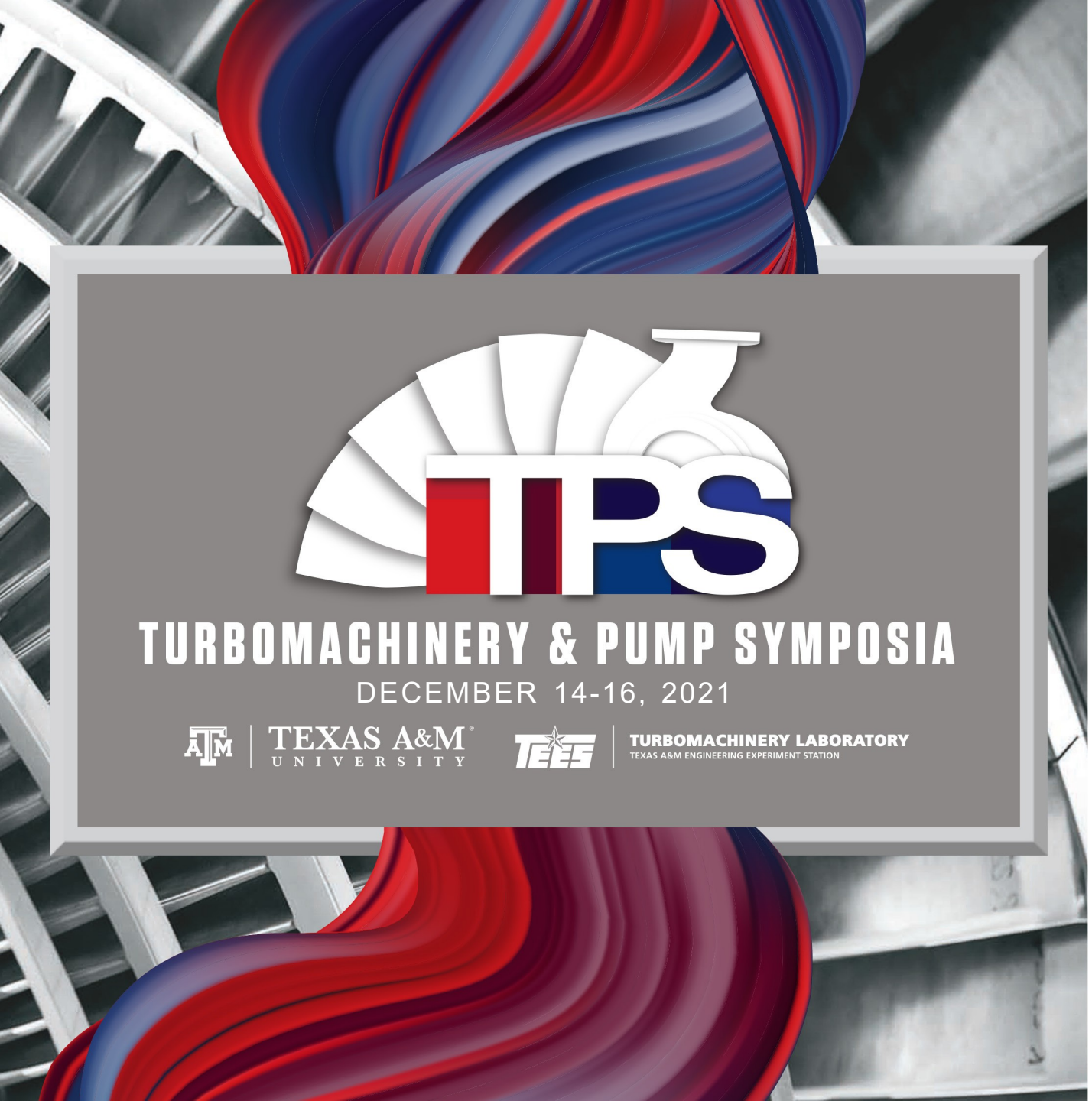

Pump Success Stories

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Author Bios

Syed Hussain received his MSc. degree in Mechanical Engineering from the University of Greenwich in 2011, his Bachelors from the University of Engineering & Technology in Lahore, Pakistan in 2007. For over 12 years he has worked in the field of Condition Monitoring, initially focused on portable vibration analysis, thermography and balancing to resolve machinery faults with REB for SKF and DNV GL. In 2017 he expanded his horizon into online condition monitoring & machinery diagnostics with Bently Nevada as a Machinery Diagnostics Services Engineer serving the UK Energy sector.

Martin Strachan received his Master's degree in Mechanical Engineering in 2014, from the Robert Gordon University in Aberdeen, UK. Although initially covering the subsea and metallurgical fields of the Oil & Gas industry, he stepped into rotating equipment with Bently Nevada in 2016. Here he held the position of Machinery Diagnostic Services Engineer, delivering remote and on-site diagnostic support directly for operators through their Bently Nevada Supporting Service Agreements (SSA). He also spent some time as a Project Engineer for Industrial Gas Turbines with Ethos Energy Group before returning to Bently Nevada in 2019 as SSA Site Lead.

Peter Popaleny received his MSc. degree in Electrical Engineering in 1997, and his Ph.D. degree in Mechanical Engineering in 2013, both from Slovak University of Technology in Bratislava. He has been working for Bently Nevada part of Baker Hughes since 1999 and holt different positions as System Engineer, Senior Machinery Diagnostics Engineer and currently Technical Leader West Europe, Machinery Diagnostics Services. His current research activity is focused on applied diagnostics using Vibration Analyses and Motor Current Signature Analyses. He is author of several papers in this area, published and presented at the international conferences.

Short Text Abstract

The case study two Pump fault scenarios which may help diagnostic engineers understanding real life vibration signatures from lubrication starved Pump bearings. Specifically, comparison between recoverable and unrecoverable lubricant starvation conditions.

TURBOMACHINERY & PUMP SYMPOSIA

Introduction – Pump bearing lubrication breakdown

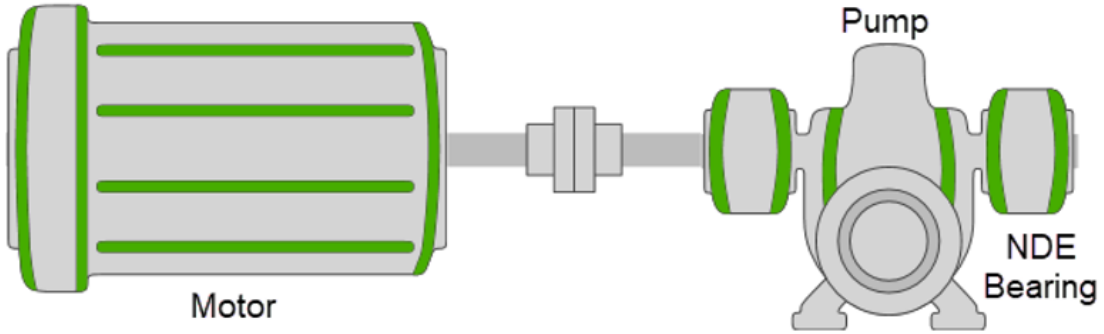

Figure A1: Case 1 Pump Train Diagram.

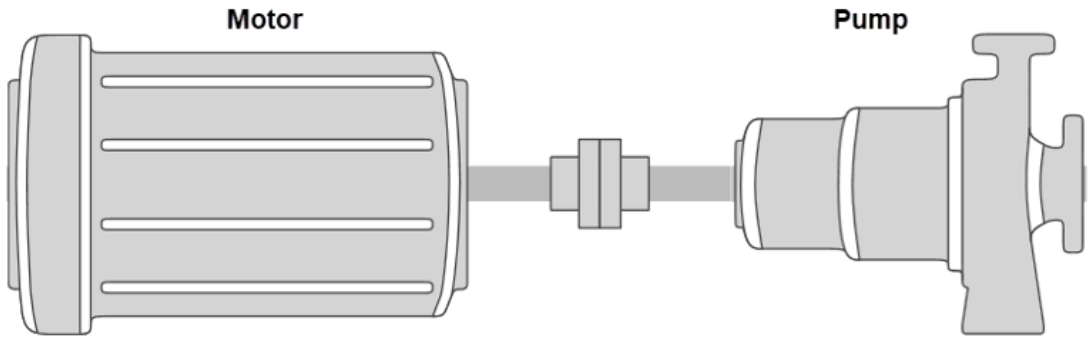

Figure A2: Case 2 Pump Train Diagram.

- It is believed that Roller Element Bearing (further referred as REB) where fitted, plays key role in machinery health monitoring by providing a solid path in transferring the shaft vibrations to the casing.
- This reduces the loss of energy from the shaft to the casing and makes data collection relatively more efficient.
- Two Pumps compared in this case study contain REB, where grease is used as lubricant.
- lubricant is used to reduce friction among the components of the bearing, so any change in friction should also show change in

Problem Statement – Case 1

LUBRICATION ISSUE – RECOVERABLE BEARING HEALTH

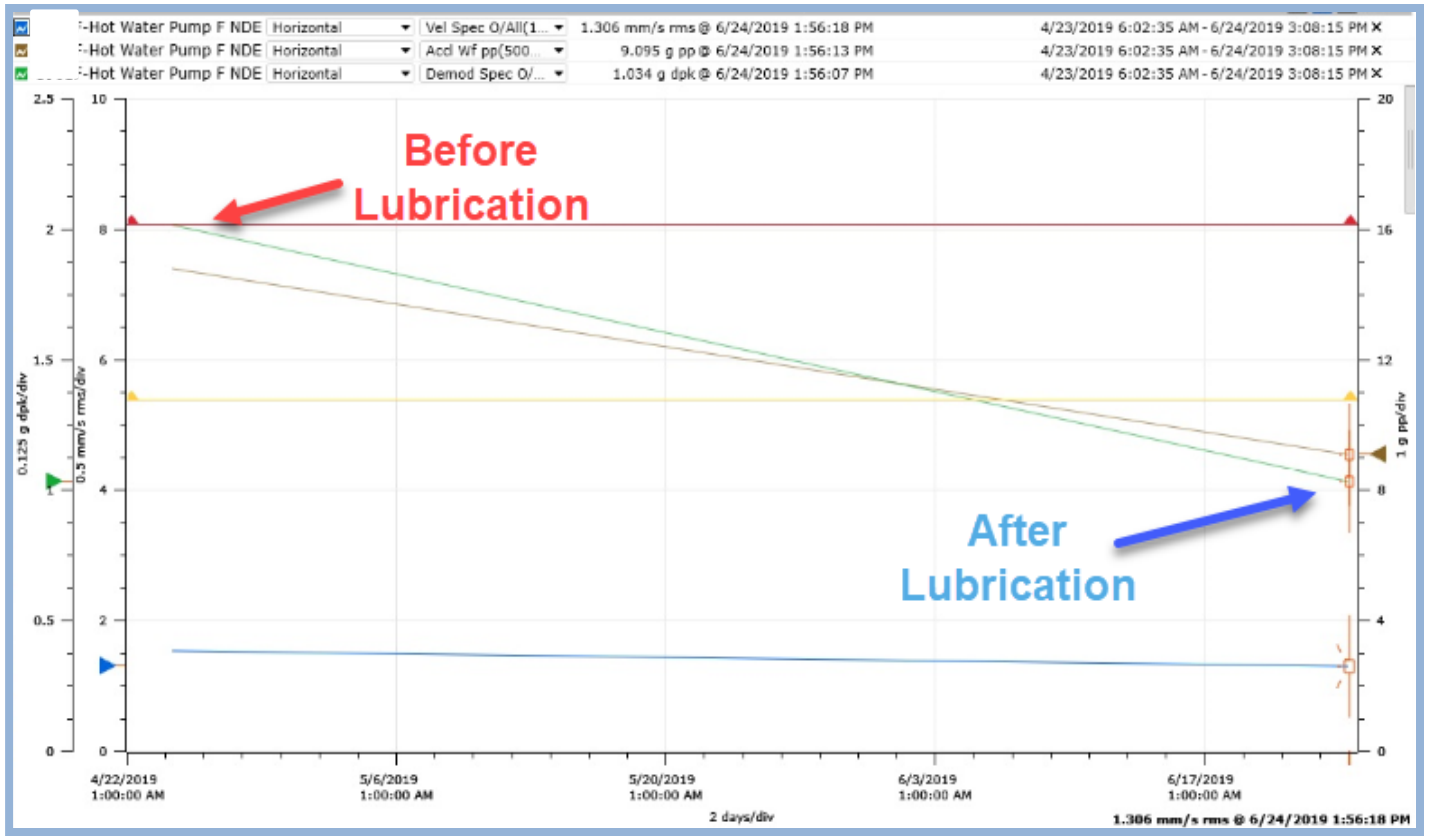

Figure 1: Showing elevated overall acceleration and Demod levels Vs satisfactory levels.

TURBOMACHINERY & PUMP SYMPOSIA

Analysis– Case 1

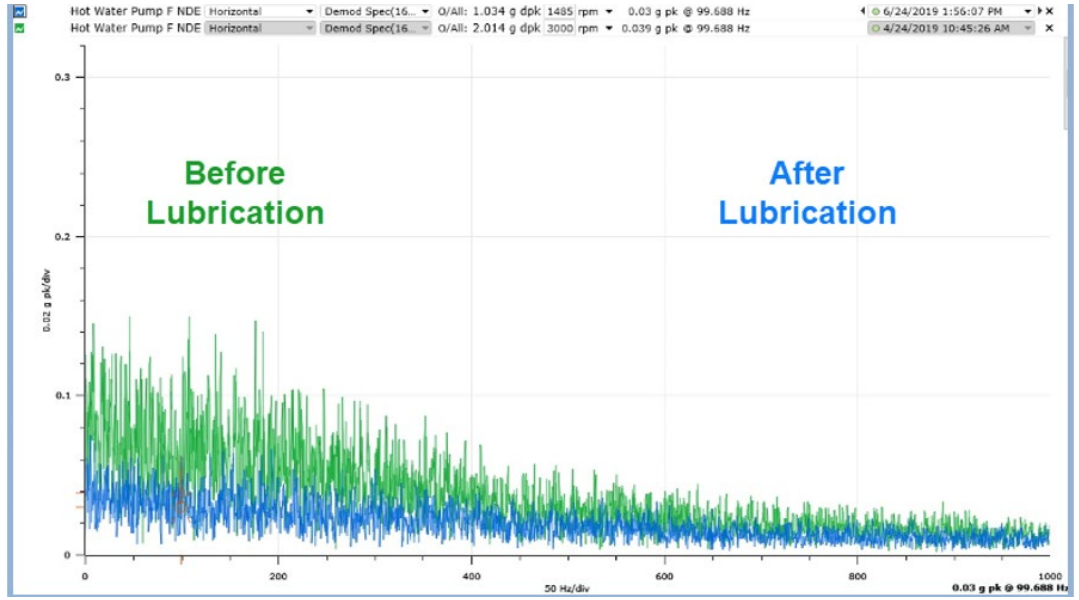

Figure 2

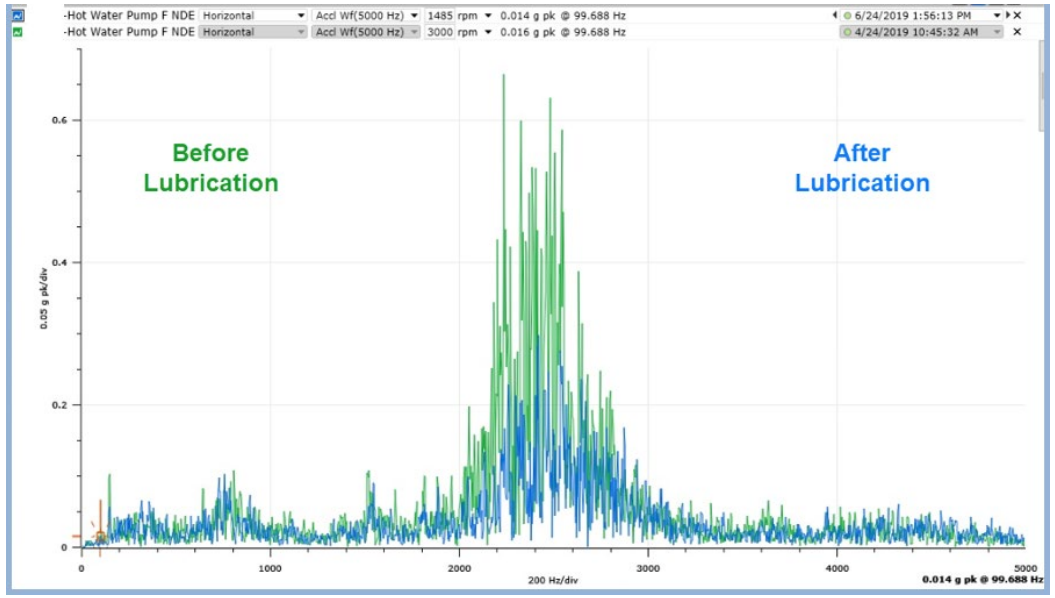

Figure 3

- Figure 2 shows the demod spectrum suffering through poor lubrication compared to state after getting sufficient lubrication.
- Figure 3 shows the difference in elevation of frequency haystack in acceleration spectrum with and without sufficient lubrication.

Problem Statement – Case 2

LUBRICATION ISSUE – NON-RECOVERABLE BEARING HEALTH

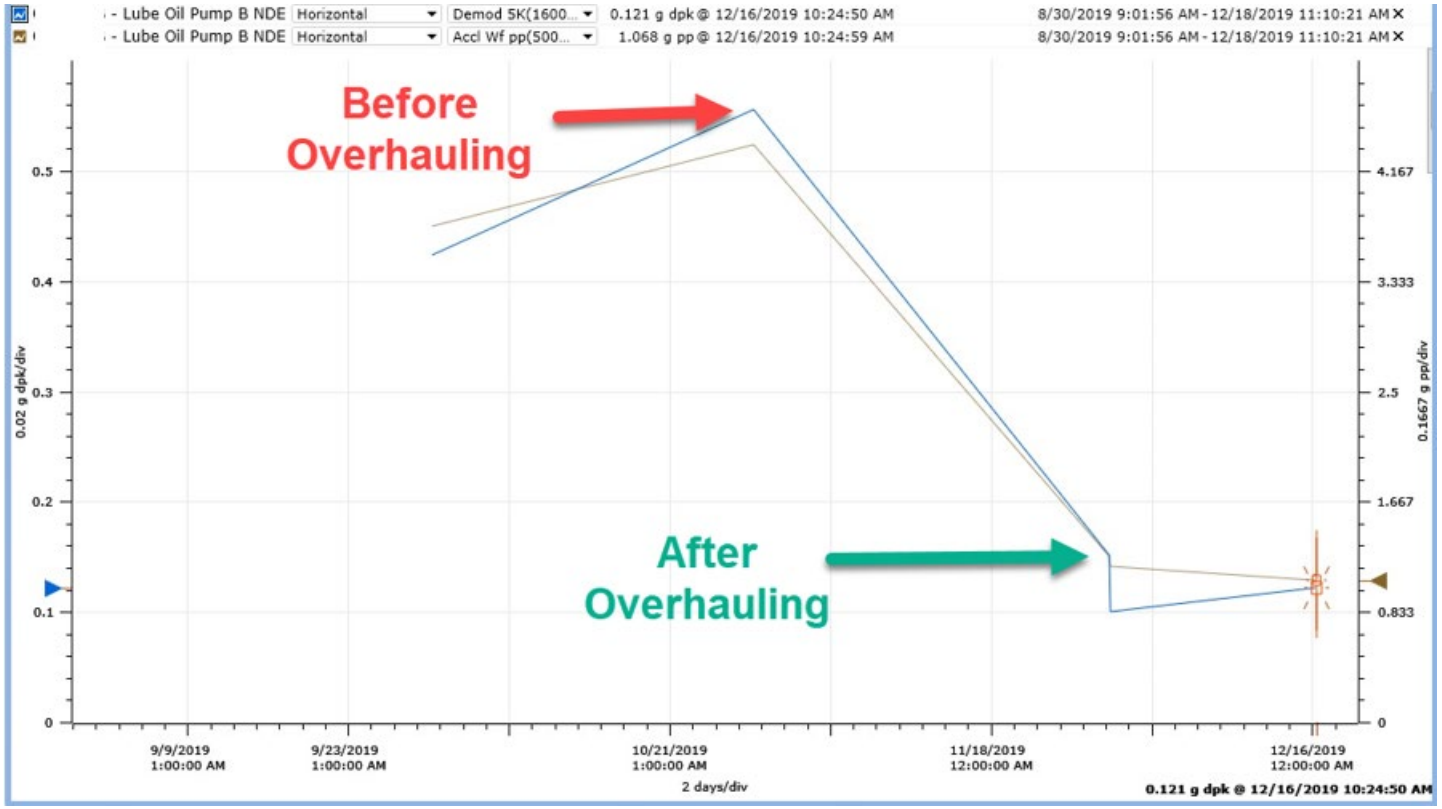

Figure 4: Elevated overall acceleration and Demod levels before & after overhauling.

TURBOMACHINERY & PUMP SYMPOSIA

Analysis– Case 2

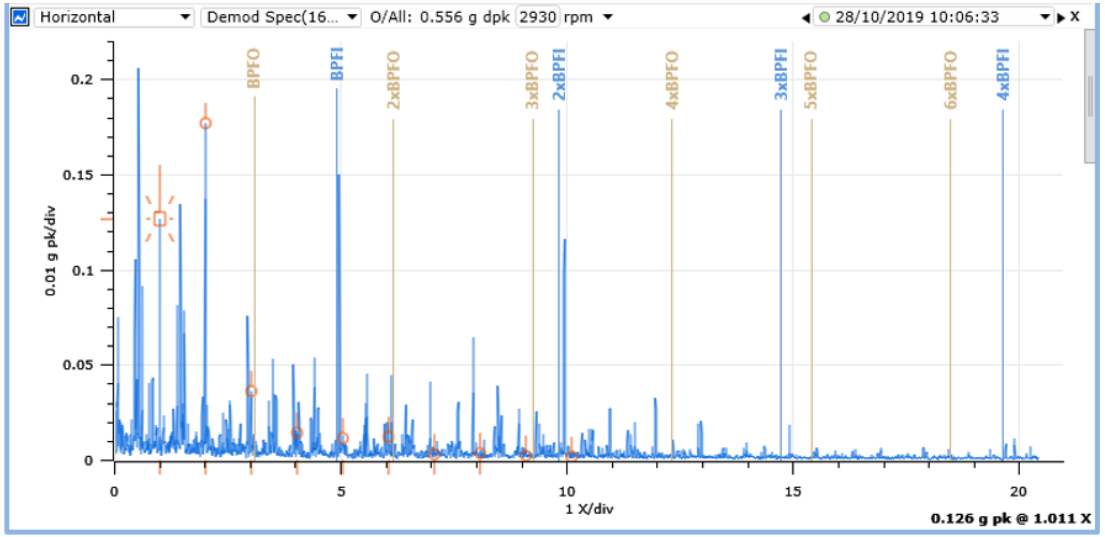

Figure 5

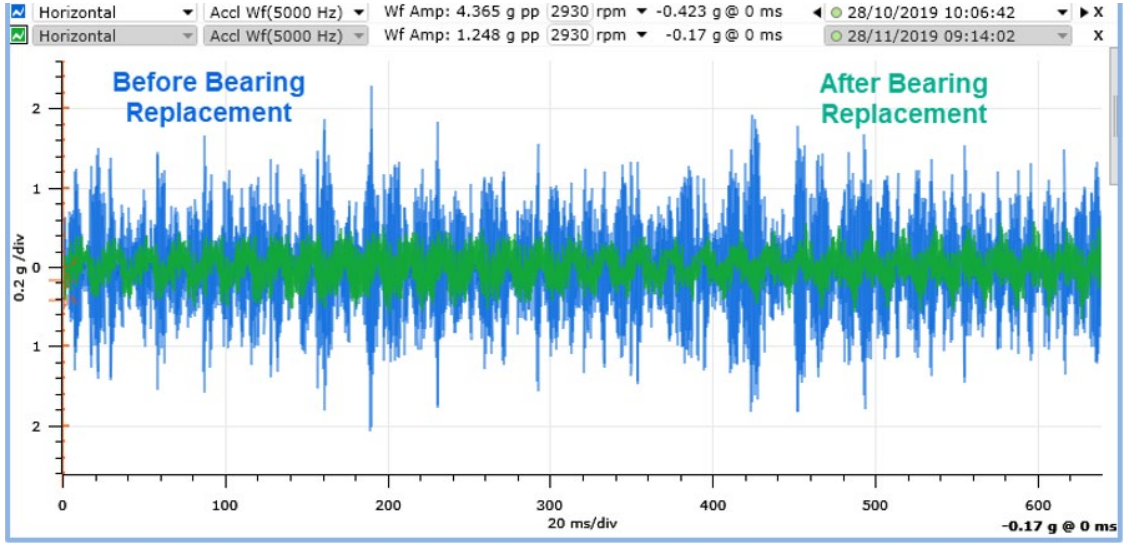

Figure 6

- Figure 5 shows the demodulated spectrum exceeded the recoverable stage.
- Figure 6 shows the difference between the Time Waveforms before and after REB replacement.

On-site Investigation & Resolution

Figure 7

- As there was no physical damage to the bearing components in case 1, vibration levels improved after adding grease into the bearing.
- In case 2: Opening the REB for replacement, noticeable damage was found on the outer race, cage, rolling elements and inner race.
- Evidence of excessive heat were found as discoloration at many locations inside the bearing (Figure 7).

On-site Investigation & Resolution

Figure 8: Bearing outer race damage.

Figure 9: Solidified grease.

- Figures 8 & 9 show non-recoverable physical damage, so bearing had to be replaced achieve satisfactory state.

Conclusions

- Average acceleration levels can increase without any defined fault frequency peaks in the demodulated spectrum at a stage where bearing condition is recoverable just by adding lubricant to the Rolling Element Bearing.
- Rolling Element Bearing may not be recoverable from elevated acceleration levels when defined frequencies with multiple harmonics start to appear in the demodulated spectrum. Also, at this stage frequencies haystack in the acceleration spectrum may change shape or move along the frequency range. At this stage (Case -2) it would be recommendable to replace the Rolling Element Bearing or at least carry out internal inspection of the bearing if possible.

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- This lecture may provide valuable knowledge for condition monitoring / machinery diagnostic engineers looking to design lubrication schedules or for general fault finding especially lubrication issues.

Lessons Learnt

- **Bearing at the stage of lubrication breakdown is recoverable if timely actions were taken preventing unnecessary downtime of the machine**
- **Neglecting condition monitoring (CM) recommendations and absence of lubrication program / schedule defeats the purpose of CM program and may put site rotating equipment at risk.**

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