

SUCCESS STORIES

Paper Mill



Implementation of an ultrasound-based preventive maintenance program on rotating machinery

Author: Patrice Dannepond

Introduction

Today, we would like to share an experience feedback from a paper mill that has implemented a preventive maintenance program to monitor rotating machines using ultrasound technology. SDT International helped implement this monitoring program by training and coaching the teams in charge of mechanical maintenance reliability. The purpose of this program is to monitor a fleet of about 70 rotating machines during the year after its implementation and to extend it to 100 machines over the second year.

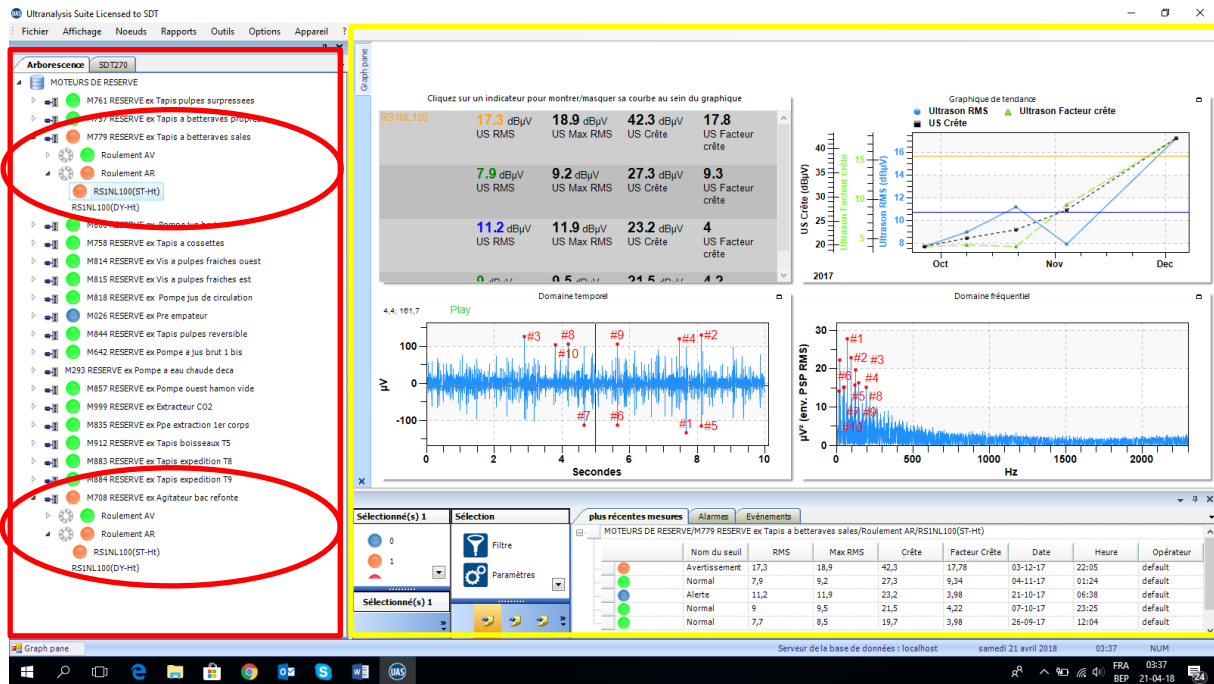
Issue

This paper mill has relied on preventive maintenance for many years, using known and proven technologies for the monitoring of rotating machines. In 2018, they decided to extend this monitoring to equipment with rotation speeds up to 30 RPM, as well as to their speed-reducing gears.

They purchased an SDT270 type ultrasound detector, in DU version, along with its Ultranalysis® (UAS) software, and SDT International and the Reliability department of the paper mill developed a training program suited to the rotating machinery monitoring program. The first step consisted in creating the database including these 70 machines, and then in recording an initial measurement of the mechanical status of each bearing and each gear. After a simple onsite analysis (ultrasonic listening) and a more detailed analysis (overall or static measurements and spectral or dynamic measurements) using UAS, pre-alarm, alarm and danger thresholds were assigned to each measurement point.

This background work, which is required, allows technicians of the reliability department in charge of the measurements routes to get a quick overview of the asset hierarchy and immediately see the machines that have an alarm status.

Display of the database in the UAS software



Display of the asset hierarchy including all rotating machines under monitoring and alarm statuses for each piece of equipment. In the present case, 19 rotating machines are monitored, 2 of which have exceeded the warning threshold for the bearings of the rear motor.

Display of the software graphic tools (matrix, trend curves, time signal, FFT spectrum, measurement time history).

Issue

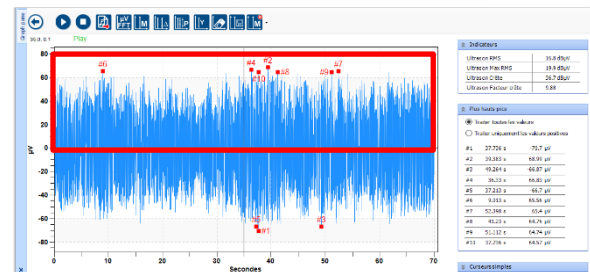
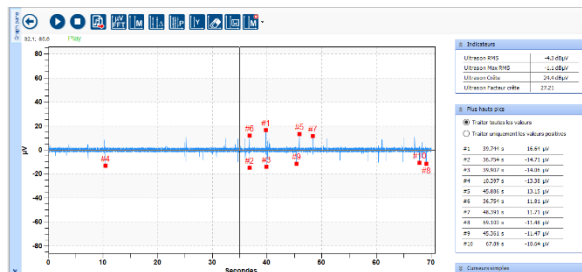
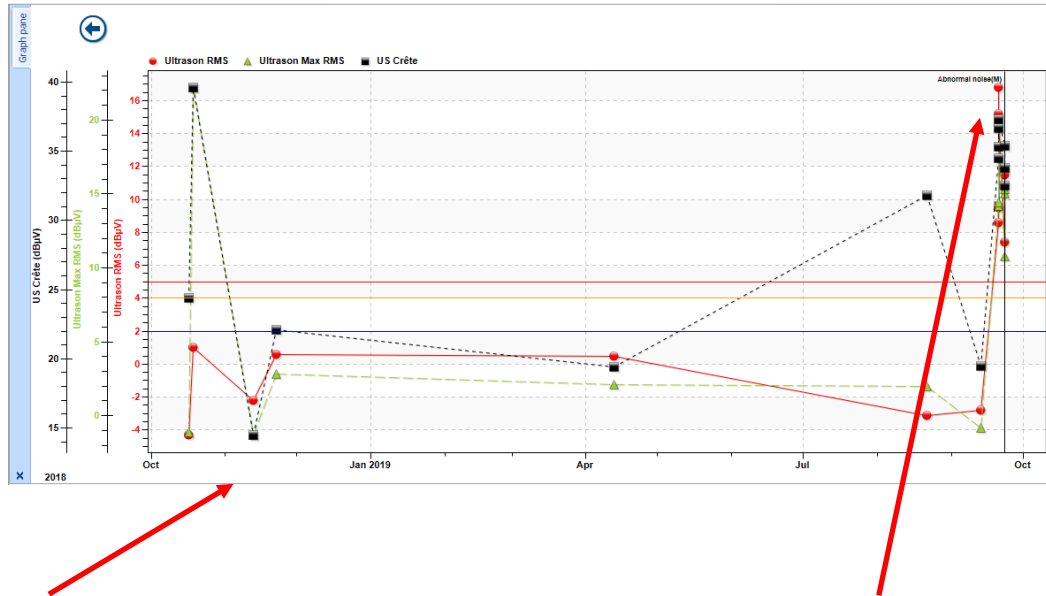
This preventive maintenance program has 3 objectives:

- Highlight the efficiency of ultrasound measurements on rotating machines.
- Issue a relevant diagnosis.
- Offer preventive maintenance with reliable indicators and alarms.

Experience feedback after onsite measurement sessions from October 2018 to November 2019

Monitoring of a parallel reduction gear

- Machine: **Decanter – High-speed input bearing of the reduction gear**

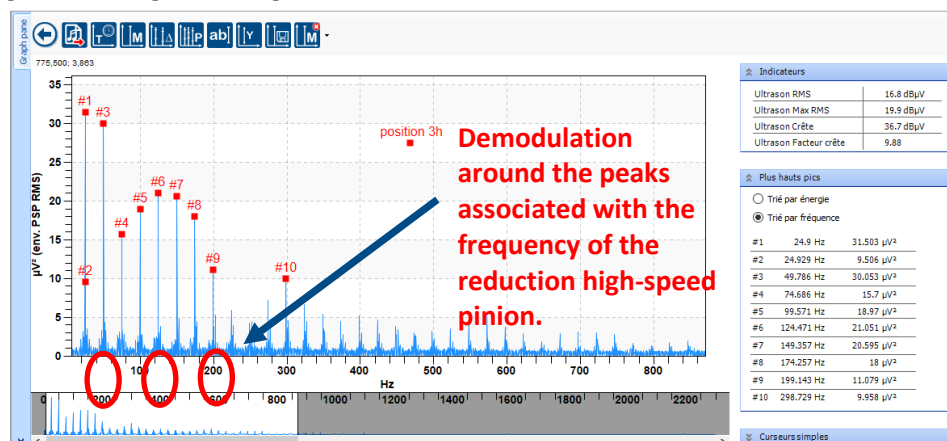


Measurement carried out on October 16, 2018

Measurement carried out on September 20, 2019

On the time spectra (same scale), we can observe the occurrence of shocks compared to the first measurement carried out in 2018. The trend curves show the evolution of the RMS static value: from **-4.3 dBµV in 2018** to **+16.8 dBµV in 2019**.

Based on SDT criteria, this increase corresponds to the early failure of a mechanical part of the reduction gear (bearings and/or gears).

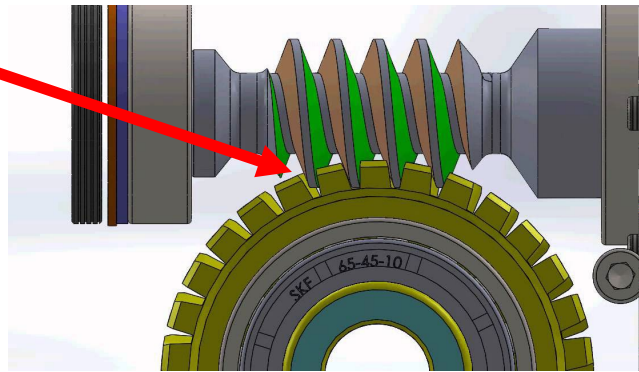


Listening to the bearing and analyzing the frequency spectra (see chart below) has allowed to confirm this diagnosis by observing the emergence of significant peaks associated with this gear damage.

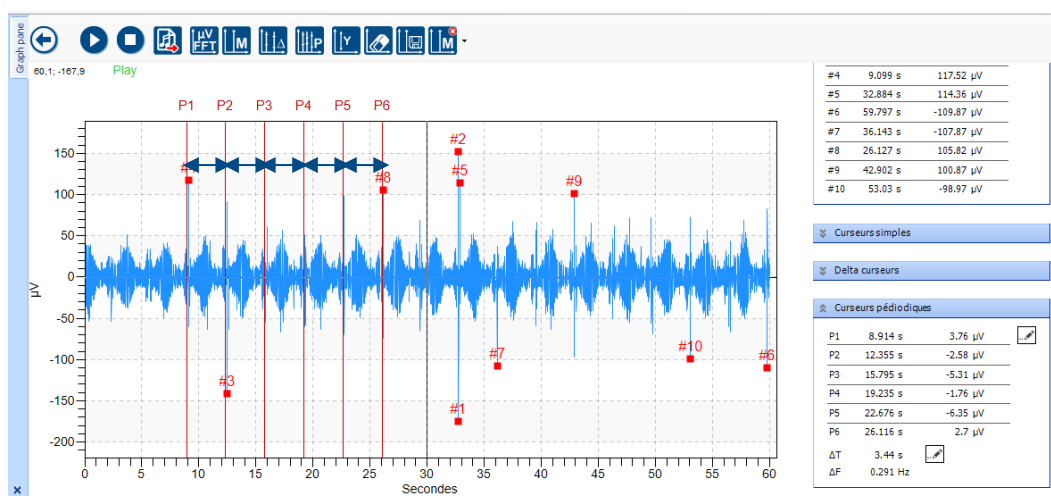
We can observe repeated shocks associated with the frequency of the high-speed input drive pinion of the reduction gear (24.93 Hz and its harmonics) with demodulation at each peak. Broken tooth and teeth clearance. Replacement of the reduction gear during a scheduled production shutdown, which avoided an untimely breakdown which could have generated significant expenses due to production losses.

Wear detected on the tooth of the worm screw of a reduction gear, wheel, and screw:

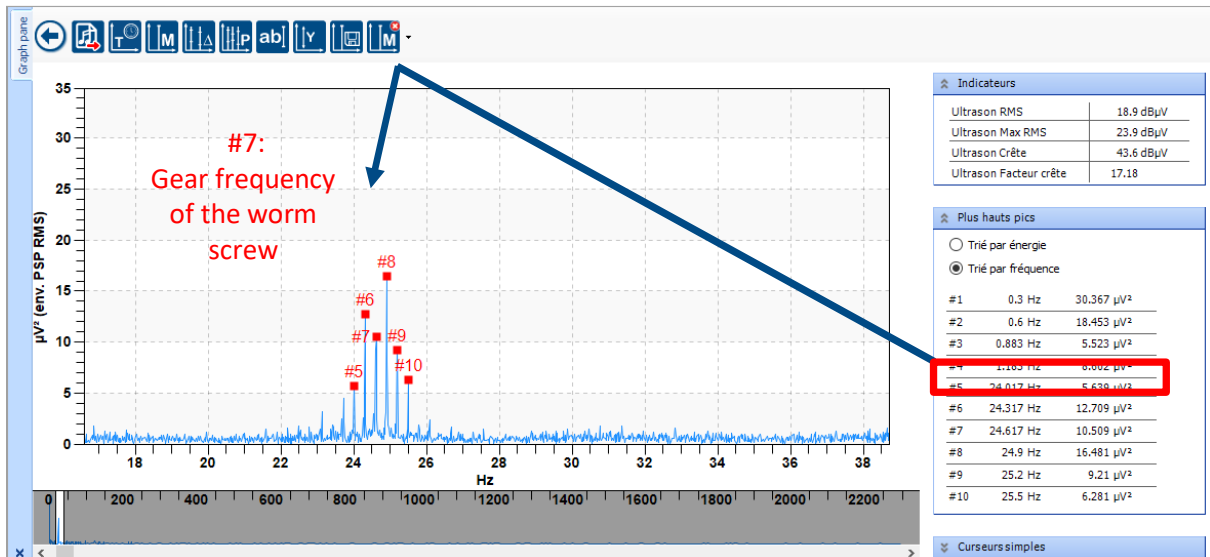
- Machine: **Lime mud filter agitator – High-speed input bearing of the reduction gear**



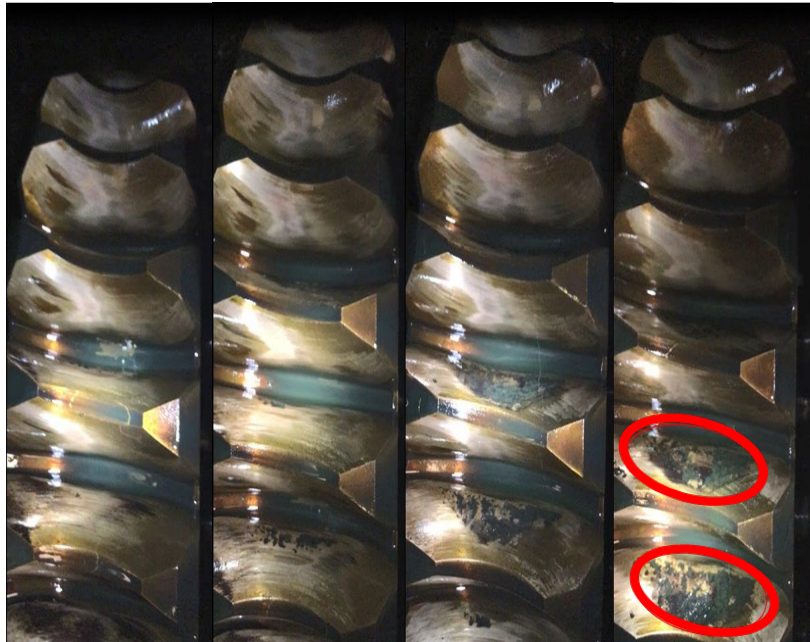
We can observe that between each revolution of the worm screw, there is a phenomenon occurring, which can be heard through the ultrasound detector as a sliding of the gear (worm screw/bronze wheel).



Measurement carried out on December 11, 2016

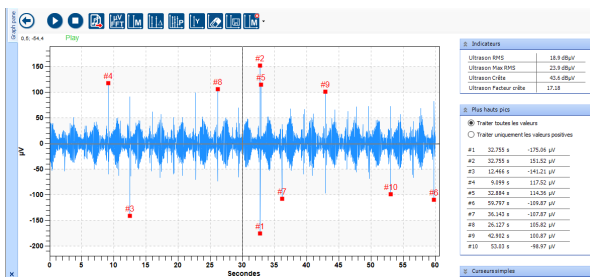


Zooming in on the envelope spectrum highlights the dissymmetry of the modulation around the meshing frequency, which is characteristic of a damaged gear mesh.

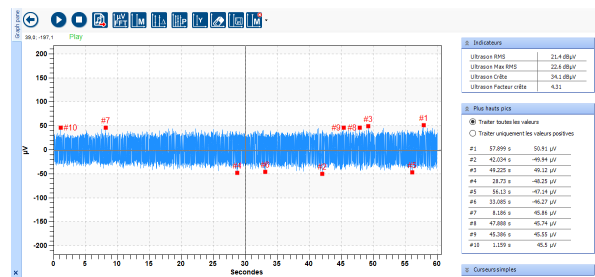


The endoscopic video inspection of the worm screw of the reduction gear confirmed the ultrasound diagnosis.

The customer took the reduction gear down during a production shutdown.



Measurement carried out on July 10, 2018



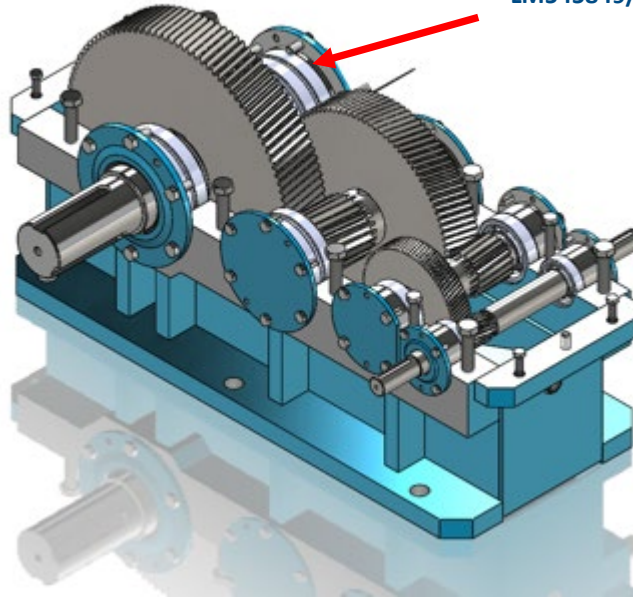
Measurement carried out on October 29, 2019
After replacement of the reduction gear

Monitoring of the degradation of the bearing of a low-speed reduction gear (opposite transmission):

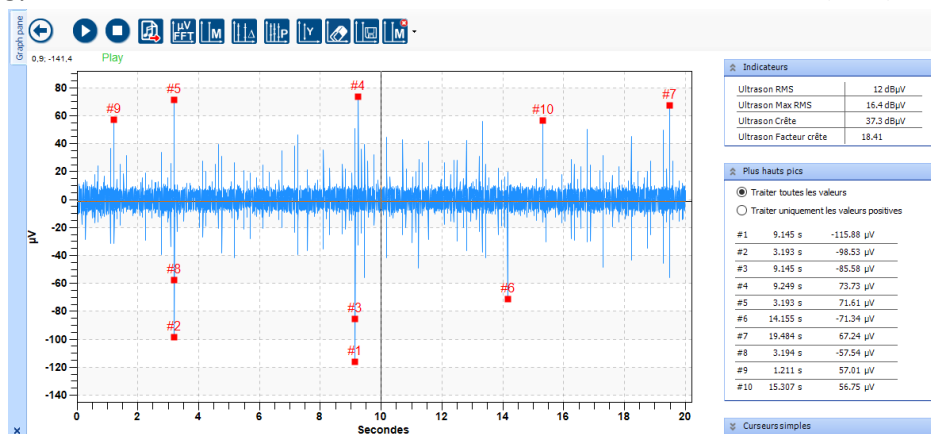
- Machine: **Vertex separator reduction gear – 4-train parallel reduction gear**

Low speed bearing of reduction gear

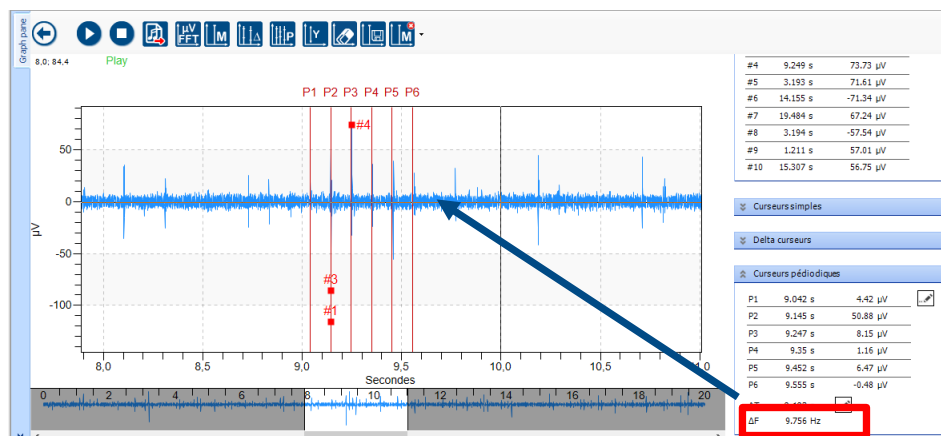
LM545849/545810



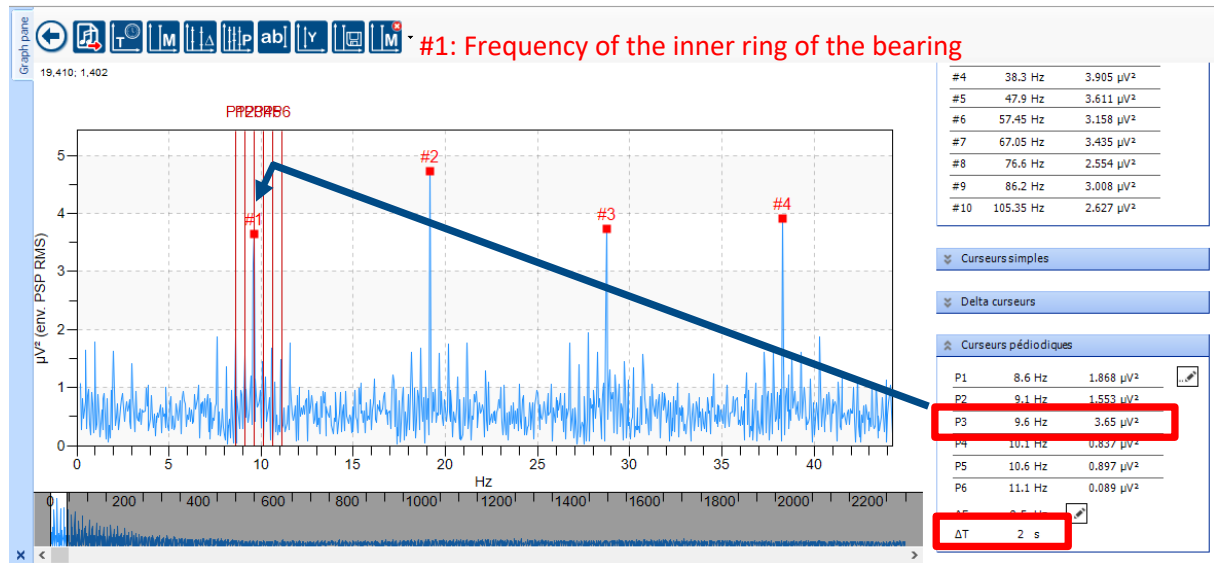
From the beginning of the monitoring of this reduction gear (August 2018) using ultrasound technology, the occurrence of shocks can be observed on the time waveform (TWF).



Below we focused on 3 seconds of the measurement, and we apply a periodic cursor to identify peak recurrences.



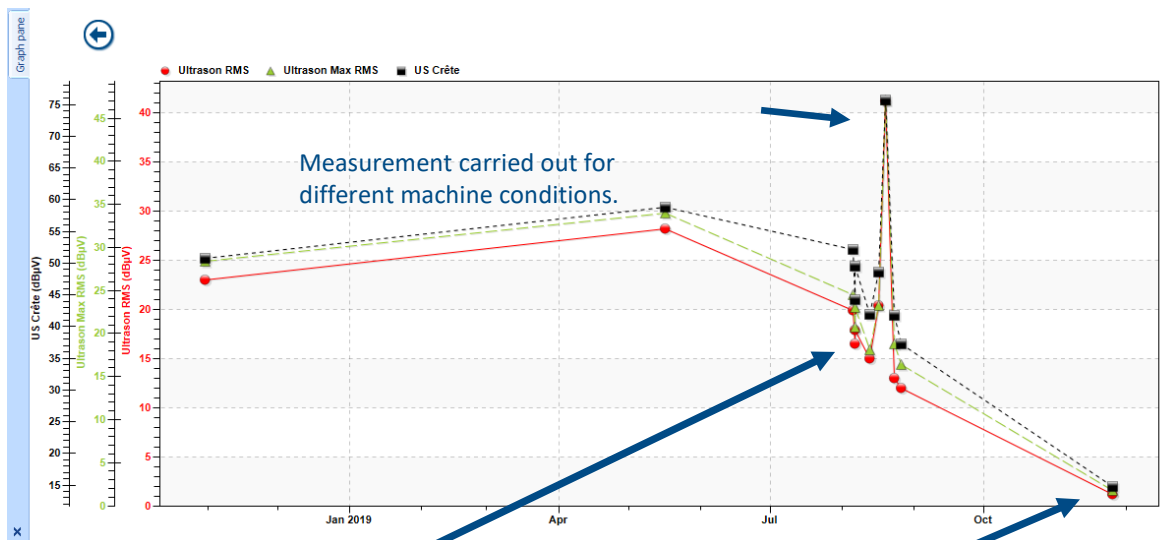
By looking at the envelope spectrum, one can observe repeated shocks at **9.756 Hz** (see the table of characteristic frequencies below) related to the frequency of the inner ring of the bearing of the low-speed reduction gear (opposite side of transmission).



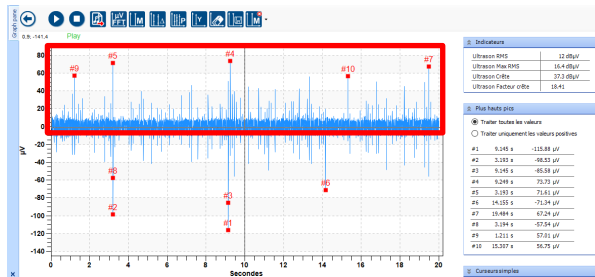
The amplitude of the scaling-type defect is modulated at the fundamental frequency of the rotation speed.

On the spectrum, this is evidenced by a peak at P3 (#1) corresponding to the bearing defect modulated at ΔF as confirmed on the harmonics: #2, #3, #4.

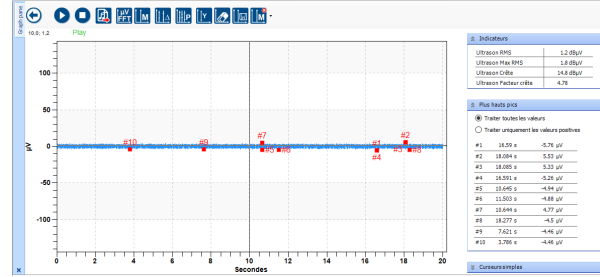
CHARACTERISTIC FREQUENCIES						
BEARING	FBE	FBI	FER	FCAGE	F ROTATION	
LM545849/545810	8.31	9.59	3.39	0.23	0.50	LOW-SPEED RED.
Spectrum	x	#1	x	x	ΔF	



The trend curves show the decrease of the RMS value in red on the graph above, also confirmed by the other indicators, **from +12 dB μ V in 08/2019 to +1.2 dB μ V in 11/2019.**



Measurement carried out on August 26, 2019

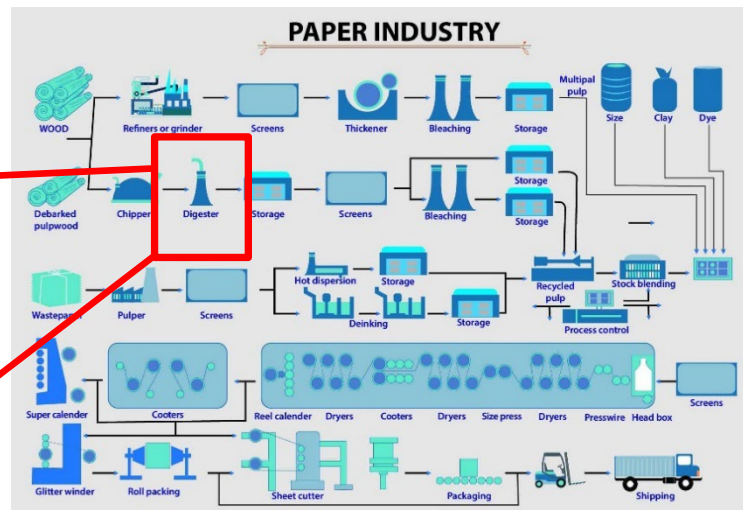
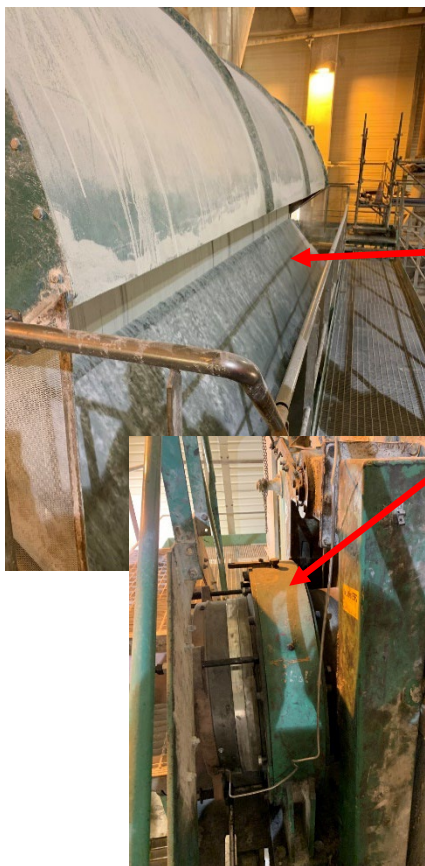


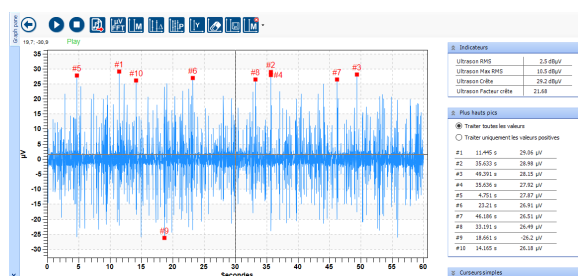
Measurement carried out on November 25, 2019
After replacement of the reduction gear

Replacement of the reduction gear during a scheduled production shutdown, which avoided an untimely breakdown which could have generated significant expenses due to production losses.

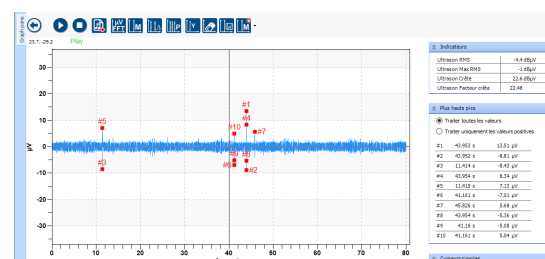
Monitoring of the degradation of the bearing of a low-speed reduction gear (opposite transmission):

- Machine: Lime mud filter – Bearing opposite transmission 23140 CCK – 14.28 RPM



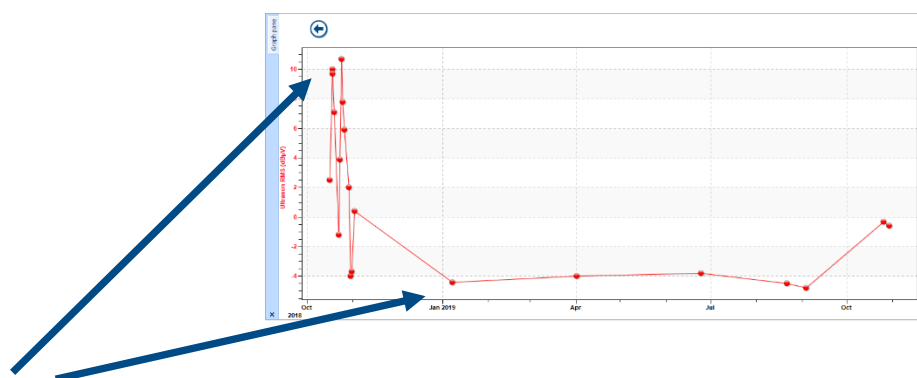


Measurement carried out on October 16, 2018



Measurement carried out on January 07, 2019

On the trend, one can observe the occurrence of high value in the RMS right from the beginning of the monitoring of this bearing. After replacement of the bearing, all shocks disappeared. The rolling elements were no longer held in their housings.



The trend curve shows the decrease of the RMS value after servicing (**from +10.7 dBµV in October 2018 to -4.4 dBµV in January 2019**).

Conclusion

The challenge was taken up by the Reliability team of this paper mill. The implementation of a preventive maintenance program for 70 rotating machines has had a beneficial and decisive outcome. It will be extended to 100 other machines over the course of 2020.

SDT International offered a simple solution and suitable measurement tools, along with a LEVEL 1 ASNT certified training program. Users have acquired a comprehensive mastery of this technology, which was new to them.

1. By using ultrasound technology to monitor low-speed rotating machines, this paper mill was able to avoid a number of unscheduled shutdowns (see examples below) and highlight the complementarity of ultrasound and vibration technologies.
2. Based on this experience, the Reliability department has decided to initiate ultrasound-aided greasing campaigns. Using suitable equipment (software and hardware), this acoustic lubrication program will ensure perfect greasing by indicating:
 - the right grease;
 - the right greasing location;
 - the right greasing interval;
 - the right quantity of grease to add;

- the right indicators for the lubrication condition.

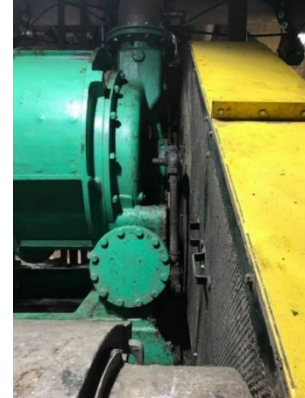
Thus, full traceability of the lubrication program will be ensured.

3. The versatility of ultrasound detector SDT270 also allowed for the implementation of:

- An energy-saving policy (detection of compressed air leaks, control of steam traps);
- Control of tube blowers (detection of leaks on steam valves);
- Preventive maintenance of high voltage electric systems (corona, tracking, arcing).

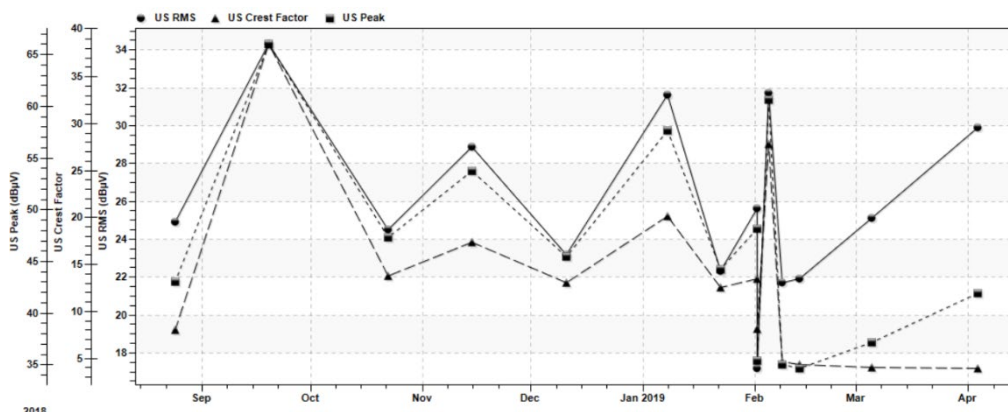
Vacuum Pump at a Pulp & Paper Facility – Defect on Pump DE Bearing

Author: Patrice Dannepond

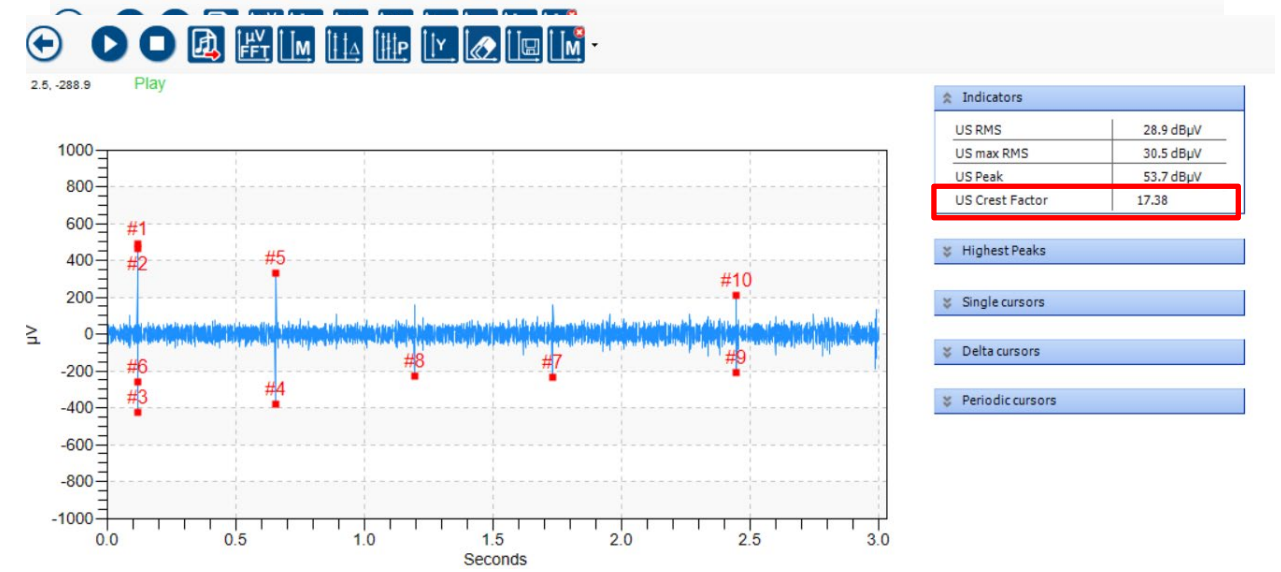


18-hour job to replace DE bearing on scheduled shutdown.
Crest Factor Alarm

	Level Name	RMS	Max RMS	Peak	Crest Fact	Date	Time	Operator
●	Normal	29.9	30.7	41.9	3.98	2019-04-03	12:58 PM	default
●	Normal	25.1	25.6	37.2	4.03	2019-03-05	9:03 AM	default
●	Normal	21.9	22.9	34.7	4.36	2019-02-13	9:23 AM	default
●	Normal	21.7	22.4	35	4.62	2019-02-08	9:57 AM	default
●	Danger	31.7	38.9	60.6	27.86	2019-02-04	3:30 PM	default
●	Alert	17.2	18	35.4	8.13	2019-02-01	1:52 PM	default
●	Alert	25.6	27.5	48.2	13.49	2019-02-01	9:37 AM	default
●	Alert	22.3	23.5	44.3	12.59	2019-01-22	12:50 PM	default
●	Warning	31.6	34.9	57.7	20.18	2019-01-07	3:30 PM	default
●	Alert	23.2	27.3	45.5	13.04	2018-12-10	3:05 PM	default
●	Warning	28.9	30.5	53.7	17.38	2018-11-14	1:25 PM	default
●	Alert	24.5	26	47.3	13.8	2018-10-22	11:07 AM	default
●	Danger	34.3	37.9	66	38.46	2018-09-19	10:04 AM	default
●	Alert	24.9	25.2	43	8.03	2018-08-24	1:28 PM	default
●	Normal	24.8	25.3	37.7	4.42	2018-07-23	1:19 PM	default
●	Normal	26.1	26.8	38.6	4.22	2018-06-25	11:20 AM	default
●	Normal	25	25.3	42.9	7.85	2018-05-29	1:16 PM	default
●	Normal	19.1	19.6	30.6	3.76	2018-04-30	8:40 AM	default
●	Normal	23.1	23.5	37.5	5.25	2018-04-02	10:55 AM	default
●	Normal	18.2	18.7	29.8	3.8	2018-03-05	1:18 PM	default

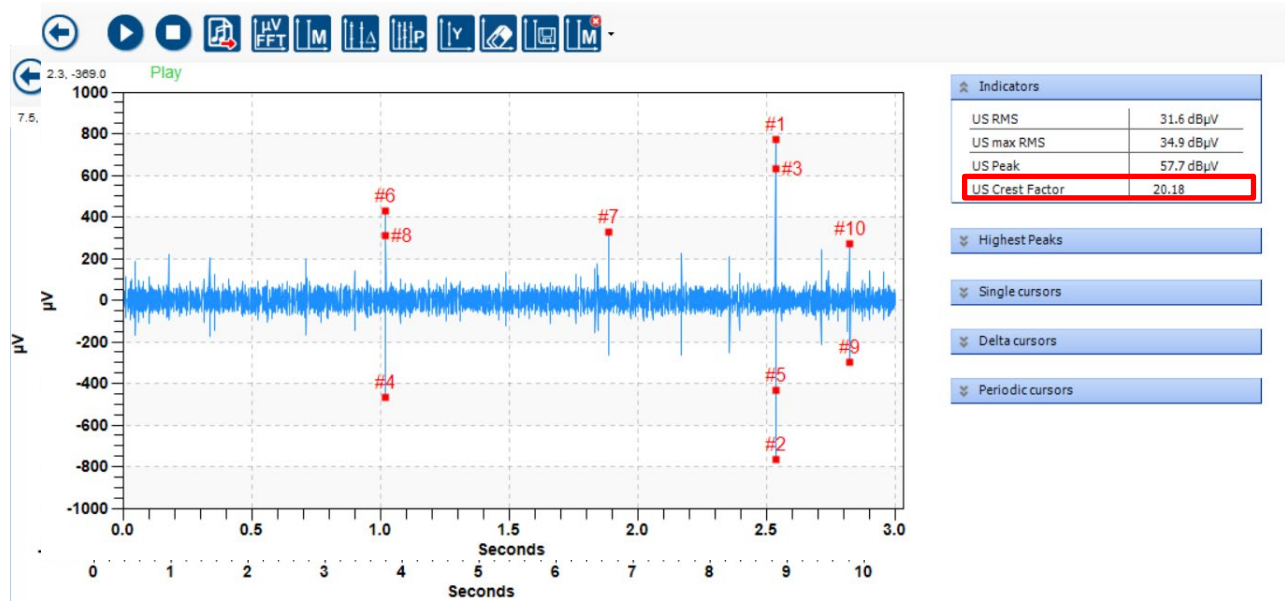


July 23, 2018



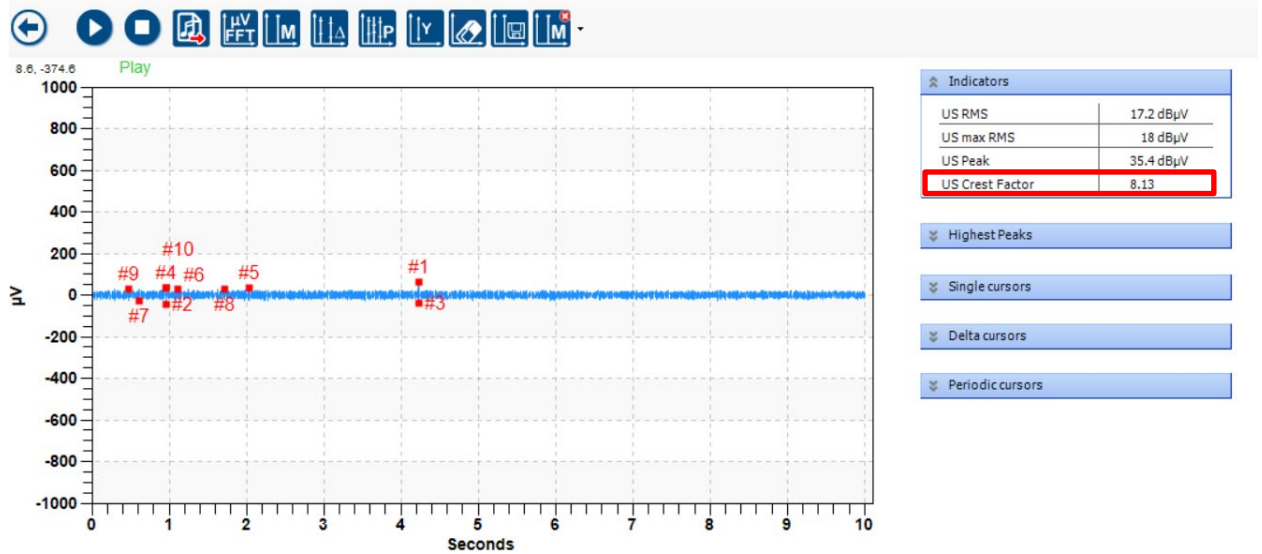
November 14, 2018 – Repetitive Impacting

January 7, 2019

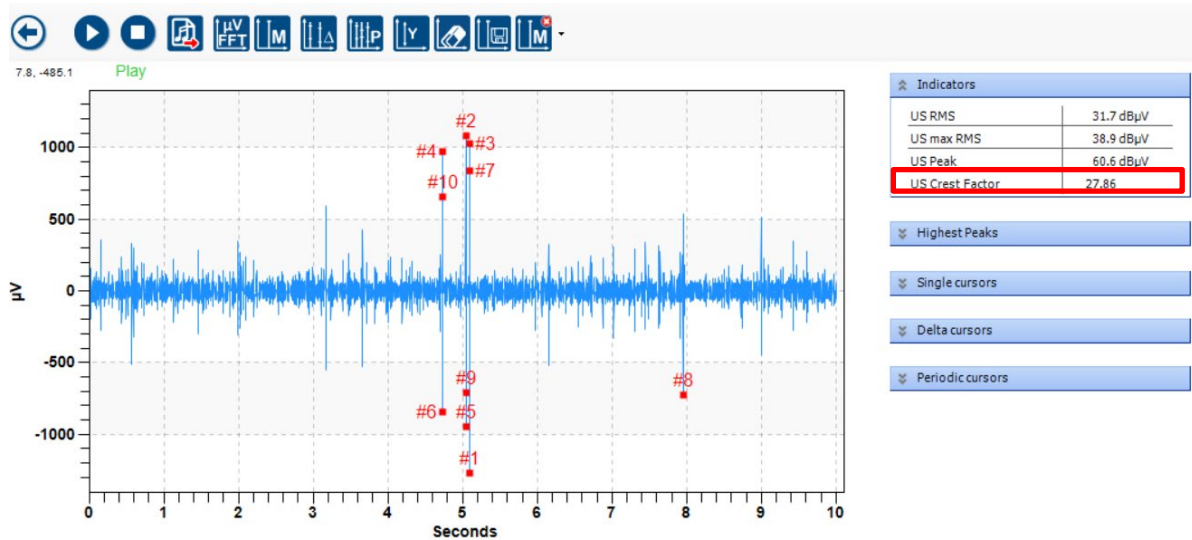


February 1, 2019

February 1, 2019 – After Greasing



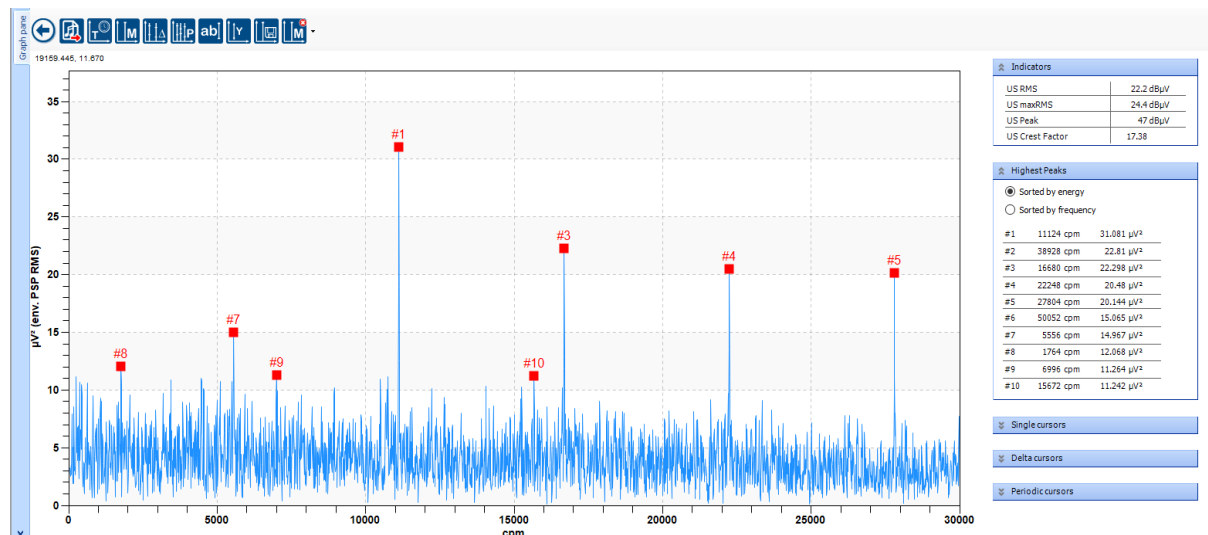
February 4, 2019 – 3 days later



Recommended bearing replacement as soon as possible due to a signal containing high peaks indicating the lifetime span of the bearing.

Next available extended shutdown – April 15 – April 17. Bearing greased repeatedly until shutdown.

Images of bad bearing – no secondary damage occurred:





Rolling elements



Inner Race



Outer Race

Low rotation speed machine control using ultrasound

Author: Patrice Dannepond

The founding principle of predictive maintenance could be “better safe than sorry”. It requires sound knowledge of the machines, taking into account of early signs and economic realism.

Today, predictive maintenance is based on different technologies that maintenance departments can use to assess failure risks, frequency ratio and severity level.

But it's another matter when it comes to selecting the right analysis tools, the right technology, and the right indicators for the early detection of a failure on a rotating machine, in particular low-speed machines. Ultrasonic technology is used to issue this diagnosis, as it can be easily and efficiently implemented.

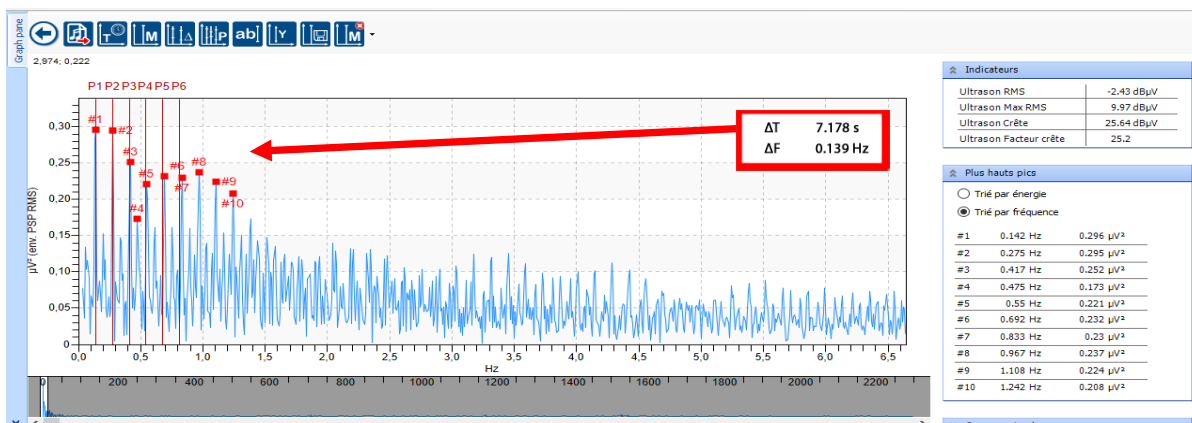


Recently, SDT International took up this challenge on a rotating machine with a rotation speed of 8 RPM= 0.13 Hz.

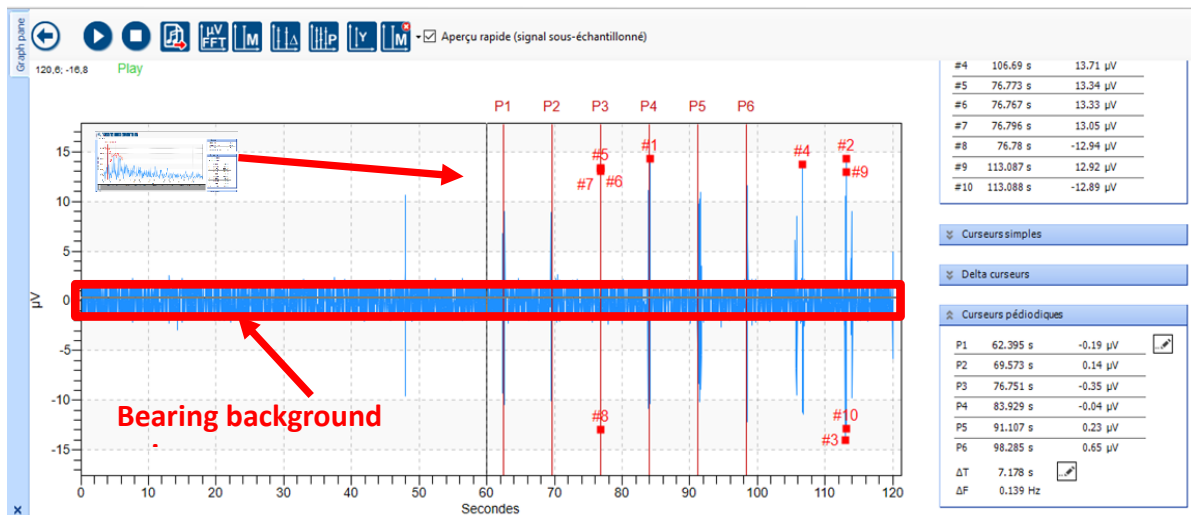
More than a week earlier, the maintenance department of a world-renowned company had detected unusual noise on a strategic production asset. The sudden stop of this machine would have led to the complete shutdown of the production site. Not to mention the financial cost of replacing these 4 bearings, the time required for the procurement of these specific bearings and the cost of the maintenance labor.

There was a dual stake here: control the condition of these bearings and attempt to detect the origin of this noise.

A diagnosis could be issued using the new ultrasonic measuring instrument, SDT340, and its FOCUS mode that can generate sampling frequencies up to 256 K samples per second.



The spectrum shows an impact at the rotation speed (0.13 Hz) of the shafts of the rotating machine, along with its harmonics. Sub-harmonic frequencies can also be observed at 0.5 x the rotation speed, which is a characteristic spectrum for a rotational clearance due to friction or significant impacts. No impact due to bearing frequencies are observed. Our diagnosis is confirmed by the time waveform.



The graph shows that the observed impacts are indeed associated with the rotation speed of the shafts of the machine at 0.13 Hz, i.e., a rotation speed of 8 RPM.

In terms of energy, these impacts are not necessarily constant for each shaft revolution (time signal recorded over a period of 2 minutes) and can be clipped if the gain is not suitable.

The encountered problem is due to the wear of the shafts and of the disks that are mounted onto these shafts and generate abnormal friction.

Now, the maintenance department knows the origin of the noise and the condition of the bearings, which just need to be monitored on a periodic basis.

Precision Lubrication with LUBExpert

Author: Ken Mitchell

Implementation of an ultrasonic lubrication program in a paper mill to acoustically grease bearings right

The LUBExpert system has allowed the maintenance team to shift away from unreliable calendar-based lubrication to on-condition lubrication with instant feedback to the technician as each bearing is greased.



Dryer section felt rolls – previously greased on a time-based schedule delivering 40 grams of grease every 4 weeks before the ultrasound program was implemented.

Ultrasonic greasing program started; first dryer felt roll greased from an RMS of 14.1 dBμV down to 12.2 dBμV after delivering only 20 grams of grease.

One month later, approx. 4 weeks to respect the established lubrication program, ultrasound shows the RMS has increased to 17.2 dBμV, again the bearing is greased, this time delivering 25 grams total quantity to reduce to 11.7 dBμV.

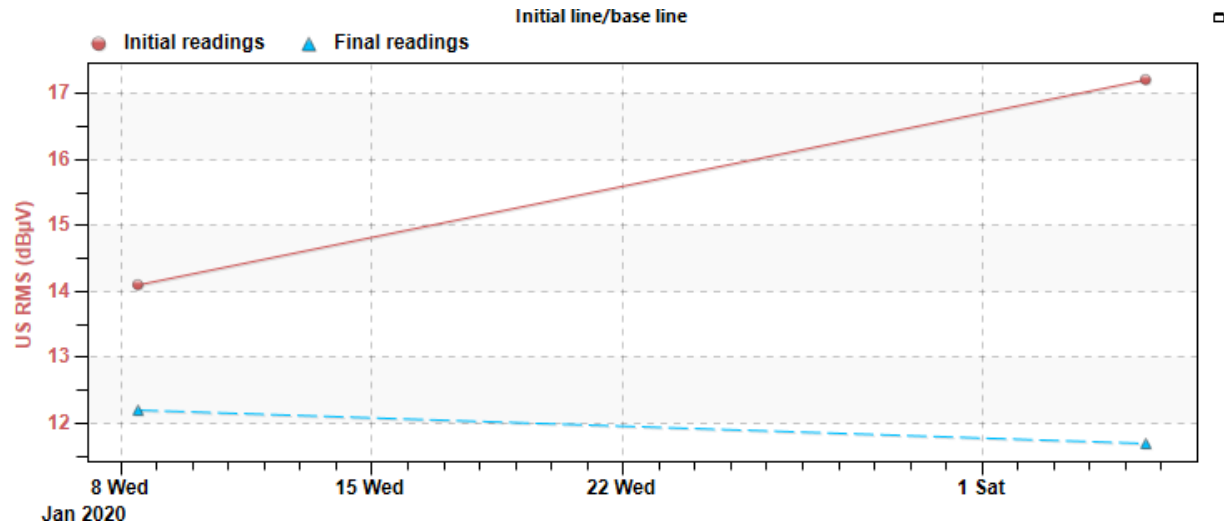


	Level Name	RMS	Max RMS	Peak	Crest Factor	Lube Alarm	Lube Alarm Level	Grease Name	Nb. Grease Shot
●	Normal	11.7	12.6	28	6.52	●	lubrication success F	SHP 460	15
●	Normal	11	14.6	36.2	18.19		free mode	SHP 460	10
●	Alert	17.2	20.5	35.7	8.42		initial reading	SHP 460	0
●	Normal	12.2	14.1	36.6	16.61	●	Lubrication success	SHP 460	20
●	Normal	14.1	16	32.4	8.22		initial reading	SHP 460	0

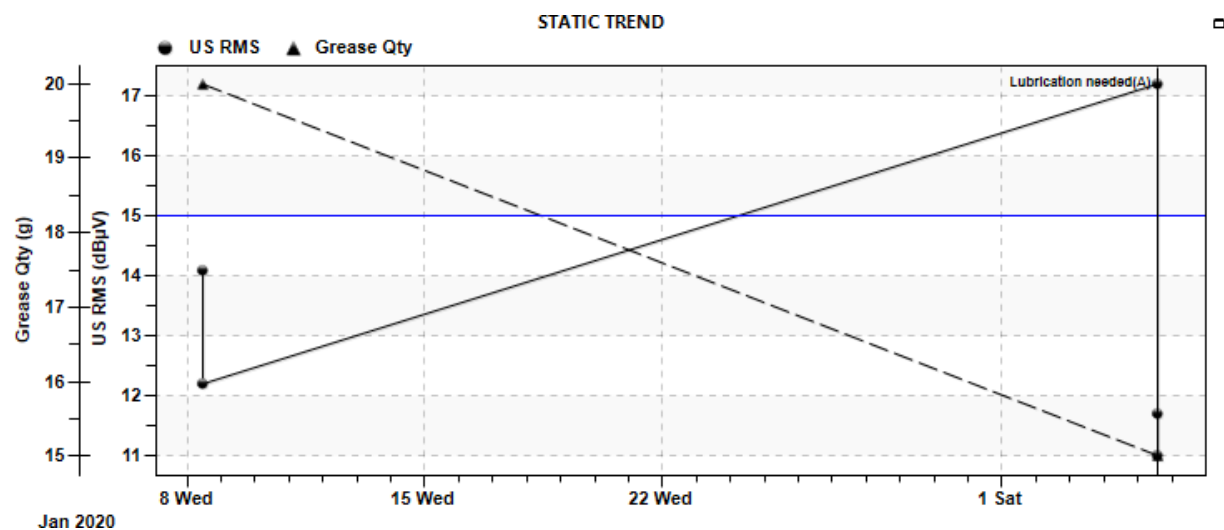
Initial greasing saved over lubrication of 20 grams (50%) and a further 15 grams (37.5%) to the first roll.

The Ultranalysis® Suite 3 software provides trending and initial/base line readings each time the bearing is greased.

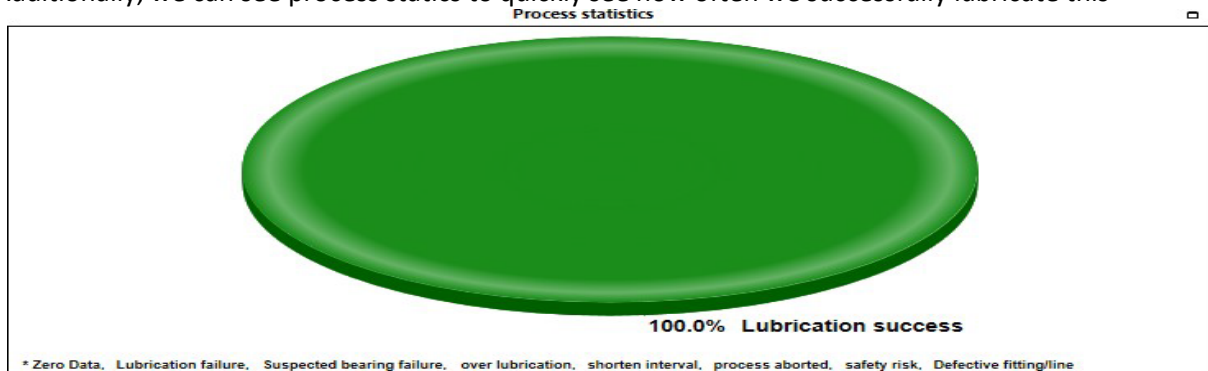
An absolute alarm at 15 dB μ V was added to indicate whether the bearing needs lubrication (over and the LUBExpert will prompt for greasing, under it will return a message of “lubrication not needed”).



This eliminates the need to inject any grease if the bearing does not require it.



Additionally, we can see process statics to quickly see how often we successfully lubricate this



bearing.

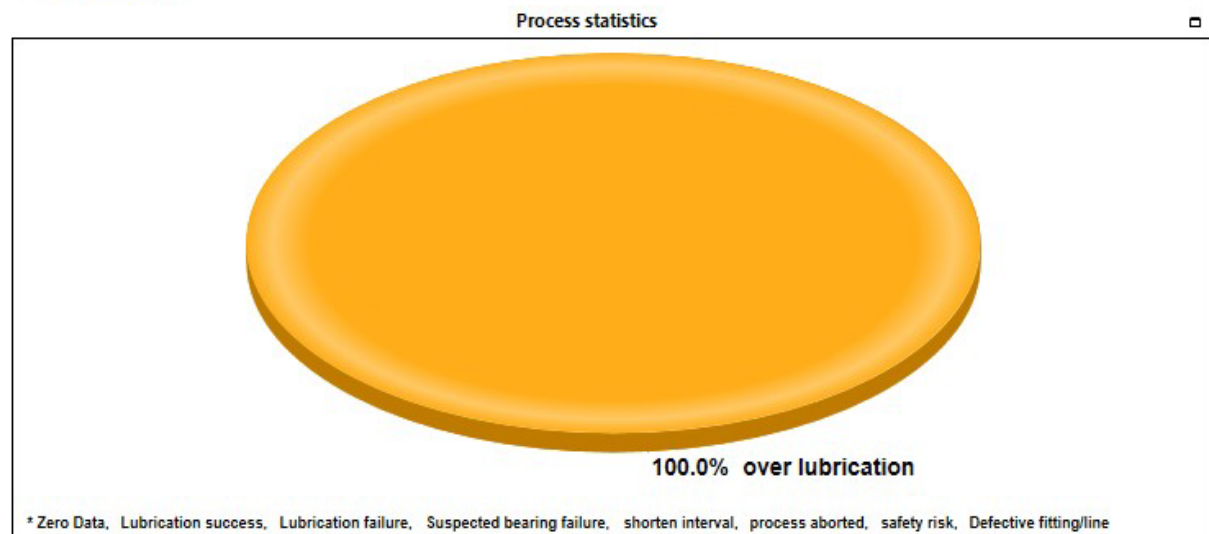
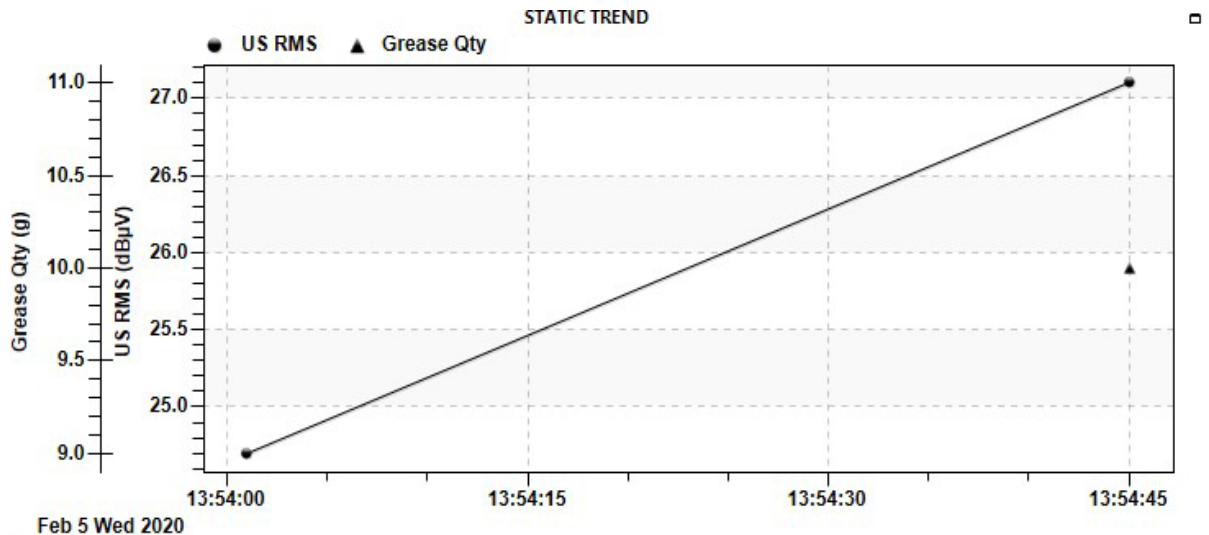
In a different dryer section of the machine, a felt roll was visited for the first time with the LUBExpert, one month had passed since the last greasing.

Not knowing the lubrication status of this bearing, an initial injection of 10 grams was delivered and the RMS immediately increased to 27.1 dB μ V.

On the onset, it would appear that we have done something bad to this bearing by entering an over

	Level Name	RMS	Max RMS	Peak	Crest Factor	Lube Alarm	Lube Alarm Level	Grease Name	Nb. Grease Shot
		27.1	30.4	47.4	10.35		over lubrication F	SHP 460	10
		24.7	31.5	52.5	24.55		initial reading	SHP 460	0

lubrication status on the LUBExpert.



However, keeping in mind that we were previously delivering 40 grams to this bearing, we have effectively prevented an additional 30 grams of unnecessary grease being injected into this bearing which would have increased friction levels, heat, and wear even further.

As more data is taken on this bearing and how it reacts to greasing, alarms can be set up to inform the operator that lubrication is not needed before injecting any grease. That will be the final setup of the program.

Suction pick-up roll bearings failed one month prior due to improper lubrication resulting in a bearing change at a cost of CAD \$16 000 (10 865€), 8 hours of labor and loss production time to change the bearing out.

The bearing was checked upon startup using the LUBExpert and it was discovered that it was not greased properly, resulting in an under greased status which could have led to another premature bearing failure.

A total of 99 grams was effectively delivered to the bearing (total capacity is 271 grams) upon startup, indicating that the bearing was initially filled to only 63% of the required capacity.

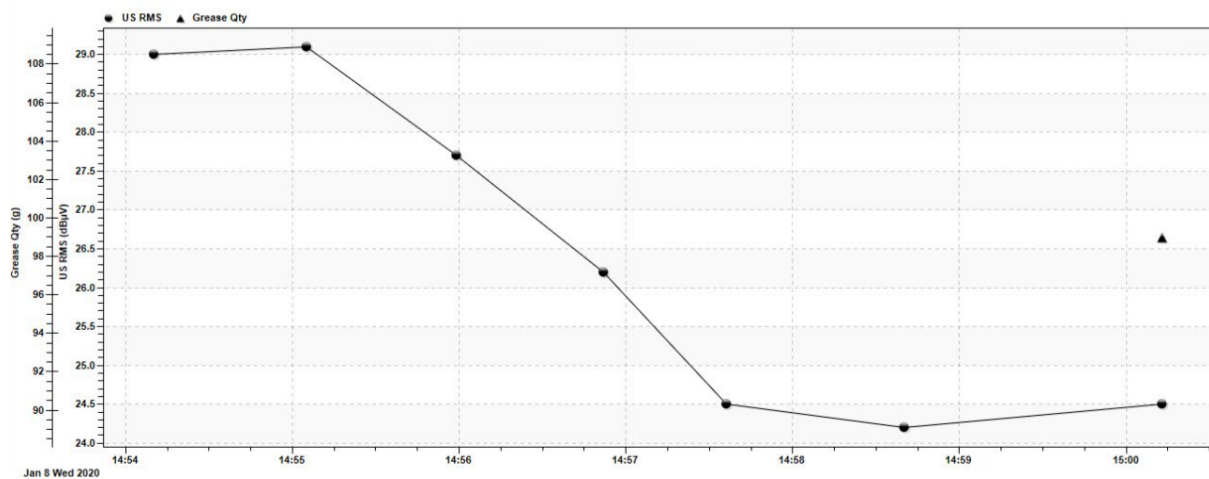
The bearing initially showed an **RMS of 29 dB μ V** and was reduced to an **RMS of 24.5 dB μ V** through ultrasonic greasing with the LUBExpert.

The Ultranalysis® Suite 3 trend shows us that we have successfully greased the bearing to the

Level Name	RMS	Max	Peak	Crest	Lube Alarm	Lube Alarm Level	Grease Name	Nb. Grease Shot
	24.5	24.9	36.5	3.98		lubrication success F	SHP 460	99
	24.2	24.8	36.3	4.03		free mode	SHP 460	19
	24.5	25	37.8	4.62		free mode	SHP 460	20
	26.2	26.8	37.8	3.8		free mode	SHP 460	20
	27.7	28.3	39.5	3.89		free mode	SHP 460	20
	29.1	29.5	40.2	3.59		free mode	SHP 460	20
	29	29.4	40.1	3.59		initial reading	SHP 460	0

optimum level as expected.

This initial check prevented what could have been another catastrophic failure during production, increasing reliability on this roll and ensuring proper lubrication, reduced friction, and wear on this bearing.



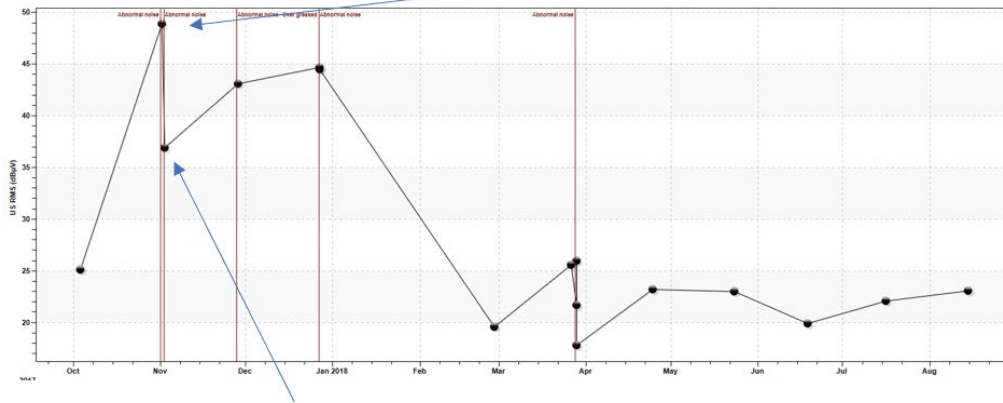
Defective Bearing on DC Motor

Authors: Gilles Lanthier and Tristan Rienstra

Email addresses: gilles.lanthier@sdtultrasound.com and tristan.rienstra@sdtultrasound.com

Problem identified by ultrasound on November 1st.

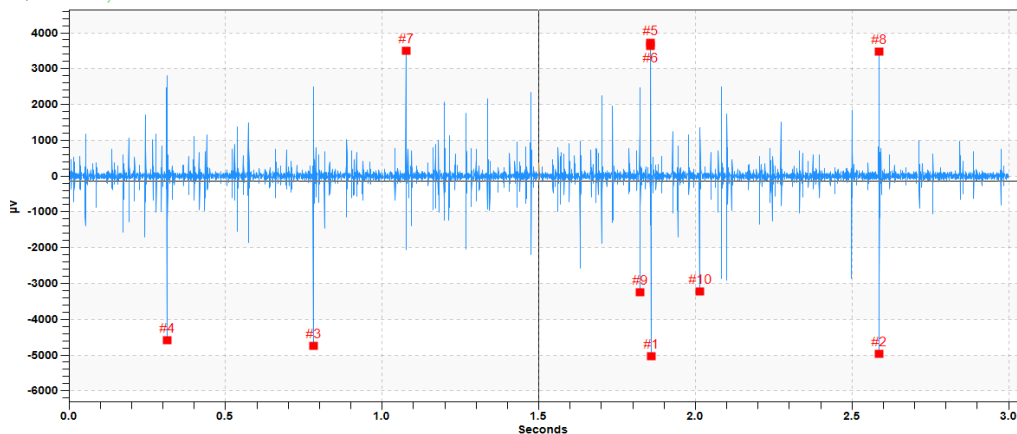
Ultrasound Trend - high RMS ultrasound values in early November



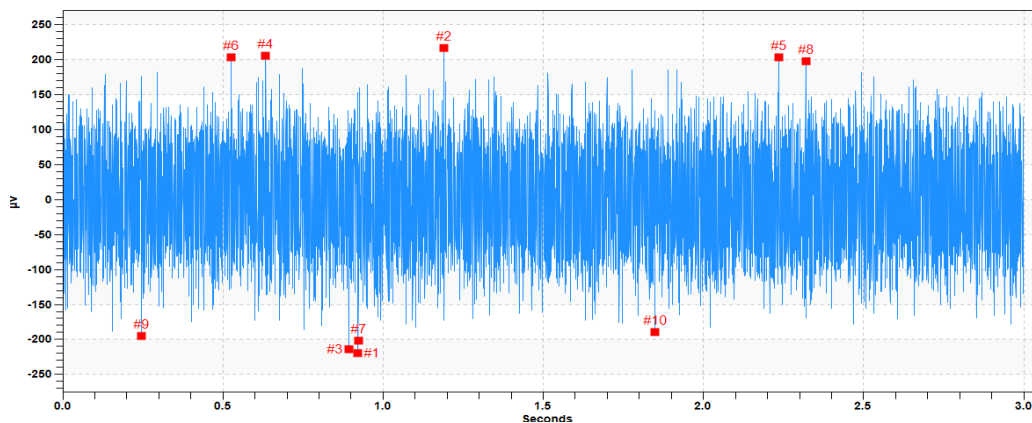
Bearing greased on November 2nd.

Whenever we suspect a bearing problem, our first step is lubrication.

November 1st ultrasound reading:

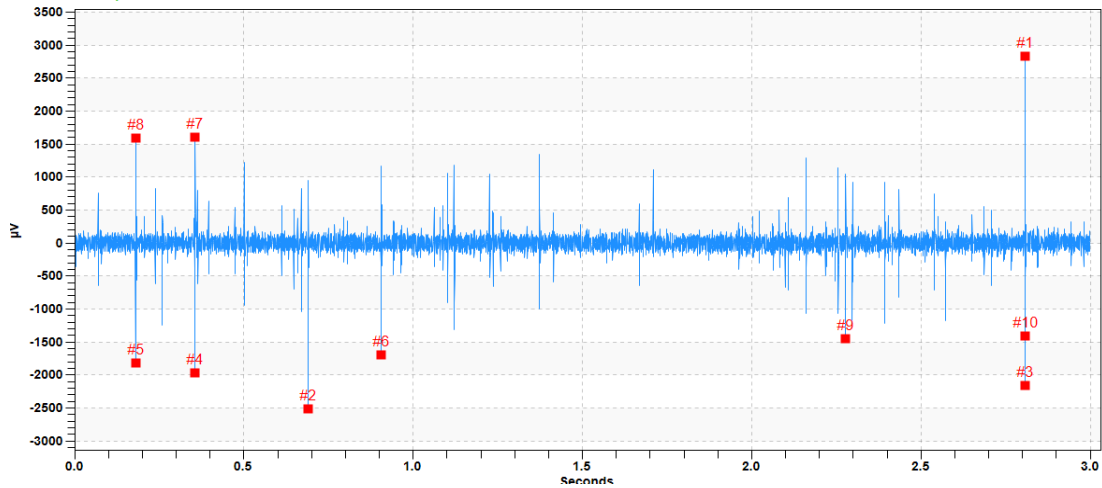


Ultrasound reading after greasing on November 2nd:

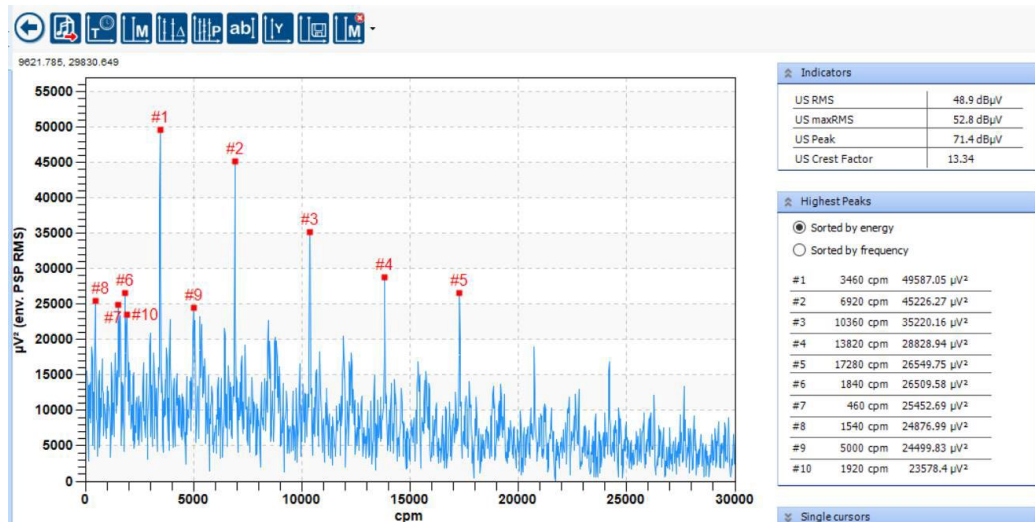


Ultrasound levels decrease as predicted.

Ultrasound reading on November 28th (still containing high peaks as November 2nd):



Levels rise back up. Bearing defect is very clear:



Defect clearly visible. The bearing is finished.

Outer race damage:



Figure 3 Outer race damage (BPFO)

Finding Vacuum Leaks in a Multi Effect Evaporator

Authors: Allan Rienstra and Karl Hoffower

Email address: allan.rienstra@sdtultrasound.com

Black Liquor Evaporator Vacuum Leak Survey

In November 2009, SDT Ultrasound Solutions received a phone call from Clearwater Paper Corporation, Lewiston, Idaho Plant asking if our ultrasound technology could find vacuum leaks on evaporator stacks.

Several leak detection service companies had been approached already but none seemed willing to risk the expense of visiting the plant with an uncertain outcome. SDT is lucky enough to have a sound technical representative situated near the Pacific Northwest willing to embrace the risk in exchange for providing customer solutions and satisfaction. Karl Hoffower, of Failure Prevention and Condition Monitoring Solutions, Inc took the call and scheduled a visit to the mill. He filed this report.

Vacuum Leak Inspection on Multiple Effect Evaporator at major Pacific Northwest pulp & paper mill.

On December 14th and 15th, a vacuum leak survey was completed on the black liquor evaporator at a major pulp and paper producer in Idaho. Evaluation of the black liquor process numbers indicated the most likely area of the vacuum leak was somewhere in the 4th effect piping.

Using the SDT170 ultrasound listening device coupled with the SDT RS-1 (resonant sensor 1) contact needle probe, contact measurements were obtained at various locations along the 4th effect stack.

These readings were taken through the insulation and outer steel wrapping. The highest reading noted was 51 dB. This location also correlated with the thinnest section of the stack recorded by ultrasonic thickness testing already done by their NDT crew.

Switching to airborne ultrasound detection mode revealed a jump from the ambient levels of 18 dB to a strong 32 dB -33 dB with the tell-tale whooshing sound of a vacuum leak.

When the insulation near the bottom of the access door was moved the airborne ultrasound levels rose to 38 dB cutting away a large section of the sheet steel and insulation revealed numerous points where the metal had been breached by the corrosive black liquor. The breaches had created a loss of vacuum in the 4th effect stack. Rubber sheets had been pre-cut in preparation for discovering the locations of the leaks. These sheets were placed over the areas of the holes as a temporary repair and to avoid a complete loss of vacuum on the evaporator system when the insulation was removed. A repair was carried out to help allow the system to function properly and continue until a planned outage in March 2010 can have the stacks replaced. Gor-tex™ sheets were Clearwater Pulp, Lewiston, ID wrapped around the stack and sealed with silicone caulking.

The OSI PI process monitoring software showed an immediate change in the correct direction by the application of the rubber sheets and an even better improvement with the Gore-Tex™ sheets and silicone caulking.

The “morning report” at IPPD on December 17, 2009, stated the following: “Vacuum improvements on the evaporators resulted in the best solids throughput tons per day we have achieved on the set in the recent past.”

Testing procedure:

Mr. Frei revealed the evaporator stacks had several access ports covered by rubber stoppers. These pre-made ports had been constructed to allow easy access for periodic thickness testing. The procedure discussed was to access these ports on the evaporator and contact or “touch” the point with the RS-1 needle probe. The decibel level would be recorded and mapped out. Mr. Frei also told us of additional access doors created on the stacks for thickness testing. These access doors were sealed with silicone and screws with 4”-6” of insulation in-between. These additional doors helped make our survey successful. By mapping the decibel levels at various points around and along the stacks, an area or areas of potential leak could be determined for further investigation.

Challenges:

There were several challenges to completing this survey, access being the primary hurdle. 4 rubber access points were easy to get to while standing on the roof of the evaporator building. A man-lift was then employed to gain access to more points. But if the leak was occurring in a location inaccessible by the man-lift, then staging would have to be employed to gain access to the other stacks. Flow is made more turbulent at twists, angles, and bends, like 90-degree elbows. The evaporator stacks had numerous 90-degree elbows.

Differentiating between excessive turbulent flow caused by a 90-degree elbow and a vacuum leak was another potential hurdle that was overcome by my inspector training. This training prepared me with the necessary skills to differentiate between internal turbulent flow and turbulent flow that is the result of a leak.

Survey:

The black liquor evaporator uses a 7-effect counter flow method to concentrate the mixture. Using the OSI PI monitoring software, Mr. Frei stated their evaluation set the most likely location to be in the 4th effect stack. The pictures here show the map of decibel levels after we conducted the survey. The decibel levels taken on the inside area of the stack dropped as we moved away from the high of 51 dB, down to 38 dB.

The survey required the use of a man-lift to access all of the doors. While the contact ultrasound measurements were made, RCM Tech Jim Storey also conducted contact ultrasound thickness testing. Mr. Storey said that the last thickness survey conducted on this stack was about 5 years ago.

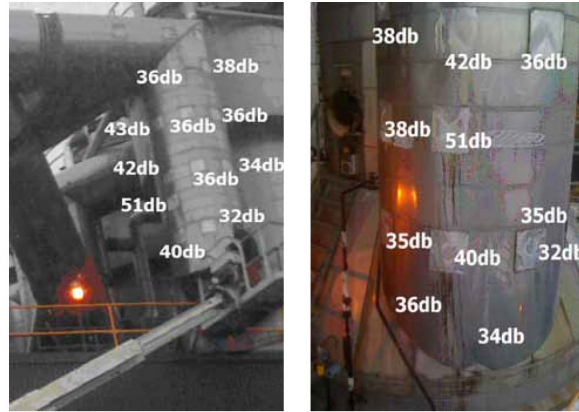


Diagram shows dB levels mapped out using SDT RS1 Contact Probe. Vacuum leaks detected through 4" insulation and outer sheet steel. Loudest areas were cut away and patched with Gor-Tex™ patches.

With airborne ultrasound leaks, a large leak usually registers at 65-75 dB or around 15' away from the source. Since no other points had anything higher than 51 dB, we decided to return to that location and investigate further.

As the additional pictures below will show, there was a strong correlation between the locations of the leaks and the thinning of the wall of the stack. At the location of the highest ultrasound, 51 dB, the wall was found to be 0.091" thin. The thinnest area found on our initial survey.



Wall thinning correlated to high dB values.

With the ultrasound level increasing as we recorded contacts close to the bottom, I changed from the contact probe to the airborne sensor. Ambient ultrasonic dB levels were 18 dB around the stack. When I brought the airborne sensor near the 51 dB access door, the airborne sensor jumped to 32 dB – 33 dB and gave the telltale whooshing sound of rapidly moving air. When I used my hand to separate some of the insulation away from the metal flange, the airborne sensor levels rose to 38 dB.



It was decided that we would need to have a larger area open for inspection.

Mr. Storey and I went back to confer with Mr. Frei and Mr. Fleischman about how we could gain access to the stack below the retaining ring. Mr. Storey marked out the approximate dimensions we wanted to have cut away in chalk.



We went back to the Maintenance shop and were introduced to Mr. Jim Rose. He discussed how he would cut the sheet steel away and remove the insulation to give us better access. Mr. Frei reminded us that we would need to have some type of blocking material to immediately cover the holes we expected to find. If we did not, the probability of losing the vacuum was great, thus potentially causing the entire process to shutdown.

Corrosion Damage Found:

As soon as Mr. Rose removed the sheet steel we could see where the insulation had collapsed around the vacuum pull of the stack. As the insulation peeled away, the holes were immediately visible. We placed two rubber sheets over the large holes to prevent the loss of vacuum. The sheet on the left covered the largest area of corrosion, about 8" wide. The 2nd major area of damage was about 1½" wide.

Opening the access door allowed further pinpointing with RS1 ultrasound probe along the underside of the metal flange area.



The exact number of holes was too numerous to count. Also, many of the holes had blended together from the corrosion.



Mr. Rose recommended applying Gor-Tex™ sheets sealed with silicone to affect a strong, yet temporary repair. The decision was to strengthen and seal the holes so that the process could continue until a planned outage in March 2010. At that time a complete repair/replacement could be implemented.

As they removed more of the sheet metal and insulation for the final repair, additional thickness testing was performed.



The areas below where the holes were discovered clearly show how the stack is wearing out. 0.077" was the thinnest area found without actually being a hole.

Conclusion:

After the Gore-Tex™ sheets were wrapped and sealed, the process monitoring software validated the repair. The amount of vacuum began returning to levels not seen for quite a while. The control valve also moved dramatically in the correct direction right as the repair was being finished.

By 4 pm on December 15th it was apparent the system had returned to normal. The survey is considered ended and a success.

I was sent an email that noted, the "morning report" at IPPD on December 17, 2009, stated the following: "Vacuum improvements on the evaporators resulted in the best solids throughput tons per day we have achieved on the set in the recent past."



The report filed by Mr. Hoffower illustrates just how complex the job of locating vacuum leaks can be. The complexity in this case was magnified by several conditions including insulation material wrapping the stack, sheet metal covering the insulation, primary and secondary air gaps between stack, insulation, and sheet metal, high elevations requiring a lift and platform, ambient noise in the ultrasound frequencies related to nonleaking turbulent flow, and of course the discomfort of high temperatures which also pose a safety risk.

The report also illustrates how rewarding the job can be. The win for this paper company is a reduction in energy costs through more efficient vacuum level maintenance and better thermal transfer from effect to effect. Additionally, they have the best throughput of black liquor in years. Make no mistake here; it is trying times for paper makers.

The difference between a profitable quarter and a losing quarter may well be decided by the efficiency of a single process such as black liquor production.

Many leak surveys are abandoned due to frustration which is the product of poor-quality equipment ill-suited to the task. It is also the product of training.

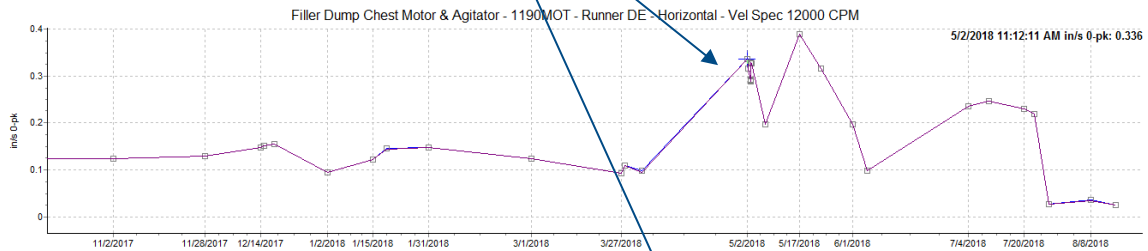
Without ultrasound training, an inspector will be overcome by the hurdles of the task. Your investment in an ultrasound program must be threefold. Invest in quality ultrasound equipment, quality personnel to carry out the inspection, and most important, inspector training. Training must address the unique place ultrasound holds for reliability and plant maintenance, ensure good transfer of knowledge between inspector and student, and return the inspector to the field with the confidence to succeed in the most trying inspections.

Filler Dump Chest Agitator

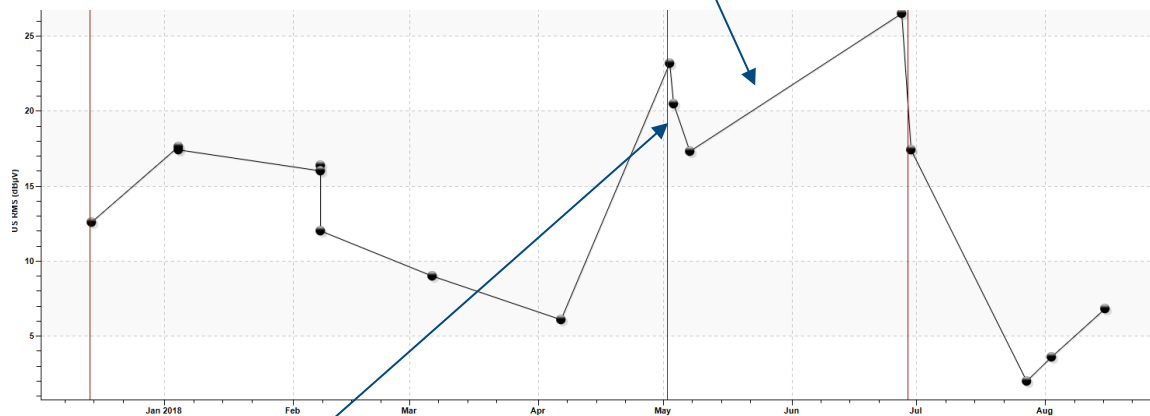
Author: SDT Ultrasound Solutions

During Ultrasound & Vibration data collection at the beginning of May increased Vibration levels could be seen as well as increased RMS (friction levels) in Ultrasound. The Ultrasound could also hear impacting coming from the bearing.

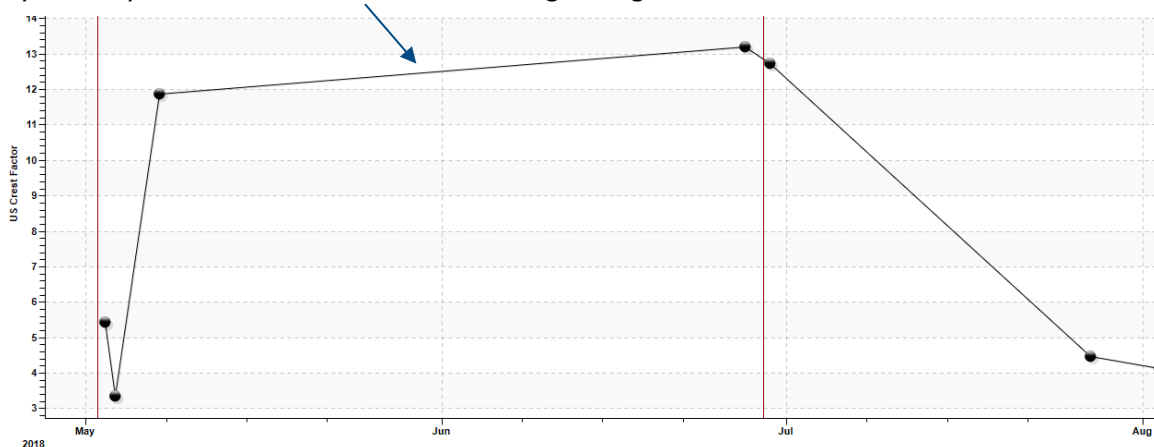
Vibration



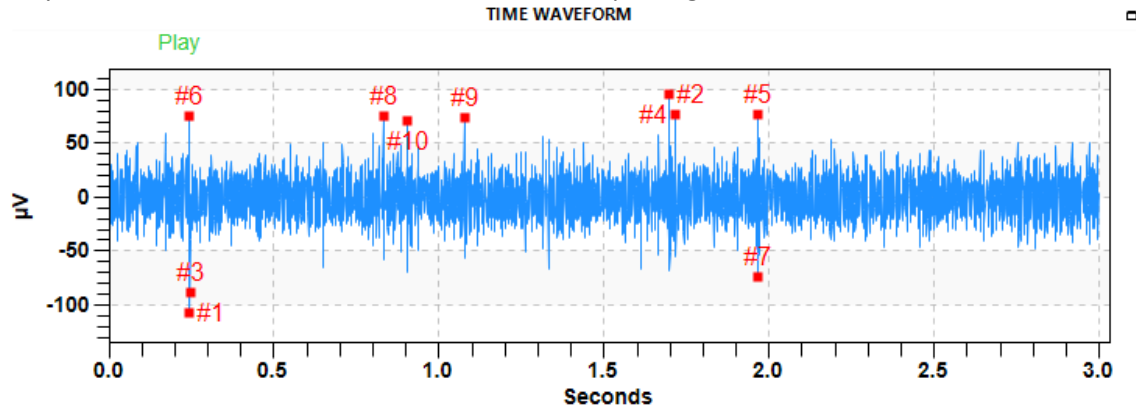
Ultrasound



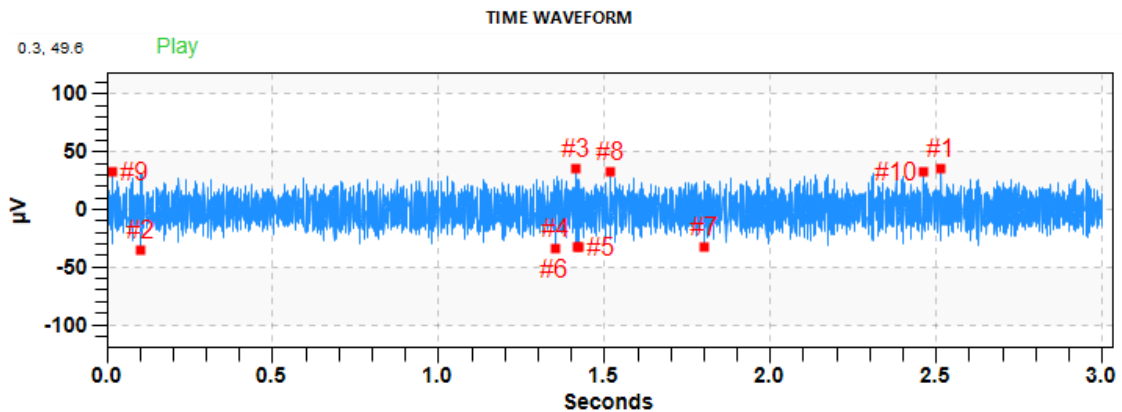
Greasing the bearing on May 3rd reduced the friction as seen by the drop in RMS over a few days and masked the impacting, but the impacting returned as seen by the Crest factor going back up to 11.88 by the May 7th. This is indicative of the bearing having a defect.



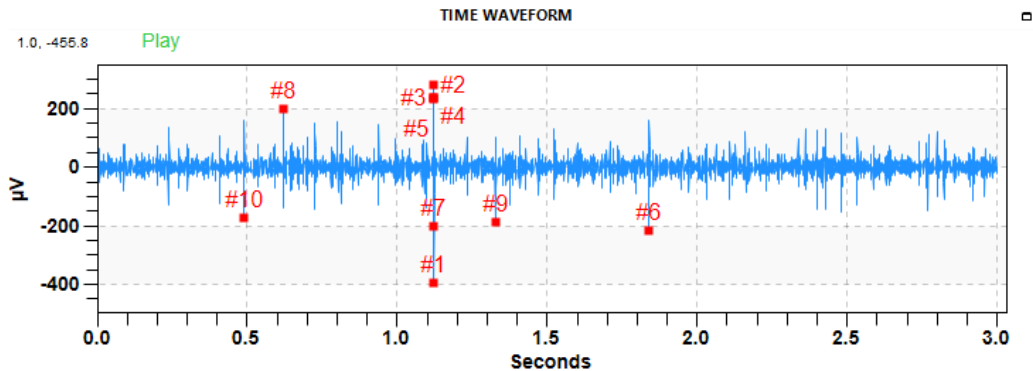
May 2nd – First Indication of increased friction & Impacting in Ultrasound.



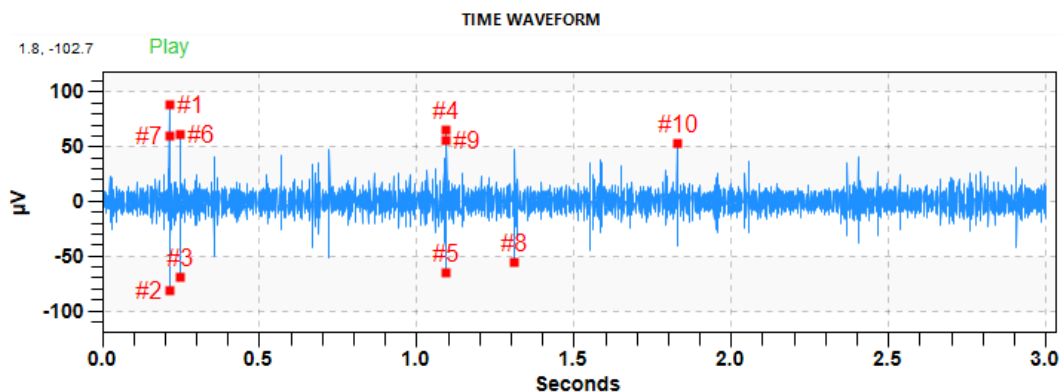
May 3rd – Greased Bearing. Reduced Friction.



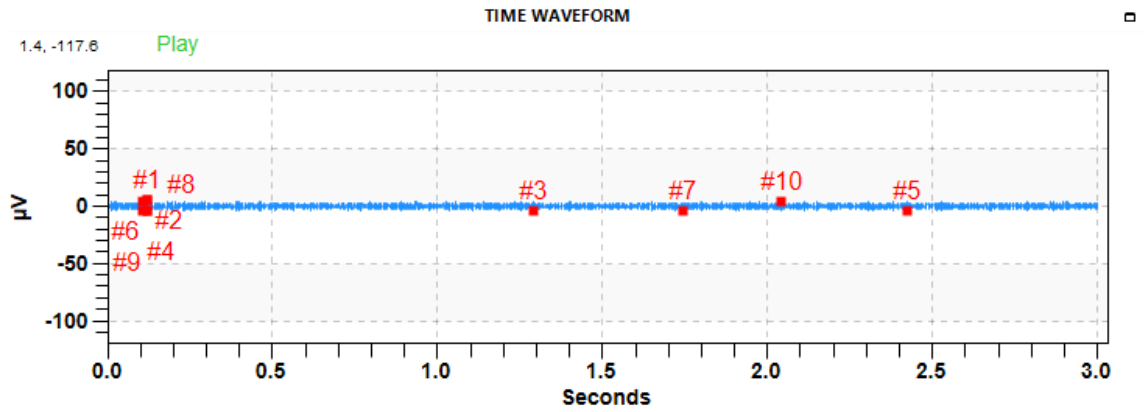
May 7th – Impacting back four days after greasing. Bearing has a defect.



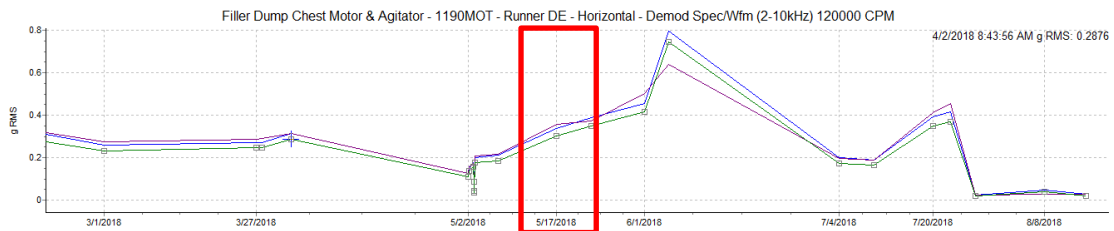
June 27th – Bearing being monitored and greased regularly but by end of June Impacting significantly worse. Scheduled for swap at next shutdown on July 24th.



July 27th – New Ultrasound reading after bearing replaced.



The g RMS trend from vibration shows increasing levels around middle of May confirming Ultrasound findings of a defective bearing.



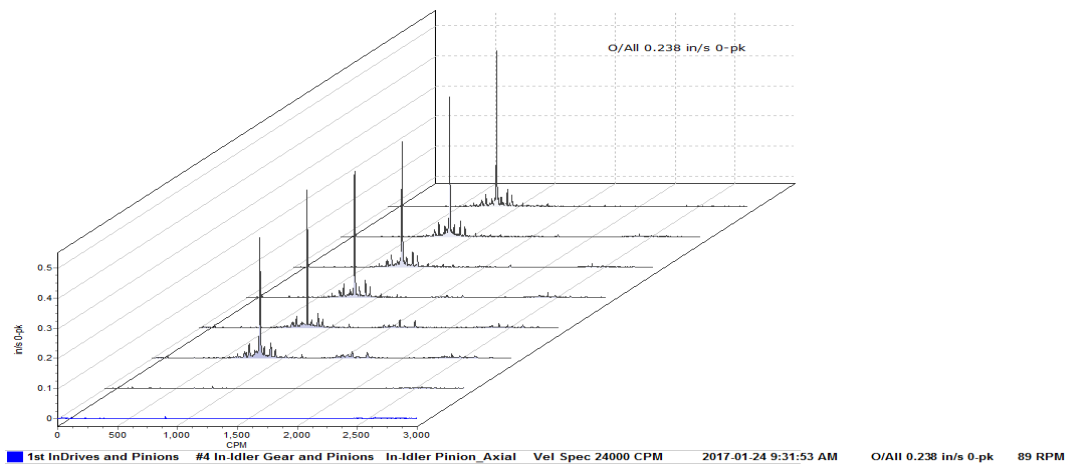
Pictures of the DE Agitator Bearing after it was removed on July 24th shutdown:



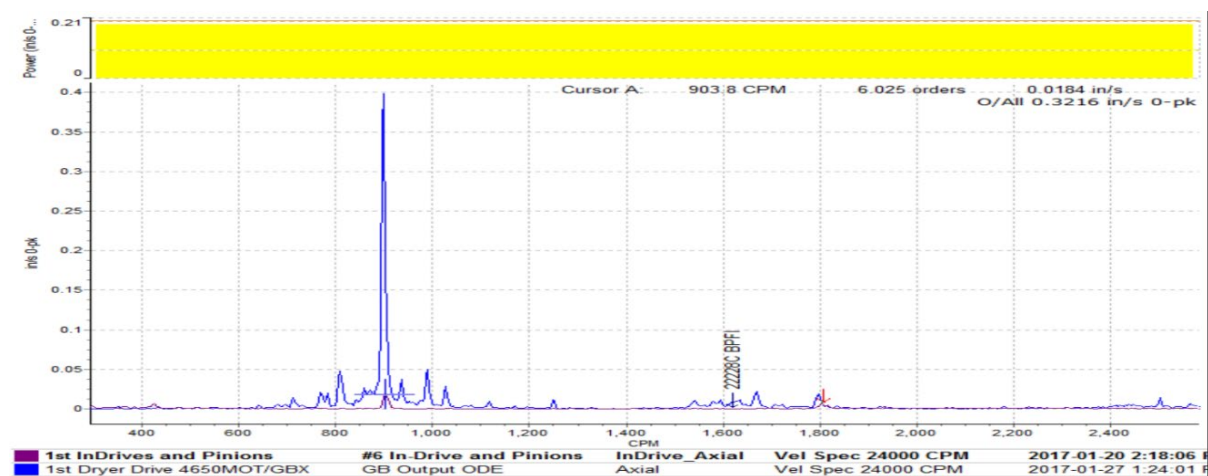
Motor & Gearbox - Pulp & Paper Facility

Author: SDT Ultrasound Solutions

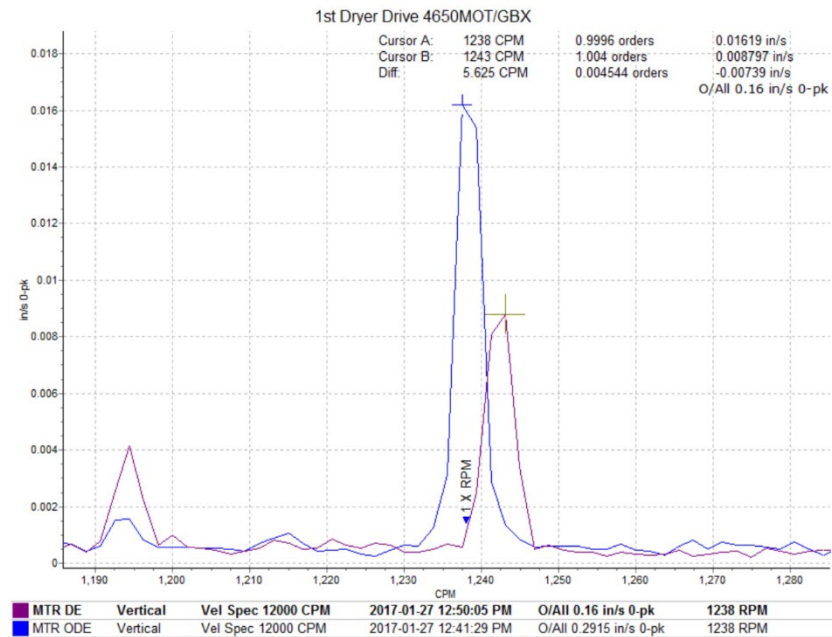
This report will cover the findings on Motor & Gearbox. This vibration was not present until this motor was changed. The motor gearbox is now vibrating excessively in the axial direction across the whole machine train when it is under a load. Usually in vibration analysis, most frequencies can be the in-drive position 4 and 6 where the 900 CPM frequency is not significant in amplitude. Related to the rotating speed of the malfunctioning component unless it is a natural frequency problem. The frequency of interest is 900 CPM, which is not related to the rotational speed of the machine. The waterfall below illustrates the high vibration in the axial direction across the machine. The First two readings belong to the In-Drive. This eliminates the In-Drive as the source of the vibration.



During the investigation, we used a strobe light to verify the speed of the DC motor. Usually under normal operating conditions the strobe light would make a reference mark (key or keyway) appear frozen. In our observation, the reference mark would vary its position 30 degrees continuously. This could be caused by either a continuous change in load or DC motor control problem. This variation could be causing a hammering on the gear train which could be causing the appearance of the 900 CPM peak as a natural frequency of one of the gears.

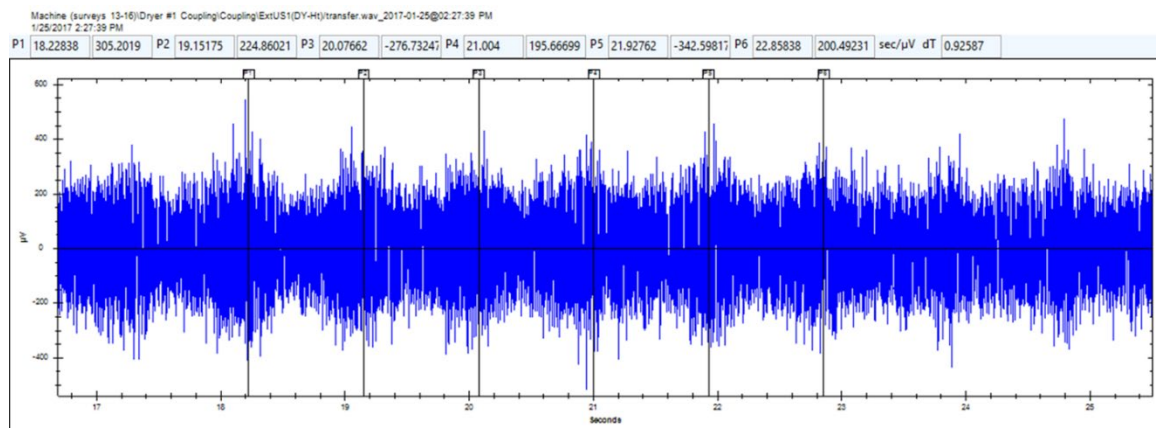


The two spectrums below illustrate the variation in speed on the motor. The first is on the DE and the second is on the ODE vertical.



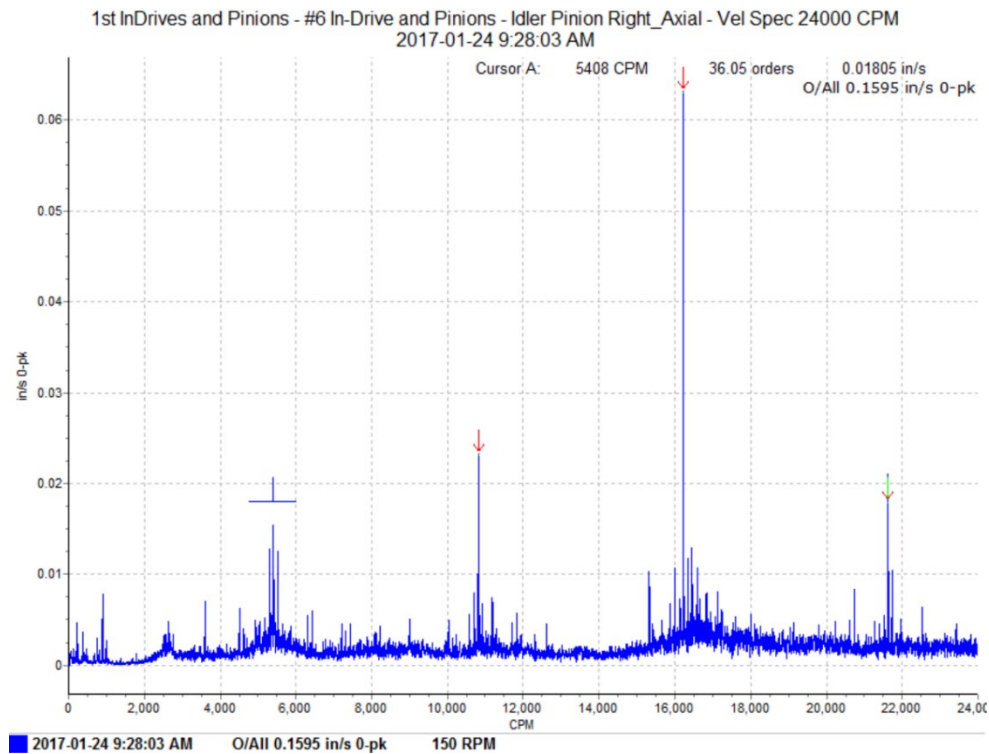
It should also be noted that on this motor the encoder shaft coupling had been replaced due to a failure.

Ultrasound readings were also taken on the output coupling. It was generating a pulsating noise which was repeating every 90 CPM or at the output speed of the gearbox possibly due to the variation of the load on the coupling due to the variation in speed.

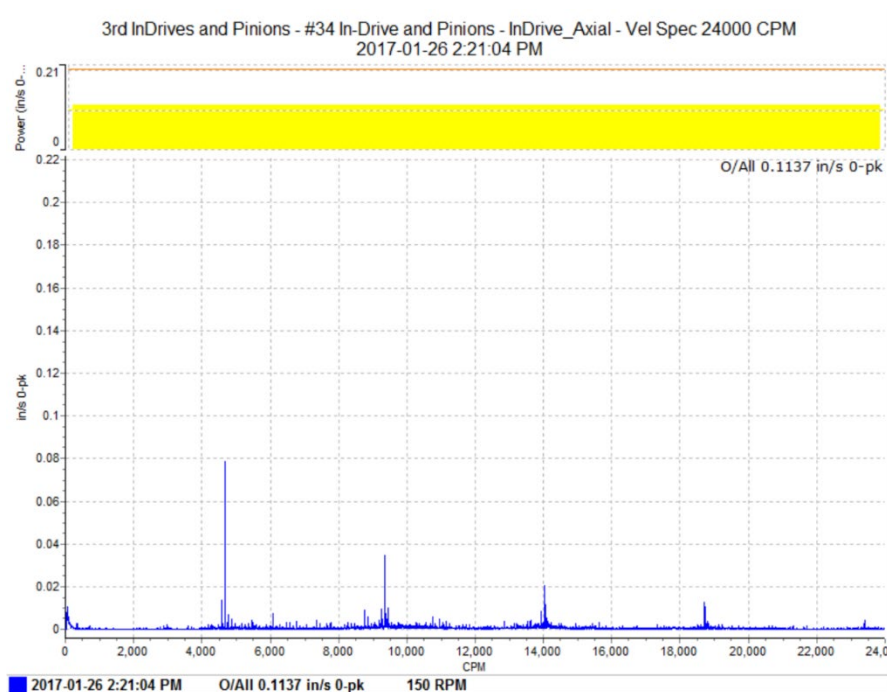


In-drive Misalignment

There is also evidence that there is a misalignment condition between the output of the gearbox and the In-Drive.



Gear Misalignment is probably the most prevalent cause of gear failure. Typically, this results from coupling misalignment between the input and/or output drive systems and the mating components. This produces Gear Mesh Frequencies (GMF) and sideband frequencies, spaced out at the rotating speed of the faulty gear. Gear misalignment can also occur internally if the gear shaft support bearings are not properly aligned with respect to one another. While not common, this problem will usually lead to premature bearing failure before gear problems are considered severe.

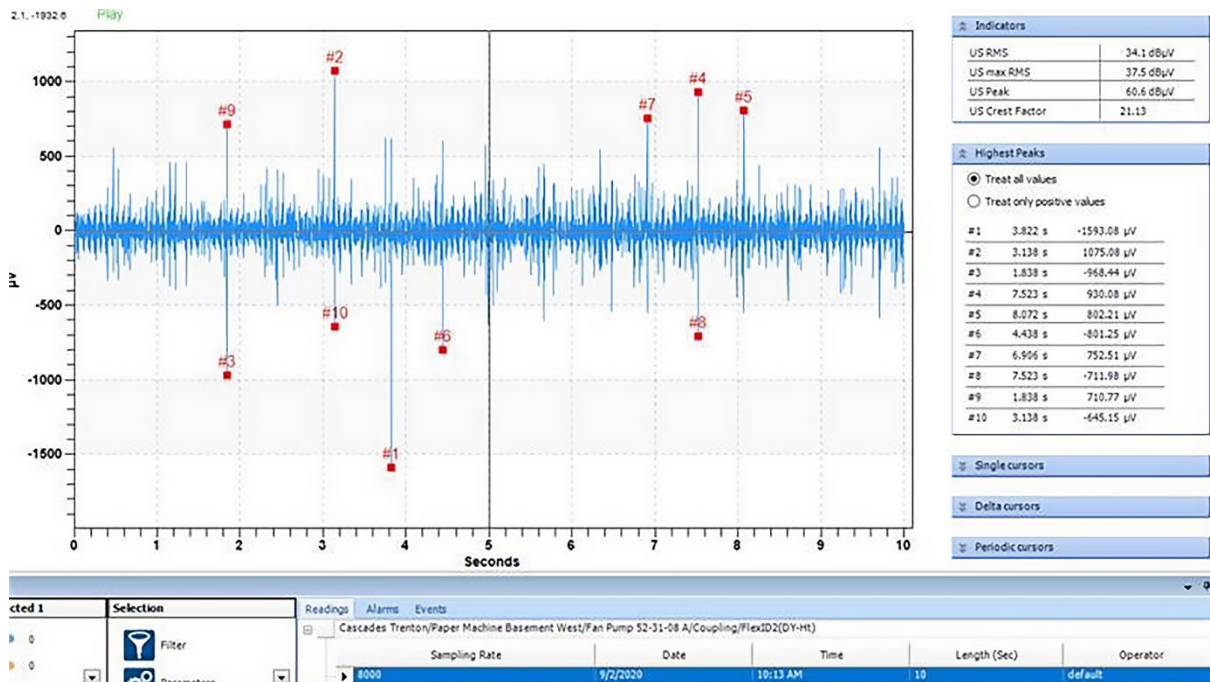


Ultrasound & Vibration on DC Motor connected to Fan Pump

Authors: Gilles Lanthier and Tristan Rienstra

Email addresses: gilles.lanthier@sdtultrasound.com and tristan.rienstra@sdtultrasound.com

The following are the time-wave and spectra ultrasound measurements, and the vibration measurements taken on the coupling of a DC motor connected to a fan pump. By using two technologies we were able to fully diagnose everything wrong with this asset.

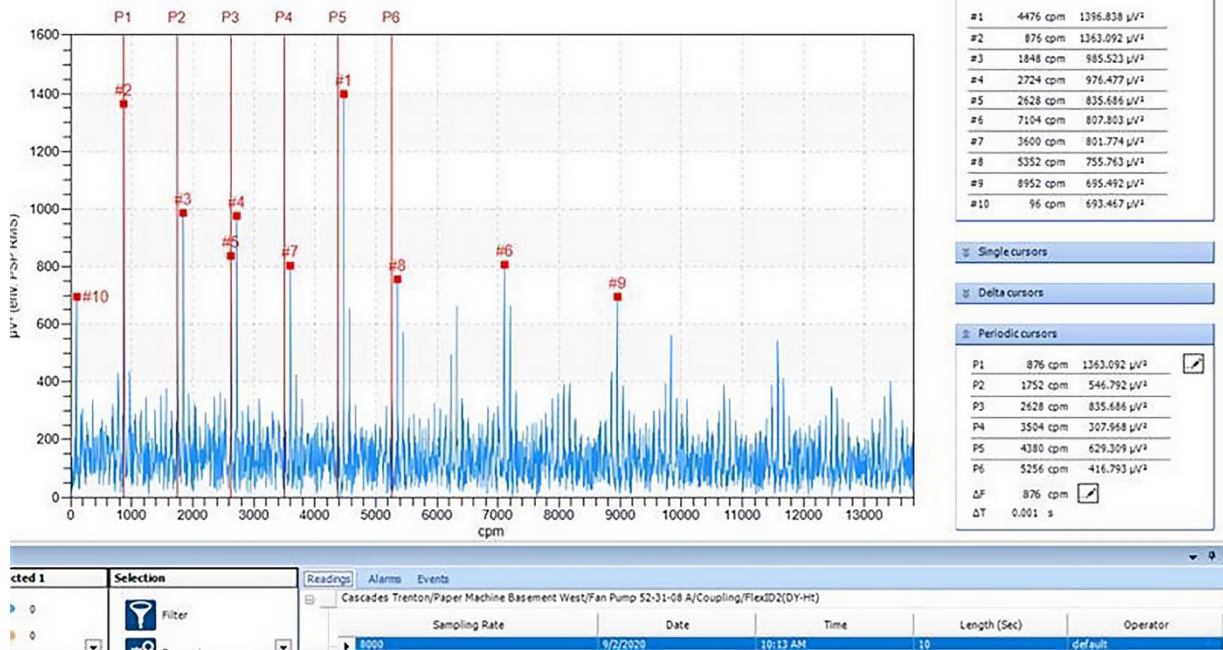


First, let's start with the ultrasound readings. As you can see in the time-wave measurement, this coupling appears to be in bad shape with lots of impacting at its regular run speed. When you look at the spectra you can note something strange, because of recurrences clearly identified with the periodic cursors. After making this discovery our data collectors from the Partnered Ultrasound team decided to utilize vibration analysis where we discovered the motor run speed was fluctuating.

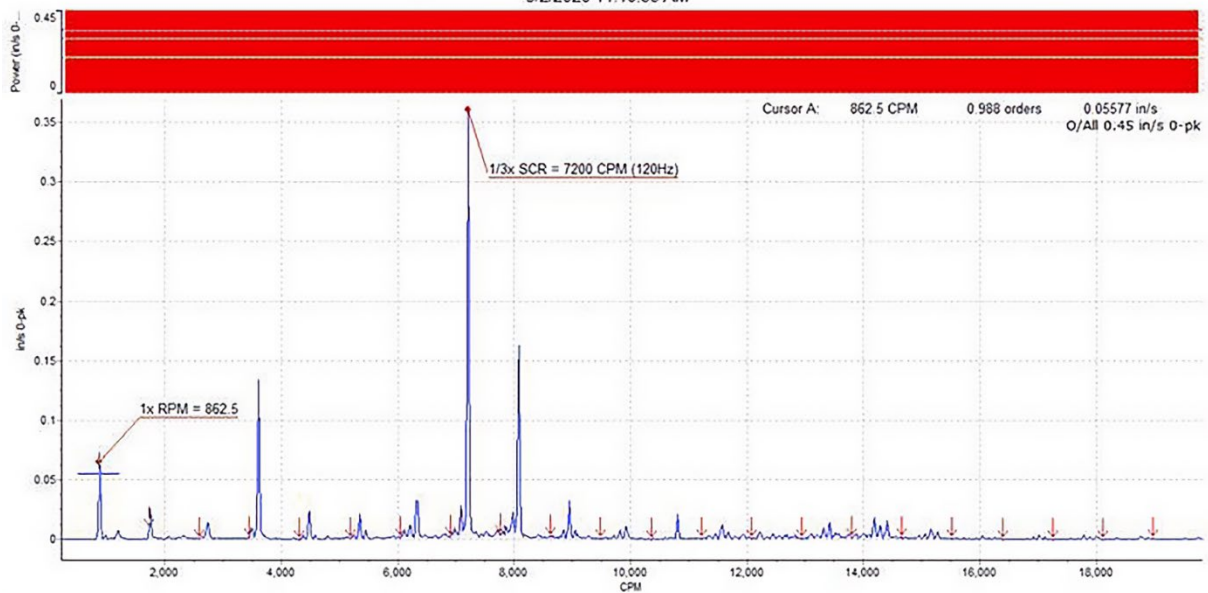
When a firing card fails, then 1/3 of the power is lost, resulting in momentary speed changes in the motor's rotation. This can lead to high amplitudes at 1/3X and 2/3X SCR frequencies. As you can see on the vibration measurement this motor was firing at 1/3X SCR which is 7200 CPM meaning 2/3rds of the firing cards were faulty.

Using two condition monitoring technologies our Partnered Ultrasound Team was able to fully diagnose the problem on this asset. Ultrasound to find the broken coupling and vibration to find 4 blown fuses out of the 6 on the DC motor.

3110 983, 13.627



Fan Pump 52-31-08 A - MTR DE - Axial - Vel Spec/Wfm 120000 CPM
9/2/2020 11:10:55 AM



Steam Up Thermal Expansion

Authors: Gilles Lanthier and Tristan Rienstra

Email addresses: gilles.lanthier@sdtultrasound.com and tristan.rienstra@sdtultrasound.com

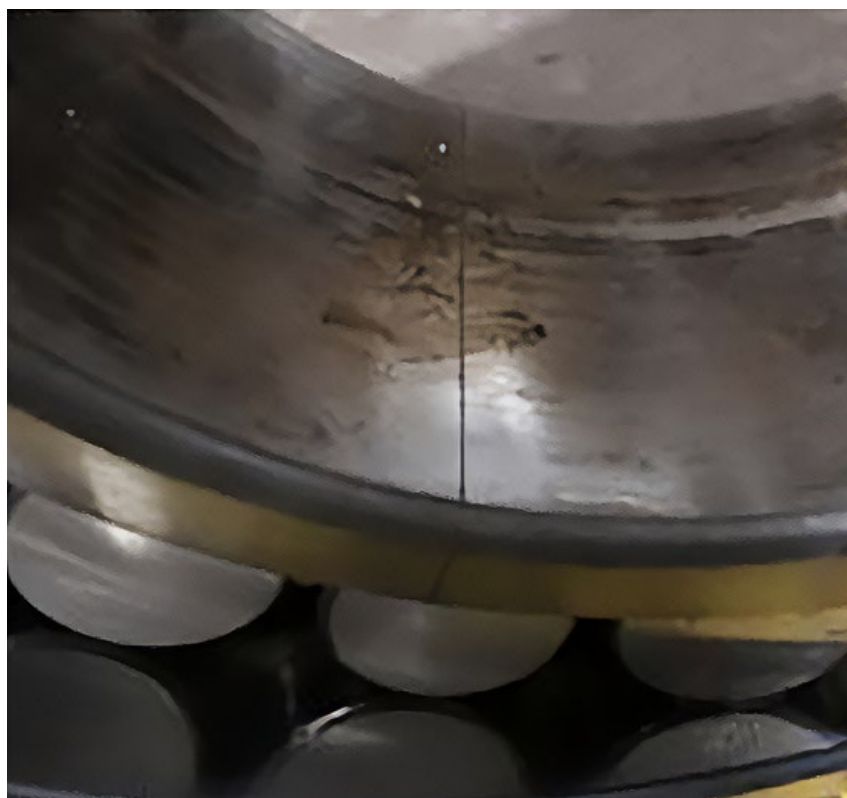
This inner race bearing on a dryer roll is the victim of thermal expansion that happened too quickly.

Factories enter shutdowns so that their assets and machinery can receive maintenance and repairs. Steam is used heavily in papermills for the process of making paper. When a paper machine is shut down for its regular scheduled maintenance the steam is shut off so that the millwrights can safely make the necessary repairs.

After the maintenance has been performed the steam is then turned back on. If the steam is reintroduced to the bearing too fast, it creates thermal shock; where the journal will rapidly undergo thermal expansion causing the split you see on the bearing in the image.

To prevent this, ensure that steam is reintroduced to the paper machine slowly, allowing for the temperature of the bearing to rise less rapidly, and therefore allowing its thermal expansion to not be so abrupt.

This defect and its cause were found by Gilles Lanthier, one of the members of our Partnered Ultrasound Team.



Paper Roll Defective Inner Race

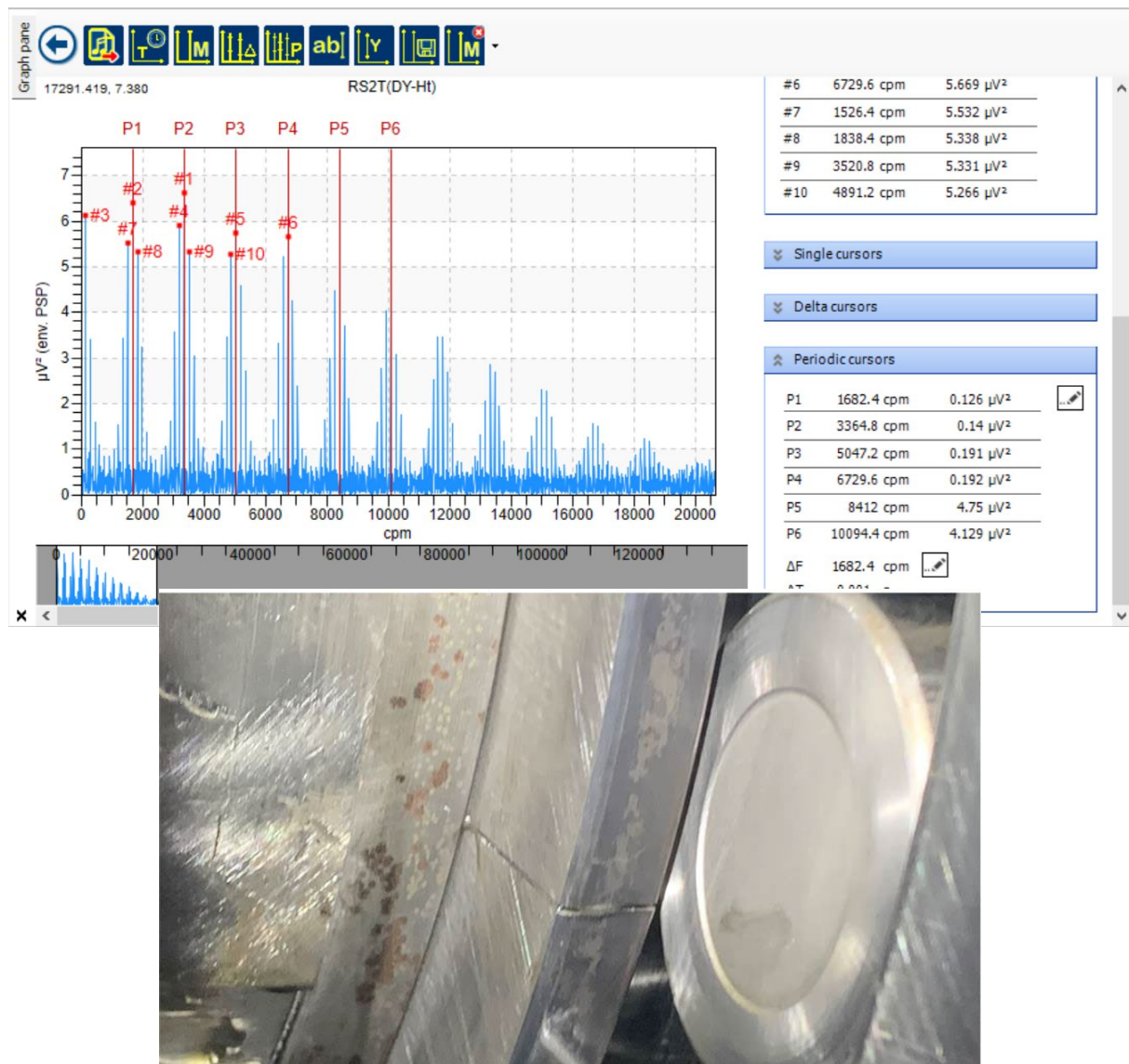
Authors: Gilles Lanthier and Tristan Rienstra

Email addresses: gilles.lanthier@sdtultrasound.com and tristan.rienstra@sdtultrasound.com

Paper roll with a defective inner race detected with ultrasound (UAS3 and SDT340).

The following is the spectrum of a slow-speed bearing (150 RPM), on a large roll (4-foot diameter), in a paper machine. Gilles Lanthier, our Partnered Ultrasound Senior Analyst found this defect using his SDT340 and performed analysis using UAS3 software. This find was then confirmed using vibration analysis.

You can use the SDT340 and UAS3 to monitor the condition of all of your slow speed rotating assets.



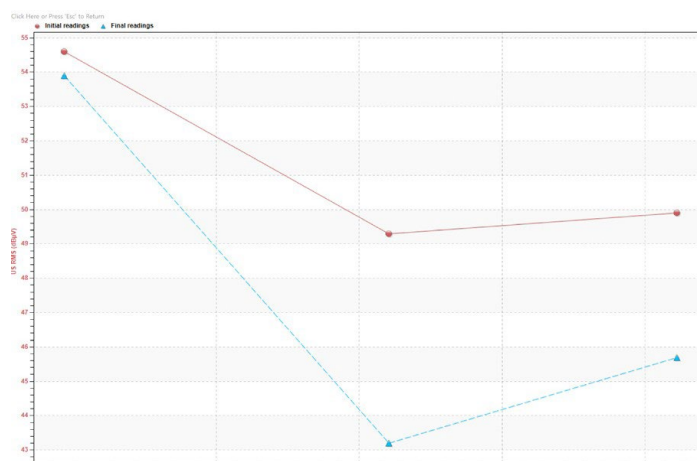
Bearing Grease Management using Ultrasound

Author: GVS Reliability Products

Inspection Technique

Greasing of bearings using ultrasound, often described as best practice, helps us understand how much grease needs to be applied. Ultrasound is a good measure of friction - too little or too much grease in a bearing produces elevated friction levels. Using ultrasound, the right quantity of grease is determined by assessing the levels.

SDT LUBExpert ensures that the right quantity of grease is applied to each bearing using ultrasound, condition-based lubrication.



The Ultranalysis[®] Suite 3 software also provides a means of storing valuable lubrication data, trending, and traceability where grease replenishment quantity, intervals and ultrasound levels are recorded. Information stored in this database may also be used to optimize lubrication schedules / intervals and for root cause failure analysis.

The LUBExpert also facilitates basic screening of bearing condition using the ultrasound crest factor algorithm.

	Level N	RMS	Max	Peak	Crest Fa	Lu	Lube Alarm Level	Grease Nam	Nb. Gr	Grease	Sa	Sof	Se	Date	Time	Manual inp	Se	In	Se	Sens	Instr	Res.F	Mixer	Lengt	Oper
		48.4	48.6	58.5	3.2		Lubrificationsuccess	AML-783	7	7	80	0x...	LU	19/09/2019	1:25 PM	☐	54	53	30	11/...	0	0	1	defa	
		56.9	57.9	69.4	4.22		Lubrificationsuccess	AML-783	6	6	80	0x...	LU	19/09/2019	1:24 PM	☐	54	53	30	11/...	0	0	1	defa	
		46.7	47.6	53.5	2.19		Lubrificationsuccess	AML-783	6	6	80	0x...	LU	12/09/2019	1:53 PM	☐	54	53	30	11/...	0	0	1	defa	
		53	53.5	66.6	4.79		Lubrificationsuccess	AML-783	5	5	80	0x...	LU	12/09/2019	1:51 PM	☐	54	53	30	11/...	0	0	1	defa	
		48.9	48.9	51.7	1.38		Lubrificationsuccess	AML-783	5	5	80	0x...	LU	6/06/2019	8:31 AM	☐	54	53	30	11/...	0	0	1	defa	
		49.2	49.9	62.9	4.84		Lubrificationsuccess	AML-783	5	5	80	0x...	LU	6/06/2019	8:31 AM	☐	54	53	30	11/...	0	0	1	defa	
		39.2	39.5	47.4	2.57		Lubrificationsuccess	AML-783	11	11	80	0x...	LU	2/05/2019	2:07 PM	☐	54	53	50	11/...	0	0	1	defa	
		46.2	46.8	57.1	3.51		Lubrificationsuccess	AML-783	6	6	80	0x...	LU	2/05/2019	2:06 PM	☐	54	53	50	11/...	0	0	1	defa	
		43.9	45	51.6	2.43		Lubrificationsuccess	AML-783	6	6	80	0x...	LU	23/04/2019	8:22 AM	☐	54	53	50	11/...	0	0	1	defa	
		49.5	50.7	66.7	7.24		Lubrificationsuccess	AML-783	6	6	80	0x...	LU	23/04/2019	8:22 AM	☐	54	53	50	11/...	0	0	1	defa	
		43.9	45.3	51.1	2.29		Lubrificationsuccess	AML-783	1	1	80	0x...	LU	9/04/2019	10:13 AM	☐	54	53	50	11/...	0	0	1	defa	
		46.5	47.3	60	4.73		Lubrificationsuccess	AML-783	1	1	80	0x...	LU	9/04/2019	10:13 AM	☐	54	53	50	11/...	0	0	1	defa	

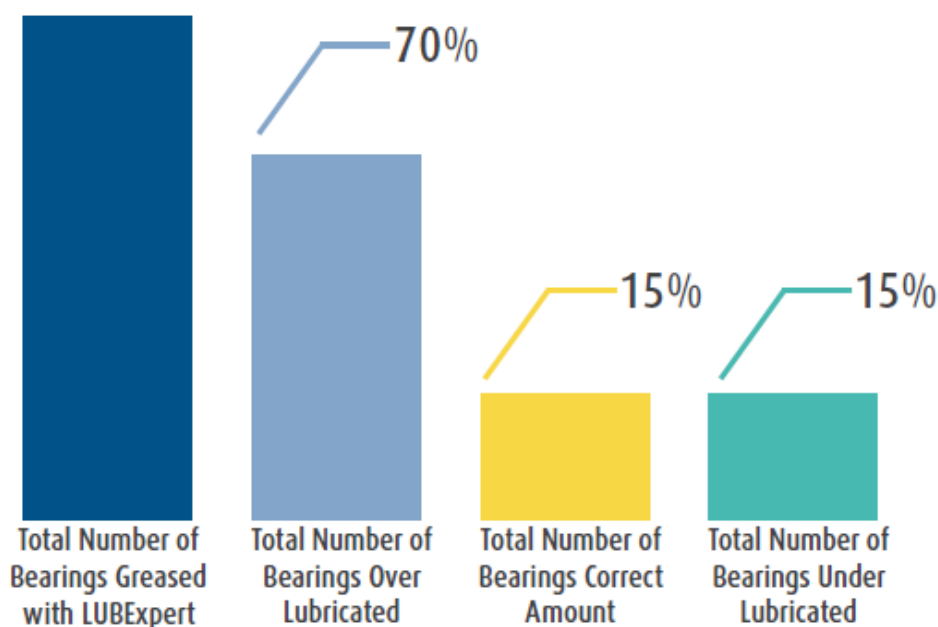
Results

After having conducted numerous trials on a large volume of grease lubricated bearings from various plants which were previously greased using fixed replenishment rates calculated from

grease application formulas and / or calculators.

In one example, using ultrasound (LUBExpert) to determine correct quantity of grease, the study indicated that approximately:

- 70% of bearings were being Over Lubricated;
- 15% of bearings were Under Lubricated; and,
- 15% of bearings had the correct replenishment rate.



Results obtained from this trial were similar to results obtained from other plants.

Conclusion

The greasing of bearings is tailored to the condition of each bearing rather than relying on fixed / calculated quantities condition-based lubrication.

Greasing using ultrasound:

- Improves equipment reliability and availability by ensuring the bearings receive the correct amount of grease;
- Information collected and stored in the lubrication database facilitates further optimization of lubrication schedules and reliability programs;
- Reduction in grease usage and optimization of schedules has cost savings implication.

Diagnosing Bearing Failure During Re-Lubrication Tasks with LUBExpert

Authors: Rob Dent and Gilles Lanthier

Email addresses: robert.dent@sdtultrasound.com and gilles.lanthier@sdtultrasound.com

Suspected Bearing Failure Discovered with LUBExpert Dynamic during Ultrasonic Greasing Task, Confirmed in UAS3

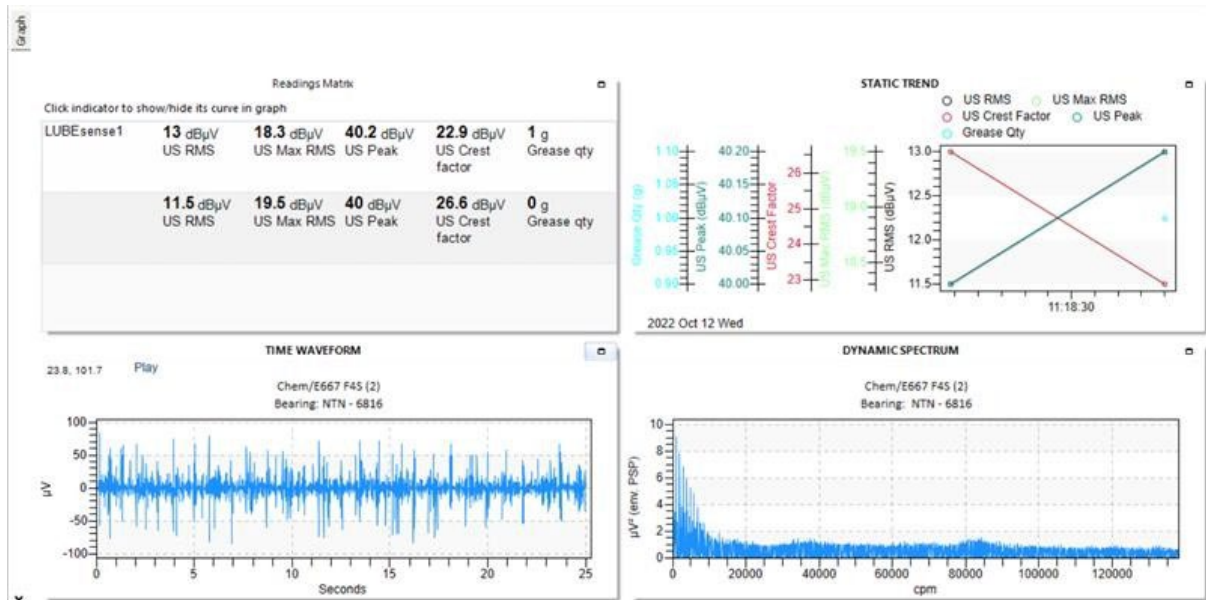
The outer race bearing defect was found by the Partnered Ultrasound Team during a routine lubrication route using a LUBExpert Dynamic.

SDT Field Services Technicians noticed the impact while listening to the lubrication task they were performing. And after greasing the bearing, its condition did not improve, indicating that the impact was not lubrication related.

After analyzing the dynamic ultrasound data in UAS3, it was confirmed that there was a suspected bearing failure.

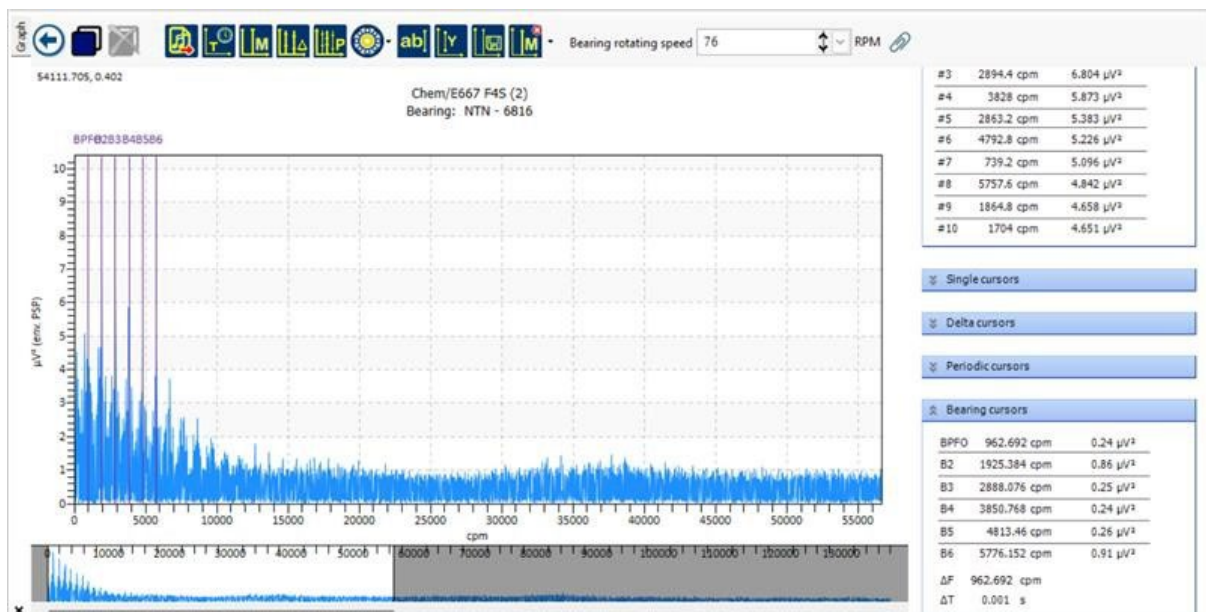


UAS3 LUBExpert Dashboard Configuration 1



UAS3 LUBExpert Dashboard Configuration 2

Further analysis using the Bearing Toolbox found that the impact was caused by an outer race defect.



Failed Bearing 2 – Figure 2 – UAS3 Bearing Toolbox, BPFO Fault Frequency Cursors.

A work order was promptly created to replace the bearing during the next planned shutdown.

What sets the LUBExpert apart from other ultrasound lubrication assistive devices is ability to listen to a bearing during a lubrication task and determine whether or not the presence of friction & impacting within the bearing are related to lubrication, or a different mechanical defect that greasing cannot fix.

Monitoring an Extreme Slow Speed Wastewater Decanter with Ultrasound

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This large wastewater decanter centrifuge is tasked with continuously separating solid materials from liquids at a Canadian Pulp & Paper Mill.

Enormous quantities of water are used in the pulp and paper manufacturing process. For the process to be successful, fibres, such as pulp, wood, wood chips, and recycled paper must be suspended in water. In doing so, large amounts of wastewater are created. This wastewater must then be recovered so it can be reused in the future. Part of the wastewater recovery process involves using a Wastewater Decanter Centrifuge.

The Wastewater Decanter Centrifuge turns extremely slowly. The Bull Gear takes about 10 minutes for it to complete one full rotation, the pinion rotates at 2.95 RPM.

Due to the slow-speed nature of this asset, an ultrasound data collector with the ability to record large amounts of data, in the form of a long acquisition time, is the best tool for the job.

When monitoring this asset, the SDT Ultrasound Solutions Partnered Ultrasound Services Team chooses to take readings with the SDT340, as it is capable of taking 10 minute readings, which are necessary to capture one full rotation of this assets bull gear.

The 10-minute time waveform recording can be observed below in Figure 1.

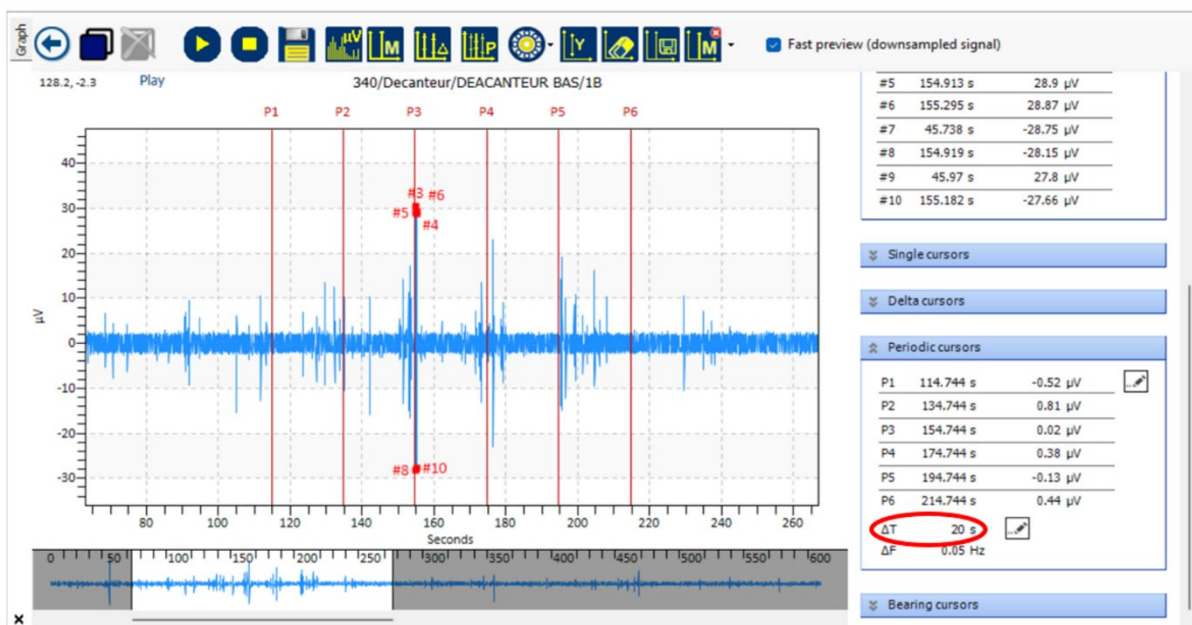


Figure 1 - 10 Minute Time Waveform of Wastewater Decanter Centrifuge Pinion

The motor powering the wastewater decanter is turning at 1785 RPM. The first reduction through a belt and planetary gearbox is 52.1 to 1. ($1785/52.1=34.26$).

The second reduction is at a ratio of 11.6 to 1. ($34.26/11.6 = 2.95$). Giving us the speed of the pinion.

Cracked and broken teeth generate high levels of ultrasound at 1 x RPM in the time waveform. Figure 2 depicts what a typical time waveform looks like when dealing with a cracked or broken tooth.

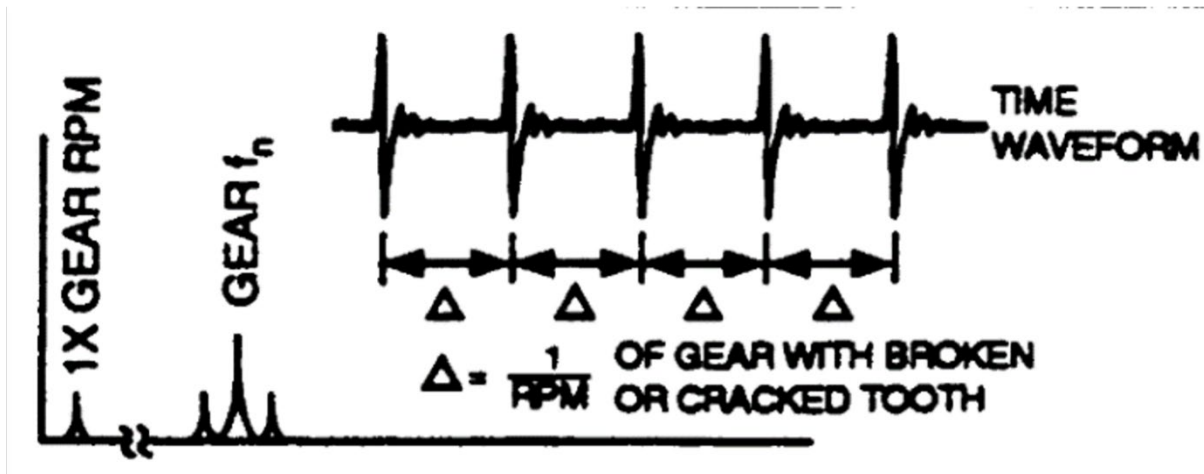


Figure 2 - Cracked or Broken Tooth

Observed in Figure 1, we can see a similar pattern to that in Figure 2. There is a pronounced spike every time the problem tooth tries to mesh with the teeth of the bull gear. The time between impacts corresponds to 1/RPM of the gear with the tooth problem. This data analysis lead SDT's Reliability Technicians to believe there is a cracked/broken tooth on the pinion gear.

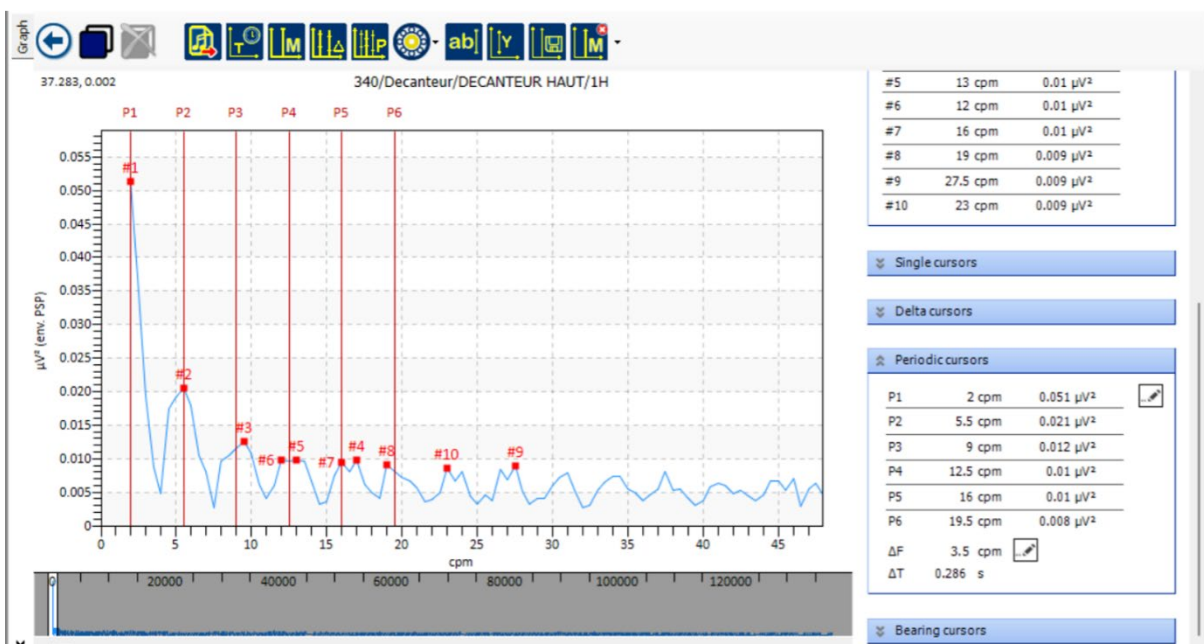


Figure 3 - FFT on the Pinion

As observed in the pinion's FFT, it can be seen that high levels of ultrasound above the sound floor are appearing at 1 X RPM.

Take into account that the resolution shows us a Delta F of 3.5 RPM. This number is not accurate as recordings were taken with too low of a measurement resolution. The real speed of the pinion is 2.95 RPM as shown in calculations earlier.

With the use of the SDT340 ultrasound data collector, the Partnered Ultrasound Team was able to record data a full rotation of an asset turning once every 10 minutes. With this data, they were able to detect a broken tooth on the pinion, despite the slow speed, and low aptitude of the impacts.

It would have been very difficult, if not impossible, to draw these conclusions with any other condition monitoring technology due to the low speed & amplitude of this defect.

Ultrasound measurement on slewing ring and expertise after replacement

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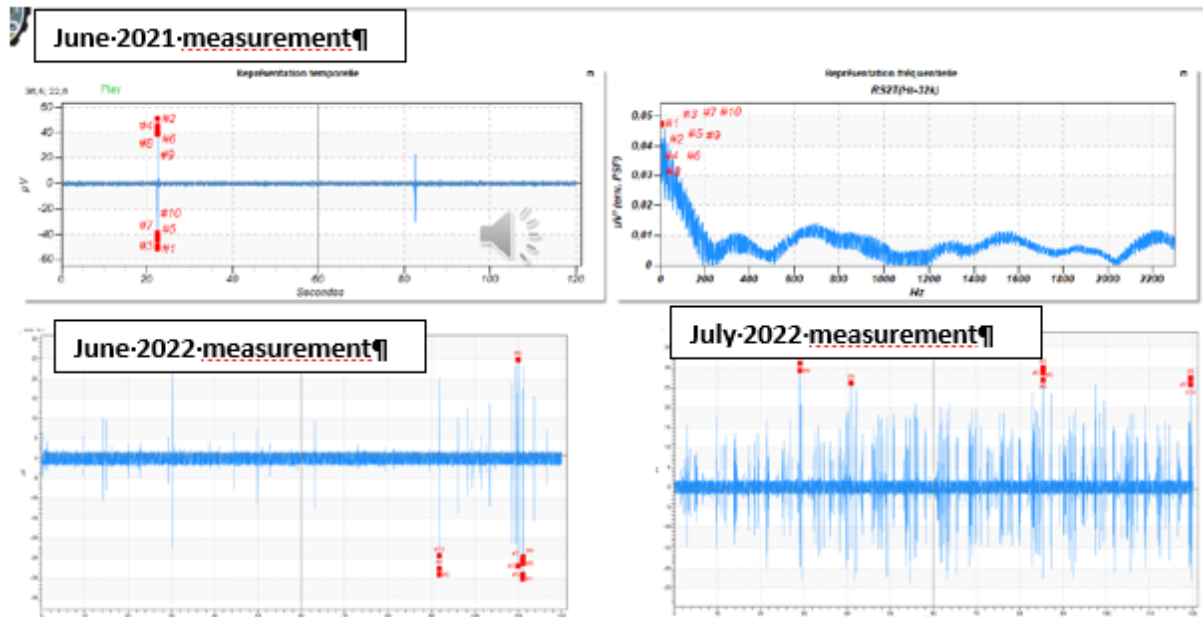
For years, the reclaimer at a paper mill in north-western France had worked reliably, pivoting on three pinions mounted on reducers. The reclaimer is used to collect wood chips from a pile and convey them by buckets. However, quite unexpectedly, the structure supporting this equipment collapsed. Fortunately, the company had implemented a monthly preventive maintenance program to monitor the condition of these slewing rings.



It was at this point that the company made a key decision. They decided to rely on technology to assess the severity of the ring's breakdown after the collapse. They used an ultrasound measuring device (SDT340), the only technology that could provide an in-depth analysis of the situation. Reference measurements taken prior to the incident were retained to enable the current state to be compared with the initial state.

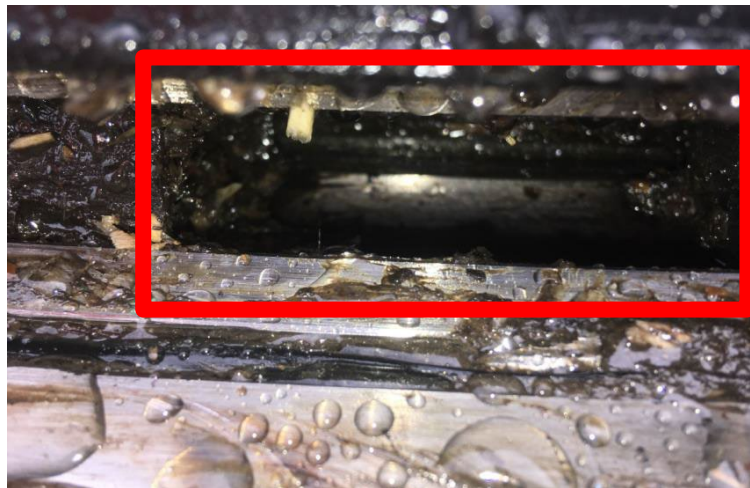
The measurement process was complex. To make an accurate assessment, they had to rotate the equipment between two of the three sprockets for one rotation cycle, which took about two minutes. In addition, there was no known frequency, at least none provided by the manufacturer, for these slewing rings. The speed of rotation was not always constant, making the task even more complicated.

However, the company was not discouraged. They knew that only a time waveform and careful listening could reveal the signs of a potential problem. By analyzing the data collected using ultrasound measurement technology, they were able to identify anomalies and deformations in the crown, indicating significant degradation.



The image above shows a rather evolutionary time waveform. Relatively normal measurements in June 2021 gradually shift towards the beginnings of unusual shocks in June 2022, culminating in a much more serious situation the following July.

After extensive work, the team was able to determine that some equipment was missing a number of rolling elements essential to its proper functioning. The missing rolling elements were probably due to wear of the "spacers" between the balls acting as cages.



Thanks to this early discovery, the company was able to take corrective action to avoid a major malfunction that would have had serious consequences for the safety and efficiency of their products. They undertook immediate repairs and reinforced their preventive maintenance procedures.

The decision to invest in ultrasound measurement technology proved to be a wise one for this company. Not only did it prevent a major incident, it also reinforced their reputation as an industry leader, demonstrating their commitment to product quality and safety. This success story illustrates

how cutting-edge ultrasound technology, prevention and innovation can save companies from potentially catastrophic situations.

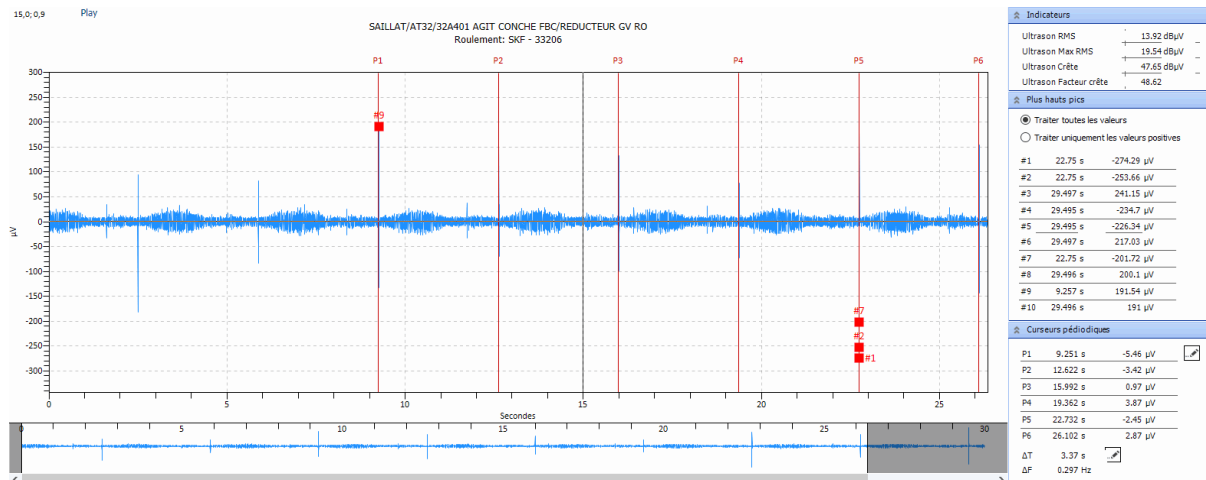
Mechanical equipment, where ultrasound comes into its own

Author: Gauthier Ghislain

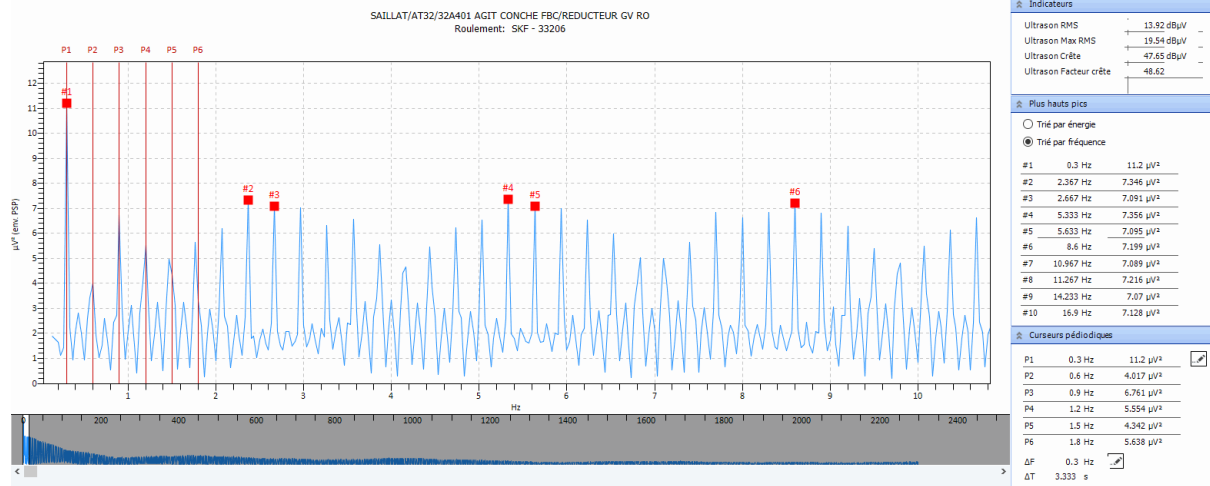
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Recently, the maintenance team at a mill in north-west France shared with SDT an unusual but crucial piece of feedback on mechanical fault detection using ultrasound, highlighting how this method surpassed the capabilities of vibration analysis in accurately identifying the problem. This paper mill had a recurring problem with its filter. This filter, essential to their production process, had a problem with annoying noise and regular shocks to the agitator. This problem was seriously affecting their productivity and the quality of their final product.

One day, the team in question decided to solve this noisy mystery using the SDT340, a state-of-the-art ultrasound measurement device. They positioned it strategically to investigate the sources of this annoying noise. After careful ultrasound listening, they discovered something interesting: shocks at a frequency of 0.3 Hz on the GV/PV points, visible in the UAS3 software in the image below.



The time waveform and frequency spectrum clearly showed a clear impact at 0.3 Hz on the GV and PV points. The maintenance team then focused their attention on the coupling location, as this was where the noise seemed to originate.



By examining the kinematics of the system, they realized that the problem resided in the gearbox that drove the filter. This reducer was linked to coupling plates, and a rubber element called a flector was placed between the coupling fingers. This gearbox drove two shafts, one on each side.

Initial diagnosis revealed that the problem affected both the PV and the GV. By moving the ultrasound sensor, they noticed that the noise was most intense at the coupling bell. On closer examination, they found that the flector was completely torn, as shown in the image below, which explained the shocks and noise. The shocks showed a coupling backlash, causing a modulation on the spectrum that even masked the GV rotation frequency.



In comparison with a vibration analysis, the team confirmed that the shock values had increased, also revealing the frequency at 0.3 Hz. This was a crucial breakthrough, as the ultrasound analysis had pinpointed the precise location of the problem, which would not have been possible using vibration analysis alone.

The recommendation was clear: the flector was in such a state that it had to be replaced immediately to avoid further damage. Thanks to this innovative approach, which combined ultrasound technology with meticulous analysis, the company solved its lime sludge filter problem and was able to resume production without disruption or disturbing noise, marking a great success in their maintenance process.

ON-GUARD Automated Lubrication System Forewarns Lubrication team of BPFO

Author: SDT North America

The LUBExpert ON-GUARD is an 8 Channel Automated Precision Lubrication System. For the past 18 months, it has been rigorously tested in a number of different industries and environments all around the world.

The Data from this Case Study comes from a Canadian Pulp & Paper Manufacturing Facility.

In Figure 1, (Pump DE) we can observe the ON-GUARD Configuration on this motor. A COMMONSense

Sensor affixed to the Grease Line for the most accurate ultrasound readings, and a pressure gauge to monitor for blockages and other pressure related issues.

In Figure 2 (Pump, NDE), we can see the COMMONSense drilled and tapped into the side of the bearing housing. The grease line & pressure gauge are not shown in this picture as they're on the other side of the bearing housing.

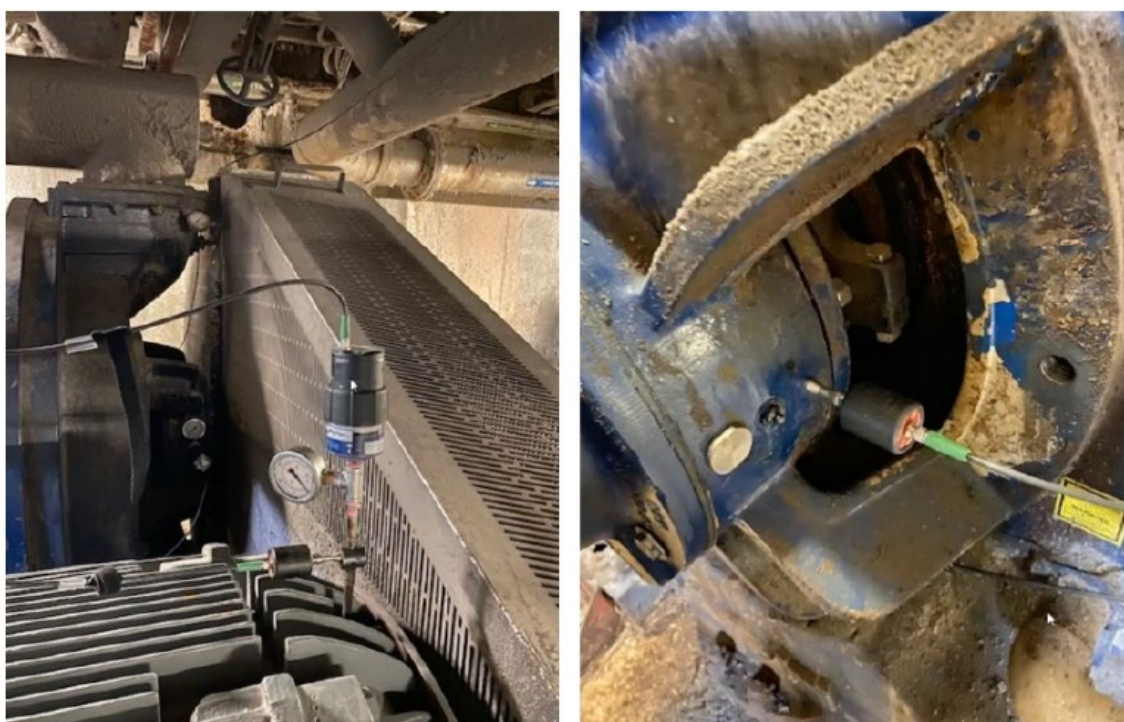


Figure 1 & 2: DE & NDE ConMonSense Sensor & Grease Cartridge Configuration

The data collected on the NDE by the ON-GUARD as seen in Figure 2 came back with a suspected bearing failure. We can observe this in the ON-GUARD Dashboard in Figure 3.

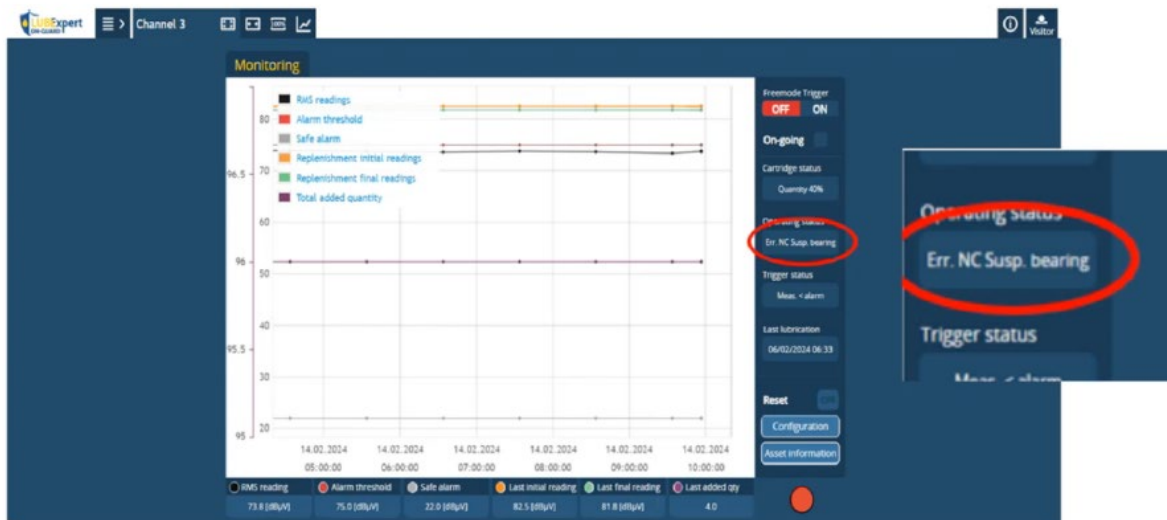


Figure 3: ON-GUARD Browser-Based Dashboard signally Suspected Bearing Failure

In response to the Suspected Bearing Failure, additional follow-up dynamic measurements were recorded using a LUBExpert. We can observe this dynamic data in Figure 4 where we can see the suspected bearing failure was proven correct. The fault frequency cursors indicate this bearing had a BPFO.



Figure 4: Dynamic Ultrasound Measurement Taken with the LUBExpert Handheld Data Collector & Analyzed in UAS3

By continuously monitoring RMS (overall friction) values of a rotating asset, the ON-GUARD determined that the bearing on the Pumps NDE had a suspected failure.

Rather than blindly pump unnecessary grease into the asset, the maintenance and reliability team were alerted to conduct additional measurements. Their follow-up data acquisition confirmed the findings of the ON-GUARD. Maintenance was scheduled for this bearing during the next planned shutdown!

Non-Intrusively Inspecting Couplings with Airborne Ultrasound

Author: SDT North America

A coupling is a mechanical component used to connect two shafts together and transfer power while providing some degree of flexibility into the system, reducing shock loads and accommodating for inaccuracies in shaft alignment. They're an essential component in many mechanical systems and manufacturing environments.

Typically, maintenance and reliability teams must shutdown the plant, disassemble, and perform a thorough visual inspection of a coupling to look for signs of mechanical wear. Having to disrupt production to perform these inspections is made worse by the number of manhours it takes per coupling. Not to mention, couplings are found in good shape all the time, only to have defects introduced to them during reassembly.



With airborne ultrasound maintenance technicians are able to perform simple inspections. Using a flexible wand sensor, airborne ultrasound signals can be captured through airgaps in guarding.

Below are some examples of airborne ultrasound signals that SDT Ultrasound Solutions Service Technicians captured while performing a condition monitoring route at a Paper Mill. To capture the data, they used an SDT340 Ultrasound Data Collector, a Flexible Wand Sensor, and UAS3 – Ultrasound Signal Analysis Software.

Figure 1 is an airborne ultrasound signal captured of a healthy coupling. This coupling is emitting very low energy, and has a stable signal with no repeated impacting.

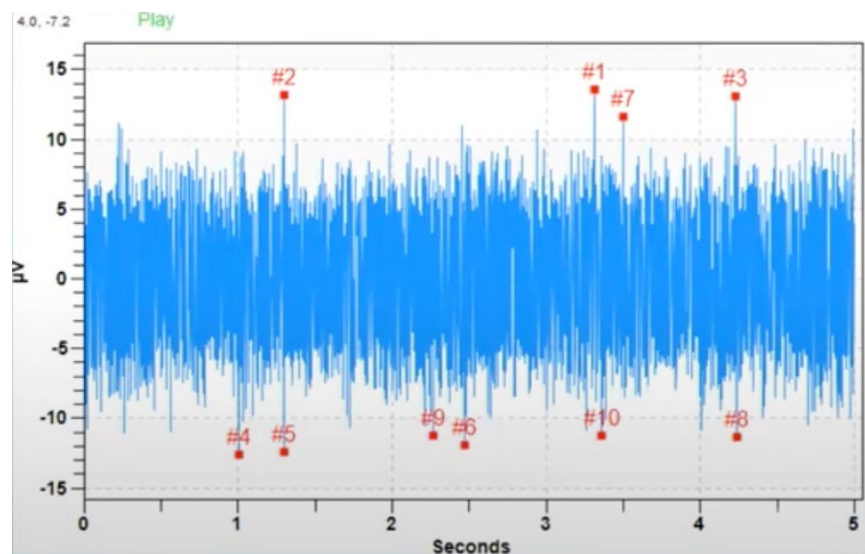


Figure 1 – Healthy Coupling Ultrasound Time Wave Form

Figure 2 is an ultrasound signal captured of a slow-speed coupling that is misaligned. Every rotation there is a large peak. There is noticeable difference in the μV between the two ultrasound time wave forms.

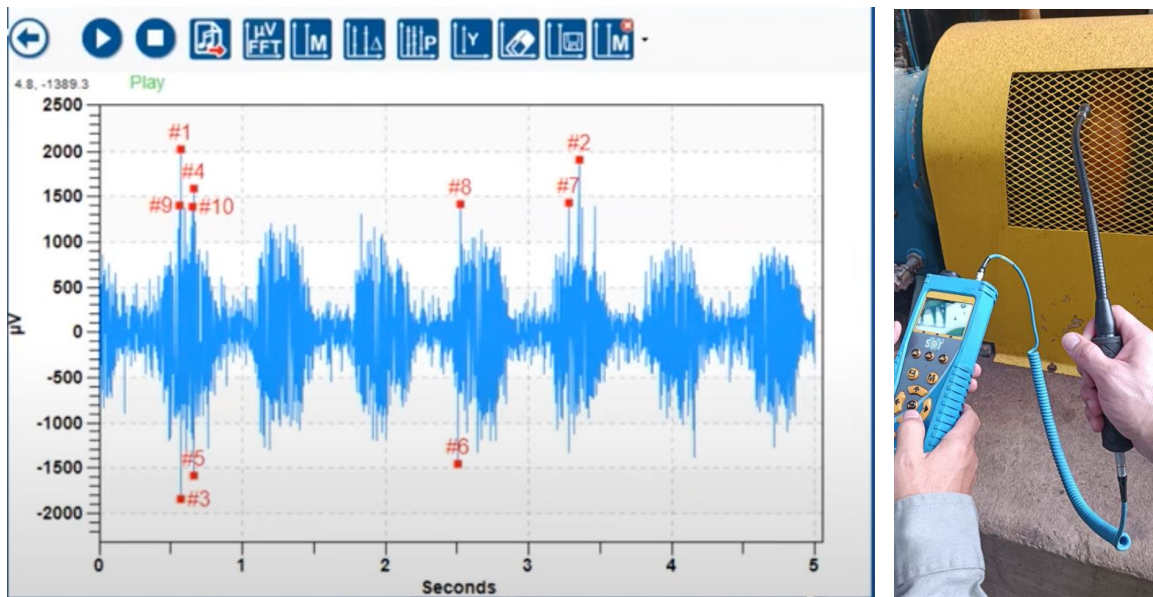


Figure 2 – Slow-Speed Coupling with Misalignment Time Wave Form

In Figures 3 & 4, a coupling with an obvious lubrication error can be observed. But by examining the ultrasound spectrum of this coupling, there is an indication of repeated impacting at run speed. In this case, SDT's recommendation would be to lubricate the coupling and then perform follow up measurements to confirm if the repeated impacting signal is still strong enough to justify further inspection.

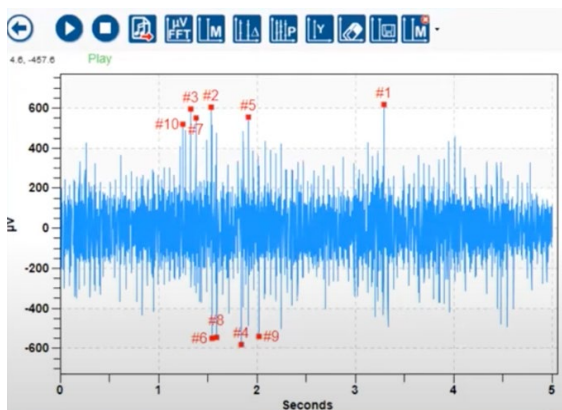


Figure 3 – Coupling that Requires Lubrication & Follow-Up Measurements Time Wave Form

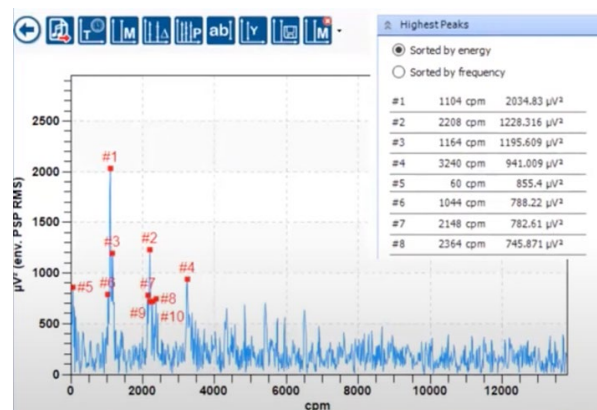


Figure 4 – Coupling that Requires Lubrication & Follow-Up Measurements FFT

In Figures 4 & 5, a severely damaged coupling was captured. There are extremely high & clear peaks at running speed seen in the FFT, and a noticeable amount of severe impacting seen in the time wave form.

As seen in the data documented in this case study, it can be concluded that ultrasound is an effective method for inspecting couplings non-intrusively, during plant operations. When a coupling produces a smooth and stable ultrasound signal, it can be safely assumed that it is operating in a healthy state.

Many maintenance and reliability teams generate PM's to be executed during plant shutdowns that involve disassembly and visual inspection of couplings. How much time could be saved if PMs were only generated for couplings that failed an ultrasound inspection?

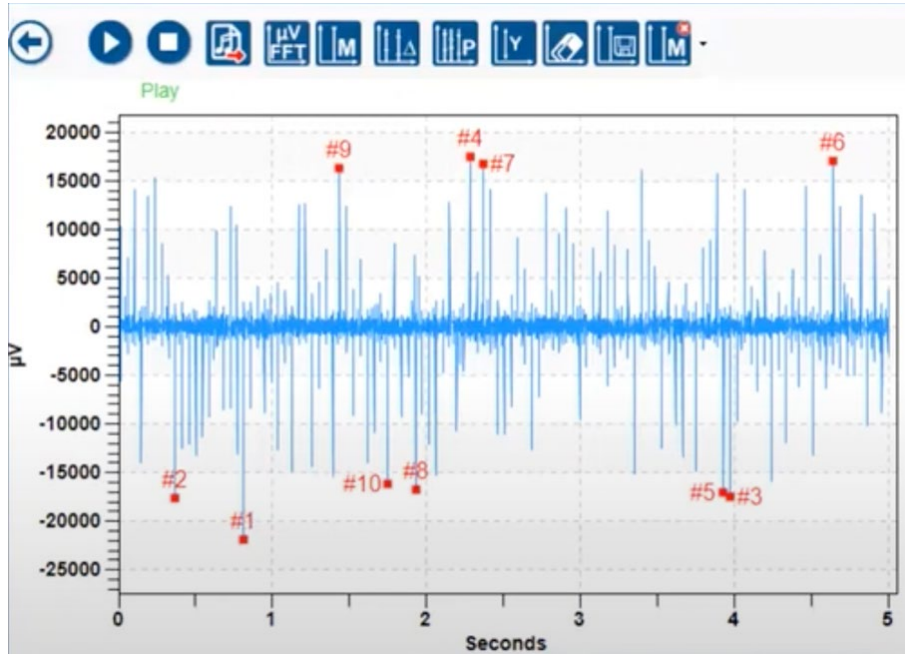


Figure 5 – Damaged Coupling Time Wave Form

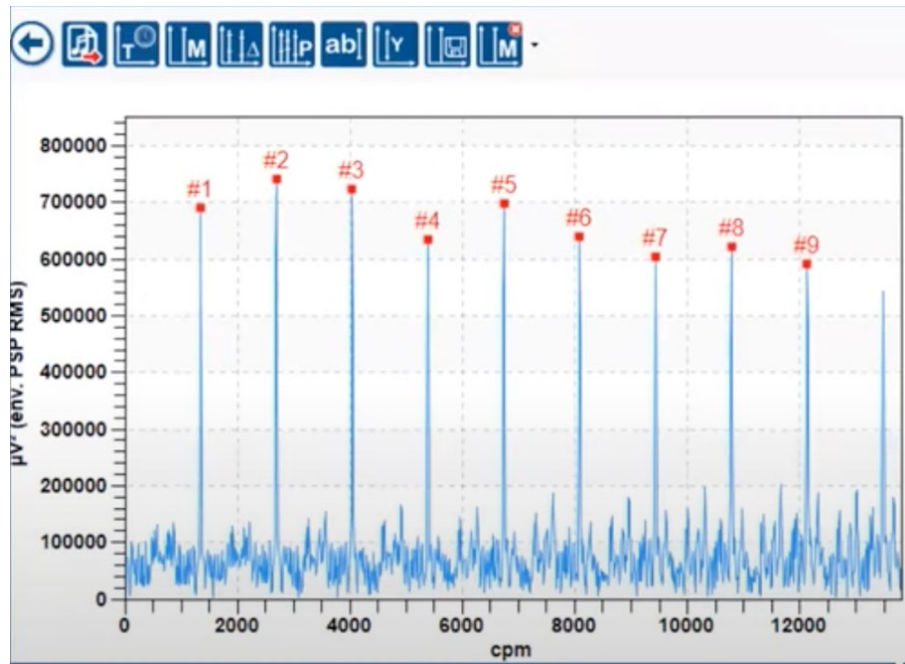


Figure 6 – Damaged Coupling FFT

Electrical Inspection on High-Voltage Transformer Leads to Corona Discovery

Author: SDT North America

Our client, a utility company operating in Europe was looking for a reliable method for the inspection of their high-voltage electrical assets under management. They recognize that total electrical systems failures are often 10 times more expensive than planned maintenance. Not to mention all the potential safety risks associated with a run-to-failure strategy with electrical assets.

Ultrasound is an effective way to pinpoint common electrical system defects such as arcing, tracking, partial discharge, and corona.

Arcing: Arcing occurs when electricity jumps between two conductors, creating a visible or invisible arc. Ultrasound can detect the high-frequency noise generated by arcing, helping technicians locate the source of the problem.

Tracking: Tracking is the formation of a conductive path on the surface of an insulating material, typically due to electrical breakdown. Ultrasound can detect the corona discharge and tracking sounds, allowing technicians to identify and repair damaged components.

Partial Discharge: Partial discharge is a localized breakdown of insulation that can lead to equipment failure. Ultrasound can detect the high-frequency noise produced by partial discharge, helping technicians identify areas of concern before a major failure occurs.

Corona: Corona discharge is a type of partial discharge that occurs in high-voltage systems, often leading to equipment degradation. Ultrasound can detect the ultrasonic signals produced by corona discharge, aiding in the early detection of potential issues.

The SDT340, UAS3, & Flexible Wand



By implementing an ultrasound-based inspection program using the SDT340 ultrasound data collector with a Flexible Sensor attachment, maintenance technicians can perform a wide range of inspections and checks on electrical systems, and equipment components utilizing airborne ultrasound.

Typically, inspections of electrical assets such as this transformer consist of scanning around air gaps in the paneling or vents. Circled in Figure 1 is where the inspectors found the defect. We're listening for distinct buzzing noises. Pristine electrical equipment is silent. Further analysis can be performed in UAS3.

In the Ultrasound Spectrum seen in Figure 2 we can see peaks with a $\Delta F = 50\text{Hz}$ (electrical frequency in Europe where the readings were taken).

Periodic shocks such as this are linked to a destructive corona effect. Which will degrade insulation further.

It was recommended that the transformer be thoroughly cleaned.

The successful implementation of ultrasound technology helped our client better monitor the health of their high-voltage electrical systems. They were able to proactively address a potential issue right away.

Reducing future downtime.

The insights gained from these inspections, coupled with the advanced analysis capabilities of UAS3, provided ultrasound inspectors with a comprehensive solution for ensuring the reliability and longevity of their electrical assets.



Figure 1 – Transformer in Question, highlighted is the area where the technician found the fault.

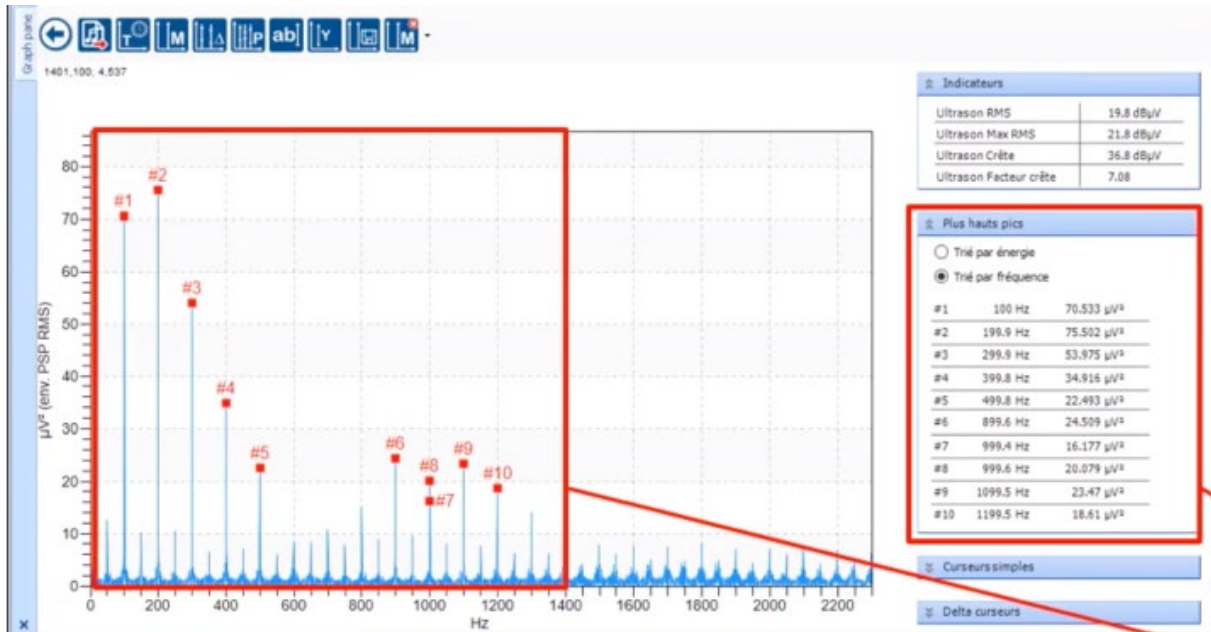


Figure 2 – Ultrasound Spectrum – Peaks at 50Hz

Transforming Bearing Reliability in a Greek Paper Mill

Authors: Gauthier Ghislain and Artemis Tzafas (REA Hellas)

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For one paper mill in Greece, frequent bearing failures were causing significant disruptions, leading to unexpected downtime, increased maintenance costs, and declining production efficiency. Despite multiple attempts to address the issue, including advice from third-party service providers, the problem persisted. It wasn't until the maintenance team adopted a new approach using ultrasound technology that they finally resolved the issue, leading to remarkable improvements in their operations.

The challenge: Unexplained bearing failures

The maintenance department at the paper mill was grappling with a perplexing problem. Bearings that should have lasted much longer were failing after just one month of operation. This frequent need for replacements was not only costly in terms of materials and labor but also caused substantial downtime, which disrupted production and threatened the company's bottom line.

Initially, the team suspected that the type of bearings used might be the issue. They followed advice from external service providers and switched to bearings with less internal clearance. However, this change did not solve the problem. With failures continuing at the same rate, it became clear that the root cause lay elsewhere.

The discovery: Over-lubrication identified as the culprit

The breakthrough came after a presentation by REA Hellas, which introduced the maintenance team to the potential of ultrasound technology for monitoring bearing lubrication and condition. Curious to explore this further, the paper mill decided to invest in an ultrasound device called the LUBEChecker and invited REA Hellas to conduct an on-site assessment of their lubrication practices.

The assessment revealed a critical issue: every bearing was being over-lubricated, causing premature failures. This discovery was a turning point. The team now had a clear path forward—by optimizing lubrication through precise monitoring, they could significantly extend the life of their bearings and reduce the associated costs.

Strategic implementation: A new approach to maintenance

With this newfound knowledge, the maintenance team implemented a more strategic approach to their work. They recognized that the bearing failures were a result of a time-based failure mode directly linked to over-lubrication. By addressing this specific issue, they could not only increase bearing longevity but also reduce grease consumption and associated costs.

The use of ultrasound technology became central to their maintenance strategy. By continuously monitoring bearing conditions and adjusting lubrication practices accordingly, they were able to prevent over-lubrication and the premature failures it caused. This proactive approach marked a significant shift from their previous reactive maintenance practices.

Expanding the impact: Beyond bearings

Encouraged by the success in resolving the bearing issue, the maintenance team decided to explore the possibility of expanding their use of ultrasound technology to other areas of the plant. They considered acquiring more advanced ultrasound equipment, such as the SDT340, which could be used for a wide range of applications including electrical inspections, valve and steam trap monitoring, and gas leak detection.

To fully capitalize on these tools, the team understood that continuous learning and skill development were essential. They aimed to build a comprehensive internal monitoring network, enabling them to collect and analyze data across various aspects of plant operations. This data-driven approach would allow them to take maintenance actions only when necessary, further increasing efficiency and reducing unnecessary costs.

Overcoming challenges: Seeking management buy-in

While the technical benefits of ultrasound technology are clear to the maintenance team, securing management's approval for further investment in these tools and practices remains a challenge. To demonstrate the potential benefits, the head of the monitoring department should propose a trial period. By setting up a framework for monitoring and comparing the results after six months, they would be able to build a compelling case for continued investment.

The team recognizes the importance of translating technical improvements into financial metrics that would resonate with management. They plan to consistently report on the cost savings and efficiency gains achieved, showing how the new approach could directly contribute to the company's profitability. However, the final decision from management is still pending.

The potential outcome: A sustainable shift in reliability

If fully implemented, the adoption of ultrasound technology could lead to a profound change in the paper mill's operations. By reducing bearing failures, the mill would experience less downtime, lower maintenance costs, and improved production efficiency. The potential success of this initiative could also foster a culture of proactive maintenance and continuous improvement within the organization.

The paper mill's journey from frequent bearing failures to potentially reliable and efficient operations is a testament to the power of innovative thinking and the right tools. By addressing the root cause of their problem and considering a strategic, data-driven approach to maintenance, they have the opportunity to achieve results that could transform their business. The success lies not just in solving a technical issue but in creating a sustainable, long-term improvement in how they operate—if management gives the green light.