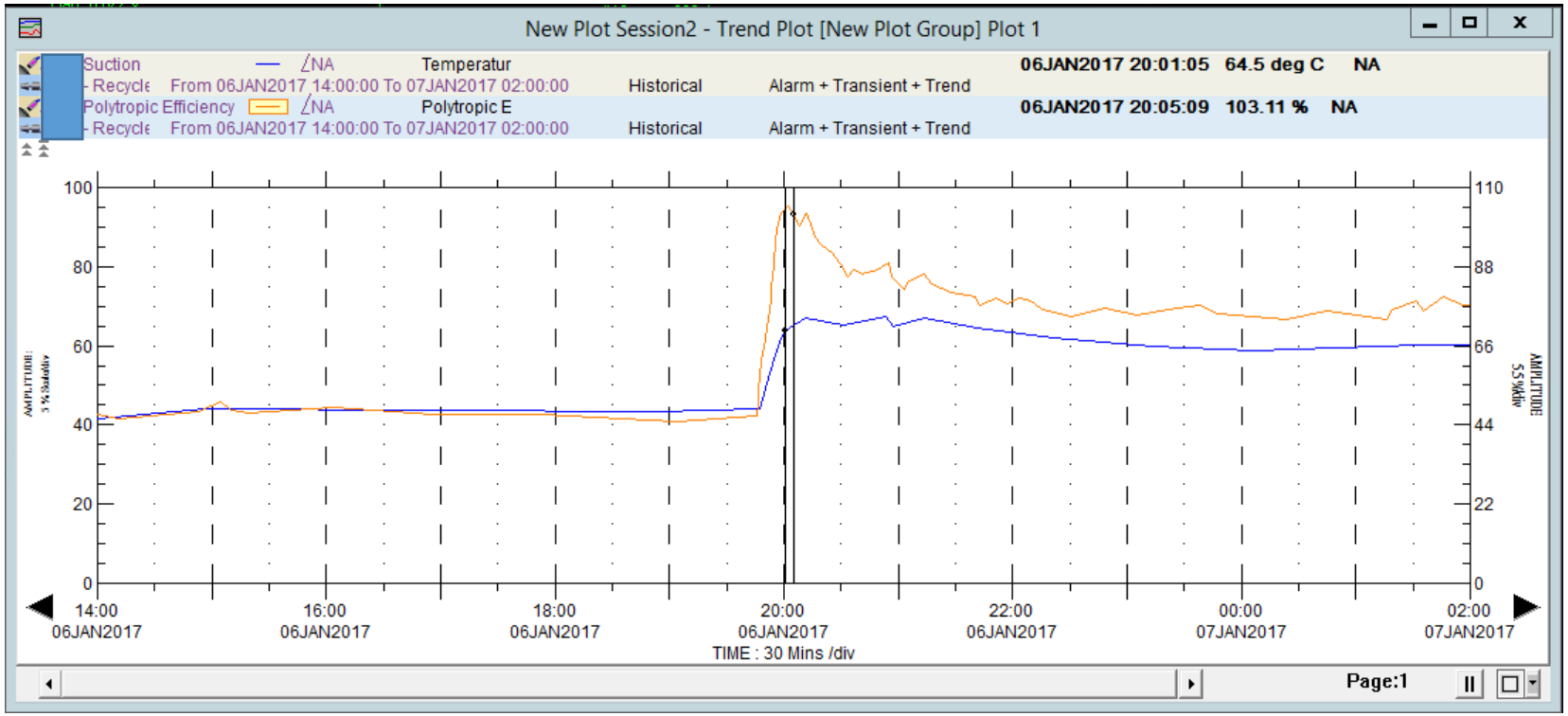
Chloride contamination, the problem……

Casing diffusers and rotor heavily contaminated with chlorides reducing compressor efficiency. Typically took between 9 to 12 months to go from clean to as shown.

Compressor efficiency from Dec 16 to Jan 17

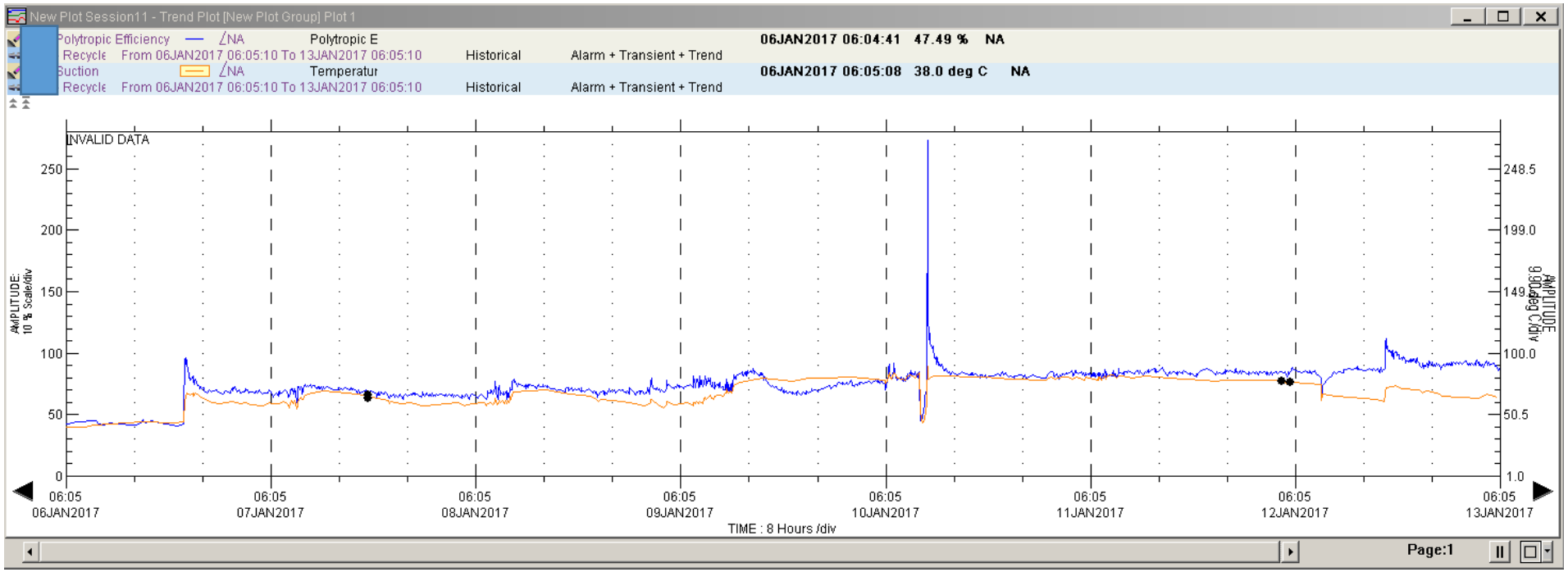


Hot strip of the compressor initial impact



- The initial impact of the suction temp increase can be seen on the trend. Together with this vibes levels were a bit “ordinary” during the transition from 40 degrees to 68 degrees over a 30 minute period.

Hot strip of the compressor on line.



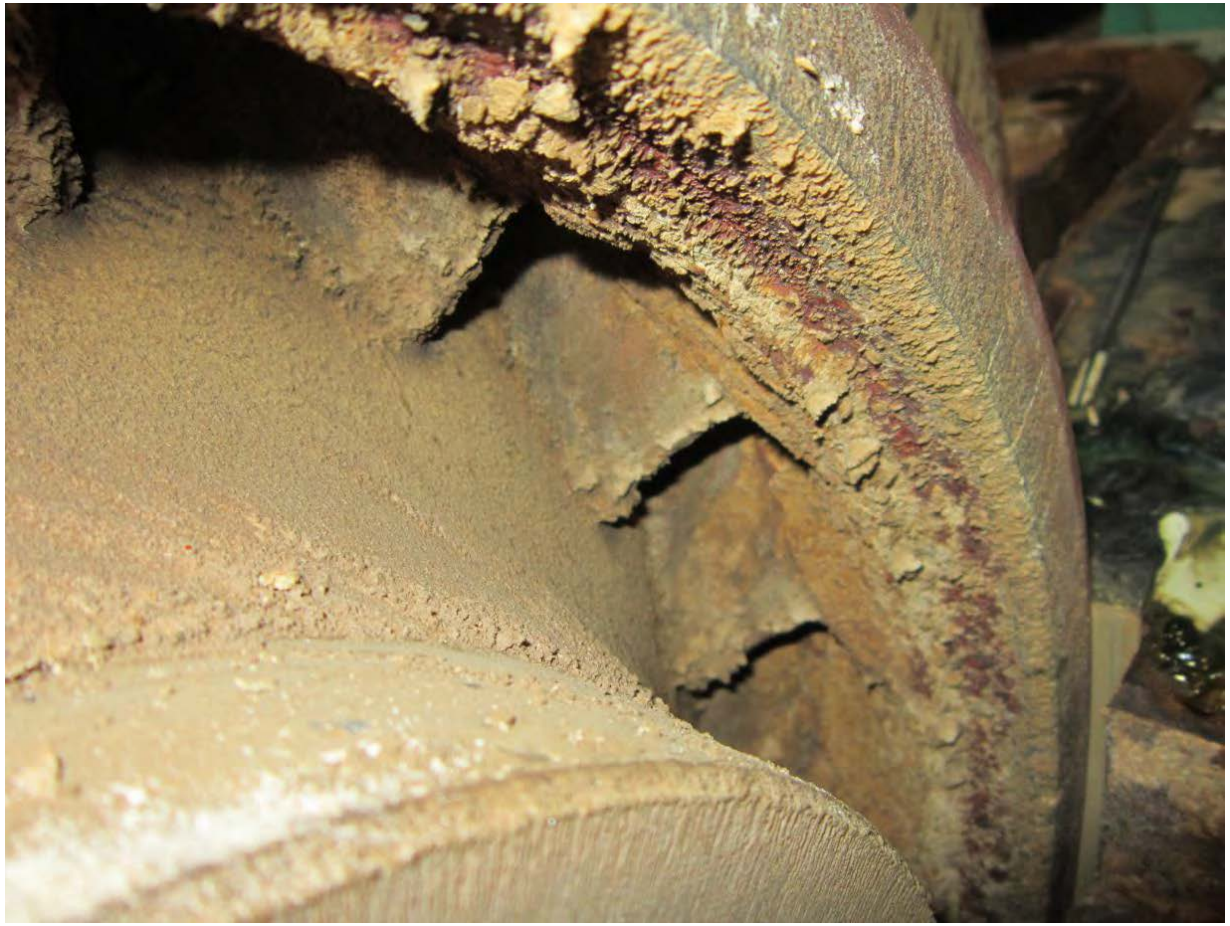
- Above can be seen the long term effect of the raised suction temp and polytrophic efficiency.

Other areas of concern.

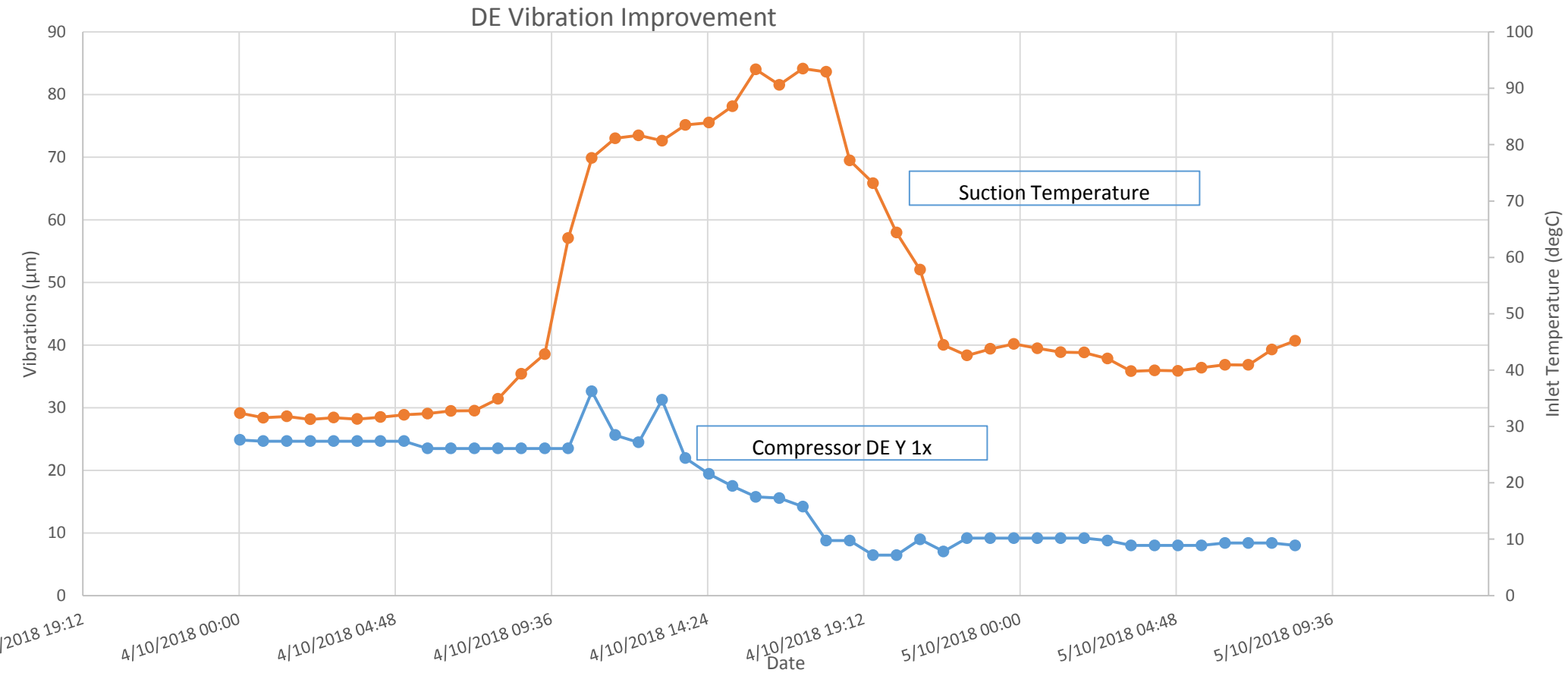
Chloride build up on the seal gas orifice plate

Seal gas filter housing, the clean side

Another example of significant chloride contamination on a centrifugal compressor



Compressor performance during the “hot strip” over 24 hours



The solution(s)……

- The first solution opted for was to shut the compressor down in a controlled manner and carry out a rotor and diffuser clean based on compressor efficiency, expected to be done roughly every 9 to 12 months depending on process conditions. This was the initial approach. ***Less than ideal*** *stripping complex machinery on an annual basis.*
- Install a coalescer to remove entrained water within the process stream. A large project. *Installed in 2017 TAR, helped but* ***not the solution***
- Change the wash water injection position to minimise entrained water in the gas stream going to the compressor. *Again helped however* ***not the solution****.*
- ***Running higher suction inlet temps to sublimate the chloride solids back into the gas stream. Has proven very successful now at two BP sites, however this comes with process related concerns @ BPRK, gas seal overall reliability an ongoing issue.***

Where we are now……?

- Prior to carrying out the “hot strip” process were stopping the compressor after running between ***9*** to ***12*** months to clean out the chloride deposits. We are now presently at ***24 months*** since the last time the compressor was turned off due to poor efficiency.
- Looking to extend the compressor major overhaul to at least ***4 years***, looking to push that out to ***8 years*** to align with other turbo machinery overhauls.
- Gas seal life will continue to be an issue until the cleanliness of the seal gas is improved. ***24 months*** is achievable to align with catalyst changes, goal is to have gas seal life aligned to compressor major overhauls.
- Compressor efficiency is now monitored very closely optimising suction temperature to ensure “hot strips” are carried out at the appropriate time.

Other wins……

- The “hot strip” process has now been used successfully at another BP facility, prevented an immanent shutting down of the compressor due to loss of efficiency and high vibration levels. Proves the Kwinana experience was not just a fluke……
- Has saved significant maintenance expenditure by not having to do annual compressor overhauls/ cleans.
- Process unit production is not interrupted due to poor compressor efficiency costing lost production opportunity.

Questions……

The only silly question is the one you don’t ask….!!