The official journal of the Vibrations Association of New Zealand

Spectrum

Autumn 2025 | Issue 115

Electrostatic discharge & ammonia compressor lubrication systems

PART TWO

+

Filling slot bearings

RCA of process flow vibrations

IT'S HERE...

- Full timetables
- Speaker bios and more...

Conference 25

NEW PLYMOUTH, NZ

CONTENTS

Issue 115 | Autumn 2025

Features

Regulars

Spectrum

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Spectrum is published by the Vibrations Association of New Zealand (VANZ). The magazine is produced in a quarterly cycle annually in both digital and printed mediums.

The magazine is designed to cover all aspects of the Vibration, Condition Monitoring, Reliability and the wider Predictive Asset Management field and distributed to all VANZ members, including corporate members.

Missed an issue?

Simply scan the QR code here to link your device directly to the VANZ website. There you will find Spectrum issues available to view or download*. You can also access previous issues by visiting our website online at: **www.vanz.org.nz**

**QR code reading app need on your device first.*

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Comprehensive condition monitoring in a (3-axis) device!

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Predictive maintenance is becoming more essential, as industry rely on the longevity and efficiency of their equipment. By employing VVB3 sensors, companies can make informed decisions, and take proactive steps to avoid equipment failure, extending the life of their machinery.

Condition indicators
Obtain digital indicators for fatigue, impact, friction, crest and temperature from one sensor

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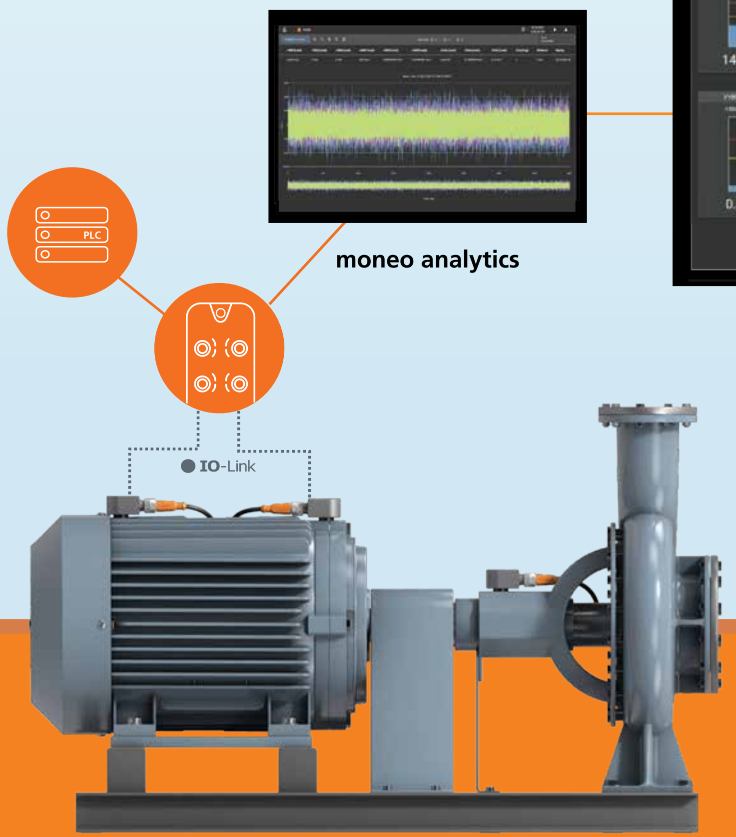
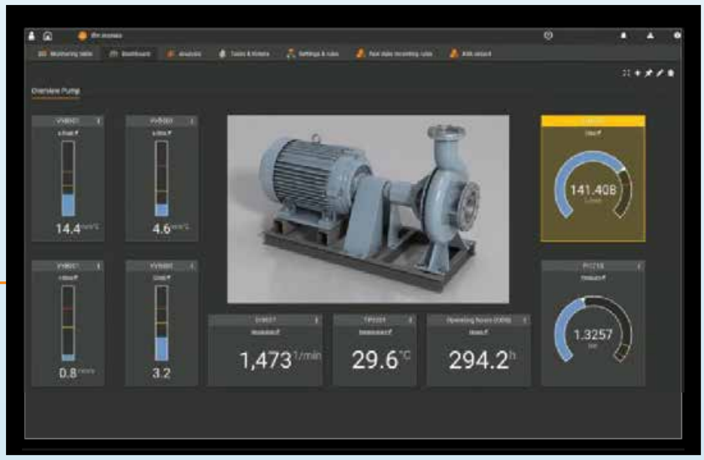
- Machine health - continuous transparency of machine reliability.
- With the new VVB and the IIoT platform moneo, maintenance is easier than ever before.





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PRESIDENTS' REPORT

By Tim Murdoch | VANZ President

The first quarter of the year is already completed and its almost conference time! How has the year started out for you?

My term as President of VANZ is coming to an end at the upcoming conference. It is a privilege to be a part of the VANZ community. My team have been amazing and putting in so much effort towards planning and preparation. Our goal is to bring you an engaging conference this year, a place of learning from each other, a place to talk directly with exhibitors and see new technology advances and plenty of opportunities to network.

A big thank you goes out to our Platinum sponsor ABD Group for their support in the leadup to the conference. Make sure to check their exhibition booth out and have a talk to their reps at the conference. We have a good number of exhibitors attending covering a wide range of specialty equipment and products. Make the most of having them there to engage with them face to face.

Presenters will be working hard to fine tune their presentations ready to teach, entertain, inspire and inform you. The timetable is set and can be found inside this magazine and will be published on our website also. One of the greatest things about the VANZ conference is you not only learn a few things but it's a great place to connect with people and make new friends and new contacts.

This year we have the privilege of a dinner guest speaker that I know a lot of you will be familiar with. Thank you to Allied Petroleum for sponsoring and organising this. Look inside the magazine to find out who it is and make sure your dinner tickets are booked!

> **"This year we have the privilege of a dinner guest speaker that I know a lot of you will be familiar with. Look further inside to find out who it is..."**

There have been changes in the Incorporated Societies Act 2022 from the old 1908 Act that is requiring VANZ to reregister as an Incorporated Society and make updates to our constitution. This is underway and will be presented at our AGM held at the conference at 9:35am Thursday 22May. Please come along to the AGM to agree on the reregistration and review the operational processes set out in the constitution.
Register now at www.vanz.org.nz.

See you at the conference!

VANZ
VIBRATIONS ASSOCIATION *of* NEW ZEALAND

Conference 25

20-22 May 2025

Plymouth International Hotel | New Plymouth

Join us for the VANZ 2025 Conference event!

Be in great company as you will be joined by a wealth of industry leaders over three days of presentations, disccusion, trade and more...

Don't forget; if you send a trainee, apprentice, or student, they can get access to the Awareness Day (Day 1) for **FREE**. If they wish to stay on for the remainder of the conference, they get in for **HALF PRICE!**

Register now, if you haven't done so already...
Time is running out!

For more info,
please contact us at:
www.vanz.org.nz or
secretary@vanz.org.nz

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Conference Timetable

New Plymouth, NZ

Note. Correct at the time of print. Timetable could be subject to change.

Conference 25

Tuesday 20th – Thursday 22nd May 2025

Tuesday 20th May - Day 1

Practical Condition Monitoring Awareness plus **Reliability Improvement**

Start	Duration	End		
7:45 AM	**0:30**	**8:15 AM**	**Registration and Exhibition / trade Stand area is open for viewing, with Tea and Coffee available**	
8:15 AM	0:05	8:20 AM	Welcome to Conference 2025: **VANZ President**	
8:20 AM	0:05	8:25 AM	Overview of Conference Timetable for the Day and the next 2 days: **VANZ Vice President**	
8:25 AM	0:20	8:45 AM	Exhibitors Introductions	
8:45 AM	0:45	9:30 AM	Keynote Presentation: **Rob Simmonds:** "All About Size" - Wear Debris Analysis versus ICP	
9:30 AM	**0:30**	**10:00 AM**	**Morning Tea in the Exhibition room / Trade Stand area**	
Two Streams of Presentations			**The Tradesman's Tools' and installation specifications**	**Asset Management and Reliability Improvement**
10:00 AM	0:30	10:30 AM	**Dr Iain Epps:** Awareness Day Intoduction	**Peter Haines:** Innovative Tools for Monitoring, Inspection and Greasing
10:30 AM	0:30	11:00 AM	**Bruce Shepherd:** Vibration Analysis	
11:00 AM	0:30	11:30 AM	**Will Dale:** Mechanical Seals	**Dr Iain Epps:** Condition Monitoring: People, Power, and Data
11:30 AM	0:30	12:00 PM	**Dr James Neale:** Infrared-Ultrasound	
12:00 PM	**1:00**	**1:00 PM**	**Lunch in the Exhibition room / Trade Stand area**	
1:00 PM	0:30	1:30 PM	**Chris Unsworth:** Lubrication Distribution	**Julien Maffre:** Developing Asset Strategies
1:30 PM	0:30	2:00 PM	**Mike Wharry:** Oil Analysis	**Robert Dent:** Program Initiation and Sustainability Stage 1
2:00 PM	0:30	2:30 PM	**Chris O'Leary:** Alignment of Rotating Equipment	**Clyde Volpe:** Developing a Reliability Drive (Strategy) by using you CM data
2:30 PM	**0:30**	**3:00 PM**	**Afternoon Tea in the Exhibition room / Trade Stand area**	
3:00 PM	0.30	3:30 PM	**John Clynes:** Fitting of Bearings	**Robert Dent:** Program Initiation and Sustainability Stage 2
3:30 PM	0:30	4:00 PM	**Craig Carlye:** Introduction to Computerised Maintenance Management	**Steve Hall:** My Condition Monitoring journey for Waikato Regional Council – Warts and all
4:00 PM	0:30	4:30 PM	**Round Table Discussions** - Your chance to ask your questions from todays presenters, panel experts and colleagues on a specific subject at an assigned table.	**Round Table Discussions** - Your chance to ask your questions from todays presenters, panel experts and colleagues on a specific subject at an assigned table.
4:30 PM	1:15	5:45 PM	**'Meet & Greet' Networking** | Complimentary Refreshments and Canapés available in the Exhibition Area	

Brought to you by: VANZ VIBRATIONS ASSOCIATION *of* NEW ZEALAND

Major sponsor: ABD GROUP

Wednesday 21st May - Day 2
Main Conference

Start	Duration	End		
7:30 AM	**0:20**	**7:50 AM**	**Registration and Exhibition / Trade Stand area is open for viewing, with Tea and Coffee available**	
7:50 AM	0:05	7:55 AM	Welcome to Conference 2025: VANZ President	
7:55 AM	0:05	8:00 AM	Today's agenda: VANZ Vice President	
8:00 AM	0:25	8:25 AM	Exhibitors Welcome and Introductions	
8:25 AM	0:40	9:05 AM	Keynote Presentation: **Rob Simmonds**: Ammonia Compressor Case Study using the Microscope	
9:05 AM	**0:30**	**9:35 AM**	**Morning Tea in the Exhibitor room / Trade Stand area**	
Two Streams of Presentations			**Stream 1: Room One**	**Stream 2: Room Two**
9:35 AM	0:40	10:15 AM	**Clyde Volpe:** Time Wave Forms learning how to interpret what its telling you	**Larry Wiechern:** Counterfeit Products
10:15 AM	0:40	10:55 AM	**Mike Yardley:** Motion Amplification - Visualisation	**Mike Davis:** Understanding the Causes and Impacts of Stator Endwinding Vibration
10:55 AM	0:40	11:35 AM	**Steve Hall:** Flood Protection Asset Care program	**Rico Van Niekerk:** Keeping it simple monitoring Wind Turbines
11:35 PM	**0:50**	**12:25 PM**	**Lunch in Exhibitor room / Trade Stand area**	
Two Streams of Presentations			**Stream 1: Room One**	**Stream 2: Room Two**
12:25 PM	0:40	1:05 PM	**Ian Van der Sar:** Case Studies	**Paul Bosauder:** Improving Reliability and Performance in Complex Engineering Systems
1:05 PM	0:40	1:45 PM	**Erik Vandenberg:** IoT and online VA for increasing predictive and on-condition maintenance strategies	**Sven Fleischer:** Laser Alignment, Line-Bore or Horizontal and Vertical Shafts
1:45 PM	0:40	2:25PM	**John Clynes:** When Critical Plant Goes Down	**Peter Caldwell:** What features/functions are important in an online CM system
2:25 PM	**0:30**	**2:55 PM**	**Afternoon Tea in the Exhibitor room / Trade Stand area**	
2:55 PM	0:40	3:35 PM	**Nick Eleftheriou:** Industry 4.0, and Non-Destructive Evaluation 4.0	
3:35 PM	0:40	4:15 PM	**Dr Iain Epps:** Defect Severity Measurement: Foundations and Next Steps	
4:15 PM	1:00	5:15 PM	**'Meet & Greet' Networking** | Complimentary Refreshments and Canapés available in the Exhibition Area	
6:00 PM	**3:30**	**9:30 PM**	**Conference dinner**	

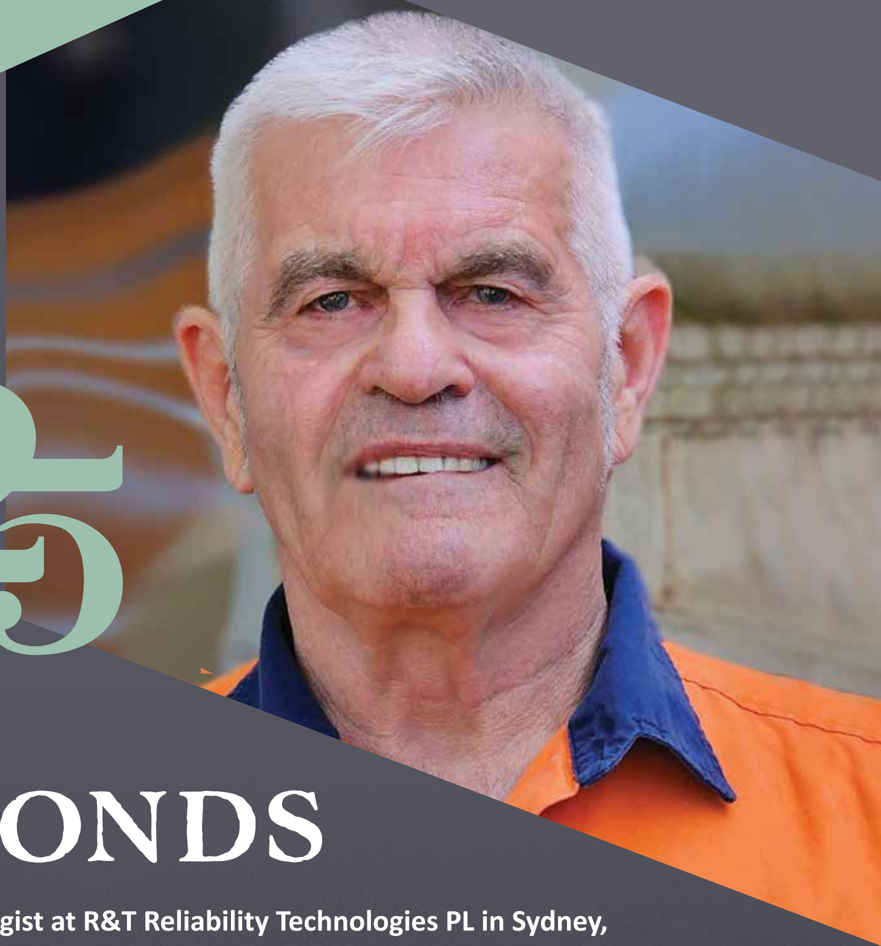
Thursday 22nd May - Day 3
Main Conference

VANZ AGM will be held at 9:35am
PLEASE ATTEND!

Start	Duration	End		
7:30 AM	**0:30**	**8:00 AM**	**Exhibition room / Trade Stand area is open for viewing, with Tea and Coffee available**	
8:00 AM	0:50	8:50 AM	**Rico Van Niekerk:** Artificial Intelligence within Industry 4.0	
8:50 AM	0:45	9:35AM	**Peter Caldwell:** The applications and implications of Artificial Intelligence on Condition Monitoring	
9:35 AM	**0:40**	**10:15 AM**	**Morning Tea in Exhibitor area** ** VANZ AGM WILL BE HELD IN STREAM-1 ROOM **	
Two Streams of Presentations			**Stream 1: Room One**	**Stream 2: Room Two**
10:15 AM	0:40	10:55 AM	**Praveen Salian:** TBC	**Glen Pepper:** Motion Amplification
10:55 AM	0:40	11:35 AM	**Cameron Blackbourn:** At Least No-One Died. HMNZS Manawanui; Human Factors	**Genesis Energy:** Unit 2 Incident at Huntly Power Station
11:35 AM	0:40	12:15 PM	**Julien Maffre:** Fast Criticality: a simple and evergreen Risk Assessment method	**Sven Fleischer:** Precision Alignment- Gas Compressor
12:15 PM	**0:50**	**1:05 PM**	**Lunch in the Exhibitor room / Trade Stand area**	
1:05 PM	0:40	1:45 PM	**John Clynes:** Underwear versus Overwear, The Naked Truth	
1:45 PM	0:40	2:25 PM	**Mike Davis:** Advances in Condition Monitoring of Electrical Machines	
2:25 PM	0:40	3:05 PM	**Rob Simmonds and Matthew Fallow:** Two Gearboxes and a Varivolt Transformer Failure	
3:05 PM	0:45	3:50 PM	**Awards Presentations, Vendor Prize Draws:** You need to be there to claim the prizes & Conference closing address	

Conference officially closed. We look forward to seeing you all again next year in 2026. Please ensure you travel safely home.

KEYNOTE SPEAKER PROFILE...
>>



Conference 25
NEW PLYMOUTH, NZ

INTRODUCING ROB SIMMONDS

Rob Simmonds is a Reliability Manager and tribologist at R&T Reliability Technologies PL in Sydney, Australia. He has 30 years of experience in lubrication, including selling, manufacturing, and monitoring. Back in 1998-1999, one of Rob's top salespeople received specialised training at Monash University by ICI on how to perform wear debris analysis (WDA) on oil samples. Monash University had developed the original technique. This salesperson was later recruited by a fuel company but not before passing on his knowledge to Rob. This pivotal moment led Rob to realise that he could better serve his customers by monitoring their plant for abnormal wear rather than just manufacturing lubricants.

In 2000, Rob and his team established the R&T lab, focusing on microscope-based WDA for manufacturing plants. Rob's career in WDA has been pioneering, as there were no similar labs available for reference when setting up R&T. This led to extensive investigative microscope work to ensure consistent, clean, and accurate results with ongoing monitoring of in lab dust levels weekly and also when samples are being processed. They developed a clean environment with proper filtration and equipment to ensure consistent results. The R&T Analysis reports have been tailored to meet customer requirements.

Key Projects and Experiences

- Wrote the paper "It's All About Size" back in 2003-2004, the paper was published in both Machinery Lubrication and Electrix Magazine, both magazines have a worldwide distribution area
- Wrote a paper on Electrostatic Discharge In Ammonia Compressors
- Botany Industrial Park (BIP): Monitored gearboxes, compressors, and auxiliary equipment for 25 years in a gas-to-polymer plant
- NSW State Rail Laboratory – Collaborated with for 2 years, gaining experience in metallurgical work and monitoring various train components, extending the rebuild time for various components on the trains
- Developed a RCA for ESD and varnish build up in turbine systems based on the colorimetric analysis technique and report for ESD and Varnish build up in turbine systems.

Diverse Industry Experience

- Worked with papermills, cement plants, plaster mills, steel mills, rod mills, tube mills, plaster board plants, cement board plants chip board plants, bakeries, flour mills, polymer injection and blow moulding plants
- Filter Debris Analysis (FDA) - Developed proficiency in identifying abnormal wear, contamination, and root-causing failures across various filter types
- Gas Engine Genset Monitoring - Extended Jenbacher engines rebuild time from 60,000 to 120,000 hours
- Iron Ore Train Automatic Braking system component evaluation, extending rebuild time from 6 years out to 8 years
- Suburban Rail Car Compressor Monitoring, extending service interval from 3 months out to 4 months saving one service per year
- Monitoring Locomotive Engines to extend the rebuild time from 18,000 hrs out to 30,000 hours work ongoing
- Monitoring Haul Truck Centrifuge Filters For the evaluation of a new engine lubricant for a fuel company
- Dust & Dirt Sample Analysis root causing the origin of the contamination found in new equipment to establish whether manufacturing left over debris or environmental contamination, shot blast crystals found forcing the warrantee back to the OEM. ■

VANZ
VIBRATIONS ASSOCIATION of NEW ZEALAND

Exhibitor Floorplan

We would like to extend a huge thank all of our exhibitors at 2025 VANZ Conference. Below is a full list of all our exhibitors and where they will be located in our exhibitor hall and social networking room. Please ensure you take the time to visit our sponsors and find out what they might be able to offer you and your business.

** - Exhibitor stalls subject to change without notice.*

Conference 25
New Plymouth, NZ

Introducing another four must-see presenters at Conference'25

Clyde Volpe

Vibration Institute of Australia

Clyde is the founder of VIA - the Vibration Institute of Australia, and is the exclusive Mobius Training Partner for Category 1, 2, and 3 Machinery Vibration Analysis in the Australia/New Zealand region. Mobius Institute awarded Clyde 'Instructor of the Century'. Clyde has trained in over 30 countries, spanning 30 years to over 10,000 students. Clyde has a reputation for his energy, and his motivating and entertaining courses. With his hands-on experience, with the Mobius simulators, he has the ability of making the very complex easy to understand. His courses are designed to use vibration analysis to drive capability.

Erik Vandenberg

Principal Consultant, Verbrec Ltd

With around 25 years of technical and leadership experience on operational resource assets, including major hydrocarbon facilities, Eric holds a Master of Engineering in Maintenance and Reliability, is a chartered member of Engineers Australia and the Asset Management Council, and a Certified Maintenance and Reliability Professional. Erik leads technical teams, focusing on optimising performance, safety, and integrity of clients physical assets. He applies his extensive knowledge and skills in engineering, commissioning, maintenance, and reliability to deliver high-quality solutions, manage multi-disciplinary teams, and foster strong relationships.

Sven Fleischer

Area Sales Manager, APAC with Easy Laser®

For the last 5 years Sven has been the customer and distributor support with nearly 30 years experience in the industry. ISO VA-Cat III, ISO ARP-Cat II (been instructor for VA I-III, ARP I-II), AMP Certified Reliability Leader. He's passionate about technology and how it is used to make today's life easier, enjoys supporting clients and partners to implement reliability strategies and to provide the best tools for their daily work. Having straightforward products is the key to our client's success to increase operational uptime in all types of industry. He is proud to work with a great team at world's leading manufacturer and supplier of laser-based measurement systems.

Peter Caldwell

Online CM Specialist, Australia

Peter Caldwell has been working in the field of Condition Monitoring, and Test and Measurement since graduating in 2004 with a Bachelor of Engineering (Mechanical) from Curtin University in Western Australia. He is a Certified Vibration Analyst (VCAT IV). Since 2012 he has been focused on online condition monitoring and helping clients design, install and operate online condition monitoring systems. Recently he has been studying data science and the application of Artificial Intelligence to Condition Monitoring.

Plus...

They'll be joining a wealth of other leading industry professionals such as:

Keynote speaker Rob Simmonds, Bruce Shepherd, Will Dale, Dr James Neale, Chris Unsworth, Mike Wharry, Chris O'Leary, Craig Carlye, Julien Maffre, Iain Epps, Robert Dent, Clyde Volpe, Cameron Blackbourn, Steve Hall, Mike Yardley, Ian Van der Sar, Anthony Mack, Peter Haines, Brian Ropitini, Paul Bosauder, Larry Wiechern *and more...*

Conference 25

New Plymouth, NZ
20 - 22 May 2025

For more info, visit our website: **www.vanz.org.nz**
Email us: **secretary@vanz.org.nz**

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GUESS WHO'S COMING TO DINNER?

He needs no introduction. He's a true inspiration and highly successful Kiwi motorsport legend, not to mention an all-round great bloke. He is... Greg Murphy!

Get the full lowdown from Greg personally as you sit back, relax and enjoy the formal dinner with fellow guests on Wednesday evening 21st May, as part of your registration to the VANZ Conference 2025.

A seasoned driver in Australian V8 Supercars, Greg Murphy's mark on the sport is indisputable. With over 400 V8 Supercar race starts, multiple Bathurst 1000 wins and appointments with some the highest profile race teams in Australasia, Greg is rightfully considered one of the greats by fellow competitors and fans alike.

Brought you you by:

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» THE NUMBERS...

448	V8 Supercar Championship starts
28	V8 Supercar Championship WINS
13	V8 Supercar Championship poles
38	V8 Supercar Championship podiums
4	Bathurst 1000 WINS
2	Sandown 500 WINS
1	Bathurst 24-Hour WIN
2	V8 SuperTourer Championships
22	V8SuperTourer Wins

Conference 25

NEW PLYMOUTH, NZ
20 - 22 MAY 2025

For more info, visit our website: **www.vanz.org.nz**
Email us: **secretary@vanz.org.nz**

Conference brought to you by:

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VANZ
VIBRATIONS ASSOCIATION of NEW ZEALAND

Host location for Conference'25

Conference 25

Welcome to New Plymouth PT.II

New Plymouth is a host city for the VANZ Conference in 2025. Here is a bit of history about the region you may not know...

Taranaki's only city, on the west coast of the North Island is 365 km south of Auckland and 352 km north of Wellington, with an urban-area population of approx. 52,000.

History

Originally called Ngāmotu (the islands), the site of New Plymouth was occupied for hundreds of years by Māori. More than 60 pā and kāinga (village) sites have been recorded as being in the urban area.

Pākehā traders set up a trading station at Ngāmotu in 1828, but it was not until 1841–42 that planned settlement by the Plymouth Company brought 868 immigrants from Devon and Cornwall in England to the 'New' Plymouth. The town site was chosen because of its fertile land, gentle terrain and sheltered beach area.

Above: At the base walk up Mt. Taranaki.
Left: The majestic Dawson Falls.
Photo: Flashpoint Design and Marketing.

As a result of intertribal fighting over land, British troops were stationed in New Plymouth around 1855. In 1860, war broke out between Pākehā and Māori, over a disputed land sale at Waitara. A decade of intermittent conflict followed, severely denting the development of the town and the surrounding area. New Plymouth's population actually fell from aprrox. 2,900 in 1864 to 1,800 in 1871.

The end of fighting in the 1870s greatly improved New Plymouth's prospects. It did not grow as rapidly as the new settlements of Pātea and Waitara, but by 1885 it had a port and a rail link to Wellington. It remained the commercial centre of Taranaki.

Throughout the 20th century New Plymouth's population increased steadily, and gained city status (20,000 residents) in 1949. Dairy farming remained the mainstay of the economy.

After the Kapuni and Māui gas fields were discovered in the late 1950s and late 1960s respectively, the petroleum industry contributed to the local economy and brought workers and executives from all over the world to New Plymouth, further bolstering it's growth.

EDITORS' CORNER

By Angie Delfino | Spectrum Editor

Greetings readers!

Conference time is rolling around again and VANZ is a hive of activity planning this years' symposium so all who attend can benefit and take away new information and techniques not to mention the latest gadgets to roll out in to the field.

Our conference committee have got a lot in store for us this year as always and our platinum sponsor this year is ABD Group!

You can register online at **https://www.vanz.org.nz/conference-2025** so check out the website for more updates as conference gets closer.

Many thanks go to all those who are helping to sponsor the event this year with a variety of different support, from trade-stands to networking nights. Also to our continued advertisers who are much appreciated and are all an important part of keeping VANZ going.

Browse through the update from the President's Report by Tim Murdoch, he gives us an idea of what to expect from this years' conference. If you want to puzzle your grey matter then flip through to Carl's Quiz and see how well you score on the latest questions.

Enjoy the read and see you at the conference!

Right: Kiwi motorsport legend Greg Murphy will be a very special guest at our Wednesday evening dinner event at Conference'25.

VANZ
VIBRATIONS ASSOCIATION *of* NEW ZEALAND

Notice of AGM

DATE: **Thursday 22nd May 2025**

TIME: **9:35am**

LOCATION: **Plymouth International - Stream Room 1**

Please attend if you can, this association is run by you, for you.

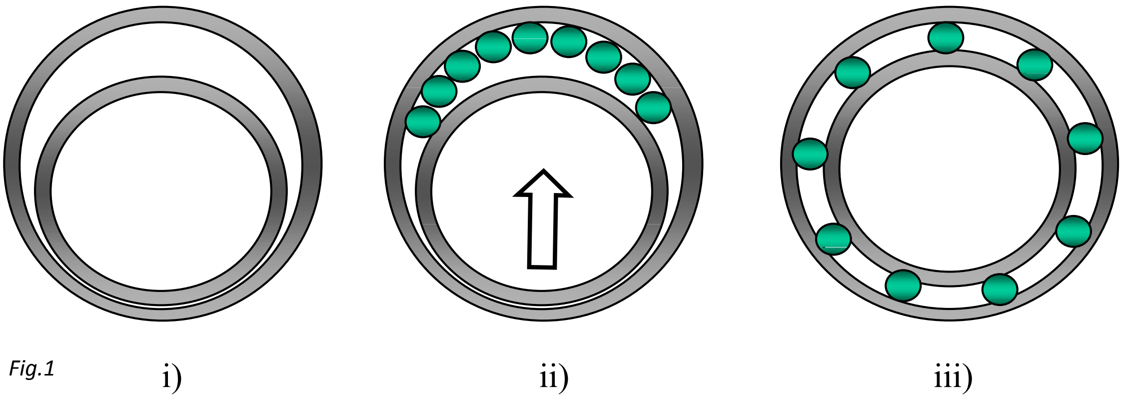


Fig.1

Filling slot bearings

Deep groove ball bearings and double row angular contact bearings can be assembled with or without a filling slot. Bearings without a filling slot are called Conrad type bearings. They are named after Robert Conrad who invented the process in 1903. Conrad bearings are assembled by i) offsetting the inner and outer races, ii) inserting the balls, and iii) centralising the raceways and fitting the cage to evenly distribute the balls. This process is shown above (fig.1).

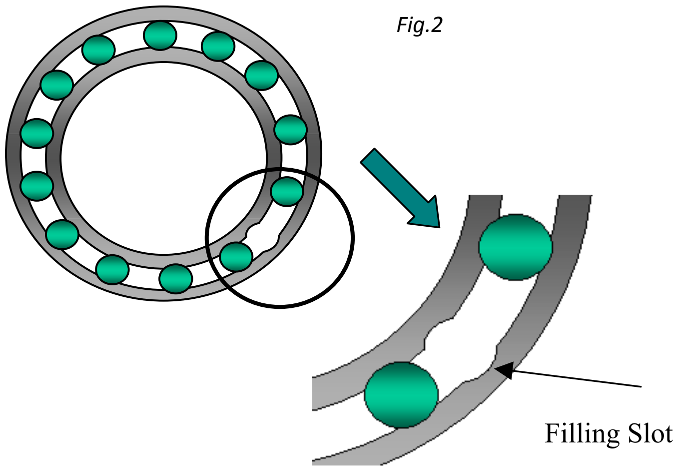
The filling slot bearing is different in that it has a notch machined in one side of the inner and outer raceways (see fig.2). Initial assembly is the same as the Conrad type, but before the cage is fitted these notches are aligned, and additional balls are inserted into the slot.

It is important to understand that while filling slot bearings and Conrad bearings may have the same dimensions for a given size, they are not necessarily interchangeable. Filling slot bearings are used where a higher radial load capacity is required. The higher radial load capacity is possible because the filling slot method allows the insertion of more rolling elements than the Conrad method.

As you know, there is no such thing as a free lunch, so this increase in radial load capacity comes at a price! The price is a reduction in axial load capacity. And any axial load must be in combination with a much larger radial load. If you exceed the rated axial load, the rolling elements run over the filling slots causing severe damage to the bearing.

There is also a reduction in the maximum RPM because of the additional friction generated by the extra rolling elements.

Fig.2



So make sure that you use only the exact bearing specified. When a deep groove ball bearing with a filling slot is specified, it must be installed as the floating bearing so that it does not take axial load. This NTN bearing (fig.3) has a 5 character code starting with BL. e.g. BL207.

When a double row angular contact filling slot bearing is specified, it may be the fixed bearing. Note that it must be

Fig.3

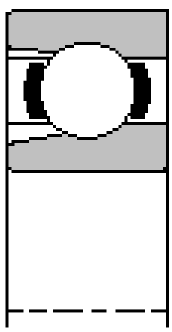
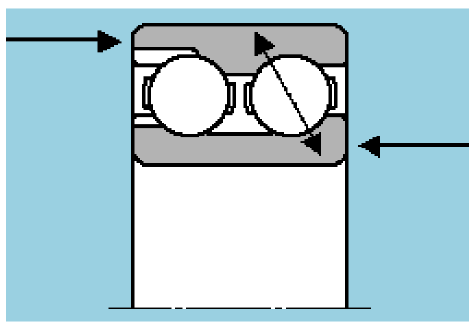


Fig.4



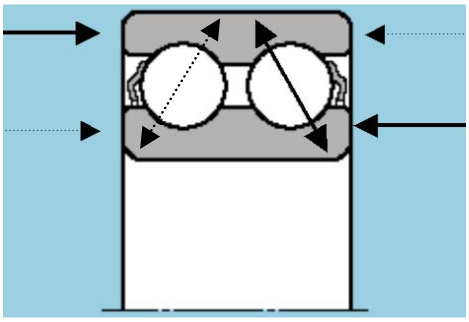
Article prepared by Rod Bennett.

installed so that the axial load is applied to the row of rolling elements without the filling slot. This NTN bearing (fig.4) has a code that is 4 numbers beginning with a 3. e.g. 3307.

When a double row angular contact Conrad bearing is used, it can take axial load in either direction. This NTN bearing (fig.5) has a code that is 4 numbers beginning with a 5. e.g. 5207.

Remember that the last 2 numbers multiplied by 5 tells you the bore of the bearing. In this case we have a 35mm bore.

Fig.5



The following pictures show the result of installing the thrust bearing with the filling slot facing the wrong way. In this case the bearing was in a vertical pump where the filling slot should have faced down so that the axial load was applied to the top race. This bearing had to be replaced again after only 6 weeks. The spalling in the raceway with the filling slot is very obvious, as is the difference in colour of the balls and cages. This shows that the bearing was also overheating and destroying the lubricant.

If you're not sure which way to face the bearing, contact your bearing supplier for advice.

FEATURE

Coupled multiphysics simulation for

Root cause analysis of process flow vibrations in piping systems

By Paul Bosauder[1], Ernesto Primera[2], Alvaro Rodríguez-Prieto[3,4]

This paper explores numerical simulation methods for assessing flow-induced vibration (FIV) in critical plant equipment. By integrating fluid-structure interaction (FSI), computational fluid dynamics (CFD), and finite element analysis (FEA), a comprehensive approach that minimizes uncertainties associated with turbulent unsteady flows is proposed. A case study investigates FIV in thermowells within a high-pressure (HP) steam line as part of a methanol plant debottlenecking project. The increased flow capacity posed structural integrity challenges, with initial ASME PTC 19.3 Thermowells guidelines highlighting a high risk of FIV. However, traditional decoupled methods proved inconclusive due to wake effects and clustered thermowell placement.

Recent inspections revealed high-cycle fatigue cracking at thermowell bases, necessitating a redesign. An FSI-based assessment confirmed FIV under uprated conditions, particularly due to wake interactions and potential "lock-in" phenomena. A revised thermowell design raised structural frequencies, mitigating vortex shedding and ensuring resonance avoidance. The coupled FSI approach offered improved root cause analysis, robust assurance modelling, and enhanced reliability.

This paper underscores the value of combining FSI, CFD, and FEA to improve FIV assessments; enabling a more accurate analysis, the proposition of effective mitigation strategies, and ensuring the structural integrity of critical equipment under demanding operational conditions is maintained.

INTRODUCTION

In mechanical engineering, the design and optimization of structural components often require the analysis of multiple physical phenomena that interact in complex ways. Coupled Multiphysics simulations that integrate Finite Element Analysis (FEA) and Computational Fluid Dynamics (CFD) are useful for addressing these challenges, providing a more accurate and holistic approach to solving engineering problems [1-2]. FEA is widely used to analyze the mechanical behavior of structures under operating loads.

Design by Analysis (DBA) methods allowing for a less conservative design basis by predicting how components will behave under static, dynamic, and thermal loads [3]. CFD plays an essential role in modeling fluid flow and heat transfer within systems, which is vital for understanding phenomena such as pressure distributions, temperature gradients, and flow-induced forces [5-6].

When applied together in a coupled manner, FEA and CFD simulations provide a comprehensive understanding of the interactions between solid and fluid mechanics.

Continued over page >

NOMENCLATURE - see page 24

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Article prepared by Paul Bosauder, Technical Director, Sequence Computational Engineering Ltd

Fig1: Example of thermowell cracking in the HP Steam line.

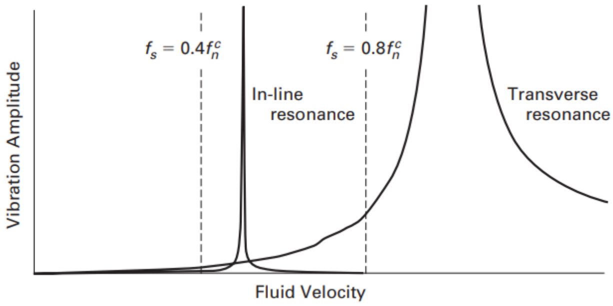

Fig 2: FIV assessment method described in ASME PTC 19-3-thermowells [9] .

This integration is particularly beneficial in the design and optimization of mechanical systems where fluid-structure interactions occur, such as in rotating machinery, automotive components, and heat exchangers [7]. The coupled simulations allow for the prediction of mechanical stresses resulting from fluid forces and the impact of structural deformations on fluid behavior [8].

Advancements in computational techniques and software tools have significantly enhanced the accuracy and efficiency of coupled FEA and CFD simulations. As computational power continues to grow, the use of coupled FEA and CFD simulations will expand across even more complex engineering problems, enabling more precise and efficient designs.

The assessment of flow induced vibration (FIV) in engineering systems can be challenging due to complex interactions and coupling between structural and fluid responses. Uncontrolled FIV can lead to high cycle fatigue damage and potential failure of key components critical to the reliability of plant equipment such as thermowells, heat exchanger tubes, chimney stacks, and other process equipment (Figure 1).

Traditional methods are generally based on a decoupled comparison of structural modes and vortex shedding frequencies [3] [9]. Reasonable predictions can be made of structural modes and excitation frequencies using both empirical and numerical methods, and these methods are generally effective for assessing the risk of FIV due to tonal excitation; for example, ASME PTC-19-3-Thermowells as shown in Figure 2. However, these assessment procedures are less effective at dealing with more complex problems involving broadband excitation, wake effects, and unsteady inlet conditions.

A common example of this is captured in thermowells clustered immediately downstream of a pipe elbow. Wake effects from the elbow and between thermowells are important (Figure 3) and it is not possible to calculate a single excitation frequency because the inlet conditions are unsteady. Also, the proximity of adjacent thermowells is likely to create "lock-in" effects [9].

This study was commissioned as part of a debottlenecking project in a methanol plant which involved up-rating flow in the high pressure (HP) and low pressure (LP) steam lines. Initial calculations were performed using ASME PTC 19.3-Thermowells [9] to assess the likelihood of FIV and several thermowells were identified as being at risk of FIV.

A number of these thermowells were positioned immediately downstream of an elbow in the line and

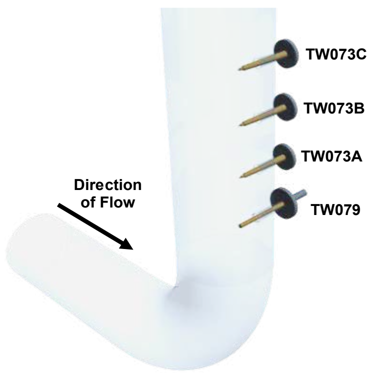

Fig 3: HP steamline CFD model geometry showing thermowells TW079 and TW073A/B/C.

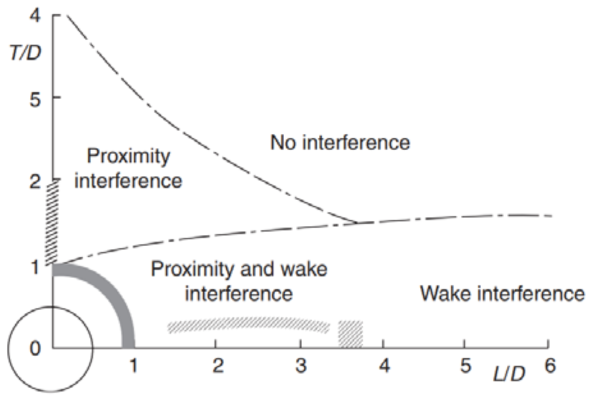

Fig 4: Wake effects described in JSME FIV guidelines [10].

were clustered in groups of three or more thermowells (Figure 3). Guidance documented by the Japanese Society of Mechanical Engineers (JSME) indicated (as shown in Figure 4) that wake effects were likely to be important and that the thermowells were at risk of "lock-in" effects and increased excitation due to wake effects [10].

CFD and FEA models allows for a more complete and less conversative assessment of FIV.

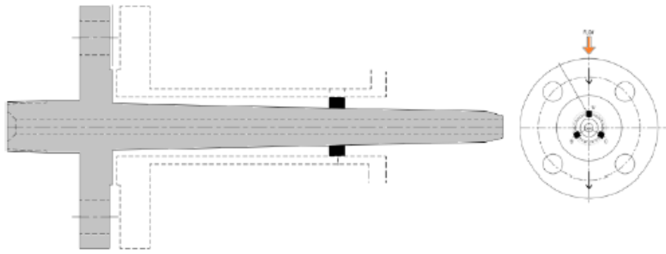

Fig 5: proposed thermowell support arrangement.

Modelling was performed at both existing and uprated conditions while accounting for the full and complex flow field developed downstream of the elbow. In addition, wake and lock-in effects are captured in this method.

Applying this approach allowed for the development and assessment of a remedial measure mitigating the risk associated with uprating the line. A drawing of the proposed thermowell support arrangement is provided in Figure 5.

2. MATHEMATICAL MODEL

A description of basic fluid dynamics and solid mechanics equations is provided in this section along with a discussion on relevant non-dimensional numbers.

2.1 Fluid dynamics model

The incompressible Navier Stokes equation

$$\rho\left(\frac{\partial}{\partial t}+u.\nabla-\mu\nabla^2\right)u=-\nabla p+f \qquad (1)$$

and continuity equation

$$\nabla.u=0, \qquad (2)$$

describe conservation of momentum and mass, where u is the velocity vector [m/s], p is the pressure scalar [Pa], ρ is the fluid density [kg/m^3], μ is the dynamic viscosity [Pa-s], f is the external force vector [N], and t is time [s]. An analysis of the ratio of viscous and inertial terms leads to the non-dimensional Reynolds number

$$Re=\frac{\rho U D}{\mu}, \qquad (3)$$

Continued over page >

where U is the nominal velocity [m/s] and D is the diameter length scale [m]. The Reynolds number is commonly used to understand if a flow is turbulent and is referenced in heat transfer correlations. The relationship between Karmen vortex shedding frequency f_v [Hz] and Strouhal number St is given by

$$f_v = \frac{UD}{St}. \tag{4}$$

The Strouhal number is also highly dependent on Reynolds number as documented in Figure 6 for a stationary cylinder.

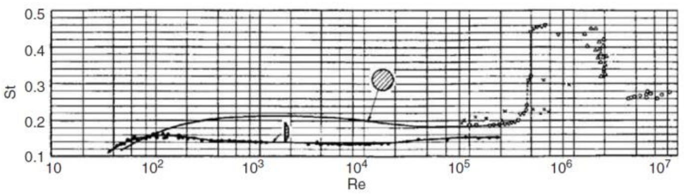

Fig 6: Strouhal number dependance on Reynolds number for a stational cylinder [9].

2.2 Solid mechanics model

In solid mechanics, it is natural to express conservation laws using a Lagrangian approach. The motion of a solid body is governed by Cauchy's equilibrium equation

$$\rho \frac{\partial^2 \mathrm{x}}{\partial t^2} - \nabla.\sigma - \rho F_b = 0, \tag{5}$$

where x is the displacement of the solid body [m], ρ is the solid body density [kg/m^3], F_b is the total body force per unit volume [N/m^3], and σ is Cauchy stress tensor [Pa].

A one-dimensional mass-damping system provides a useful tool for understanding the response of body exposed to periodic loading (6), as shown in Figure 7. The motion is governed by the equation

$$m \frac{\partial^2 x}{\partial t^2} + b \frac{\partial x}{\partial t} + kx = 0 \tag{6}$$

where x is the system deformation [m], m is the mass [kg], b is the damping coefficient [kg/s], and k is the linear stiffness [N/m]. A non-trivial solution to this equation can be obtained for the non-damped system ($b=0$) which gives a simple harmonic function

$$x(t) = A\cos(\omega_n t) + \mathrm{B}\sin(\omega_n t) \tag{7}$$

where A [m] and B [m] are constants. The resulting natural frequency f_n [Hz] for the system

$$f_n = \frac{1}{2\pi}\sqrt{\frac{k}{m}} \tag{8}$$

is proportional to the square root of the stiffness over the mass, where $\omega_n = 2\pi f_n$. This shows how stiffness and mass often work against each other when analysing structural modes.

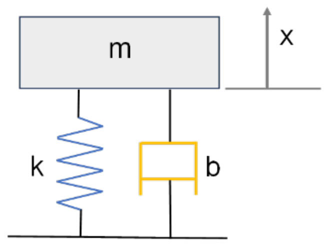

Fig 7: One-dimension mass-damping system.

3. COMPUTATIONAL MODEL

A coupled FSI model was developed in STAR-CCM+® using the coupled finite volume flow and stress solvers. A stand-alone finite element model was also developed in parallel using Abaqus/Standard® to validate structural modes and to perform a frequence response assessment of both baseline and revised thermowell designs.

3.1 FSI Multiphysics Model

The computational domain included a suitable section pipe upstream of the elbow where a fully developed turbulence velocity profile was specified as shown in Figure 8 and given by

$$\frac{U}{U_{max}} = \left(1 - \frac{r}{R}\right)^{1/n} \tag{10}$$

where U is the velocity at a radius r [m/s], U_{max} is the maximum velocity at the centre of the line [m/s], r is local radius coordinate [m], and n is the turbulence boundary layer coefficient. The velocity profile was integrated to give the desired total mass flow rate. The fluid model was assumed to be incompressible and iso-thermal with properties developed from the International Association for the Properties of Water and Steam (IAPWS) equations at the operating pressure.

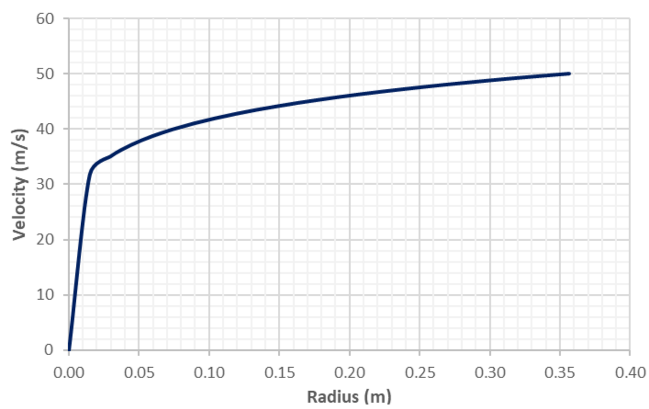

Fig 8: HP Steam line inlet velocity profile with N=7.

Turbulence was modelled using a Detached Eddy Simulation (DES) to allow suitable resolution of frequency content, inclusion of vortex structures, and capturing of wake effects between thermowells.

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The solution was initialized from a converged steady-state Reynolds Averaged Navier Stokes (RANS) solution to develop suitable initial conditions for the transient calculation. Transient modelling was performed with second order time implicit stepping and a time step size 1E-5s. This was sufficient to ensure that the Courant–Friedrichs–Lewy (CFL) number was below 1.0 for most of the computational domain. The CFL number or condition as defined in Equation 11 ensures that information cannot travel beyond a single cell during a time step. Implicit schemes can sustain CFL numbers greater than 1.0 without convergence issues, however larger CFL numbers are not recommended because they introduce artificial numerical diffusion to the solution. A contour plot showing the instantaneous CFL number is provided in Figure 9, where only a small volume of cells have a CFL number greater than 1.0.

$$CFL = \frac{U\Delta t}{x} \tag{11}$$

where U=Velocity (m/s), Δt is the time step size (s) and x is the cell size (m).

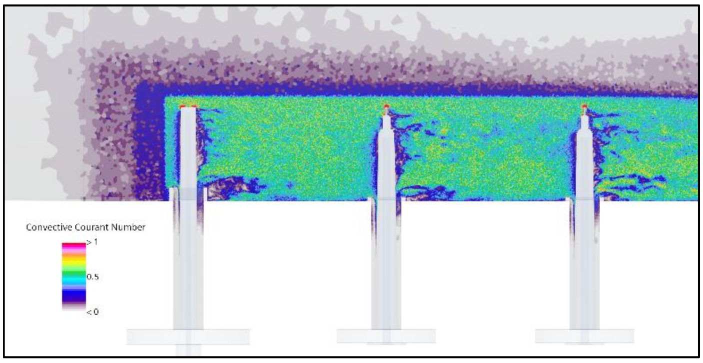

Fig 9: Instantaneous convective courant or CFL number.

The computational grid was developed using quadratic polyhedral mesh with localized grid refinement employed around the thermowells and the elbow, as shown in Figure 10. An unstructured tetrahedral mesh was employed for the solid thermowell with a minimum of four elements employed in the through-wall direction.

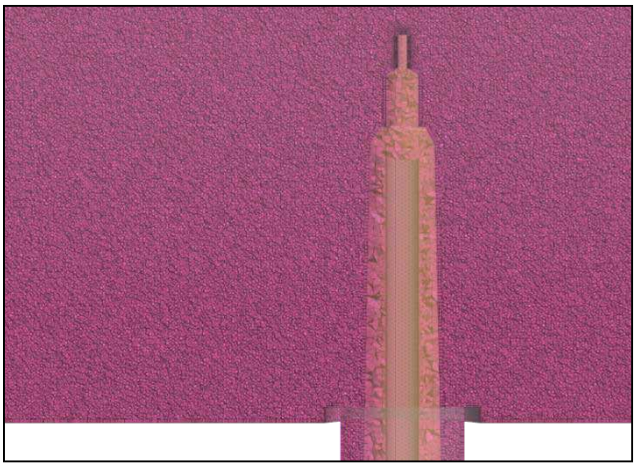

Fig 10: HP Steamline and thermowell computational grid.

Mechanical properties were developed from ASME II D and large displacements were assumed for the analysis. The FSI approach in ***STAR-CCM+®*** utilizes a mesh morphing technique to update the geometry and computational grid for both fluid and structural domains during the analysis. Employing the coupled solution with a single analysis package significantly reduced the model setup and assessment effort, therefore reducing the project delivery time.

3.2 Finite Element Analysis (FEA) Model

The Abaqus® finite element model was developed using structured linear brick elements. Modelling was also performed using ASME II D mechanical properties [11]. Modal analyses were performed to assess thermowell natural frequencies with and without the proposed support arrangement. Frequency response analyses were also performed to evaluate stress ranges in the base of the thermowell under a supposed flow induced excitation. This work provided verification of natural frequencies evaluated in the ***STAR-CCM+®*** Multiphysics model and allowed for greater confidence in analysis outcomes.

4. RESULTS AND DISCUSSION

Modelling of thermowells confirmed the high risk of FIV in the HP Steam line with the existing thermowell support arrangement. Modelling predicted strong vortex shedding off thermowells and significant wake interactions. This resulted in a mixed tonal/broadband excitation of the thermowells with evidence of lock-in and resonance at the fundamental natural frequency of the thermowells.

Good agreement was obtained between finite element predictions and calculated natural frequencies. Flow separation in the elbow upstream of the thermowells produced complex velocity distributions and unsteady incoming flow on the thermowells. This can be seen in Figures 11 and 12 where velocity distributions and vortex structures are affected by the flow separation in the elbow and wake interactions between thermowells.

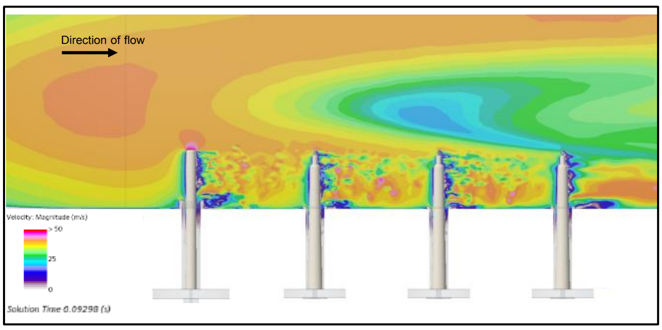

Fig 11: Instantaneous velocity magnitude on the centreline of the HP Steam line.

The CFD predicted force time history for the original unsupported thermowell is provided in Figure 13. A Fast

Fourier Transform (FFT) of this data allows frequency content to be extracted as shown in Figure 14. This gives a mixture of tonal and broadband excitation due to vortex shedding with tonal excitation observed close to the fundamental thermowell structural mode of 400Hz. The response of the structure is clearly tonal coinciding with natural frequency of 400Hz (Figure 14 and 15).

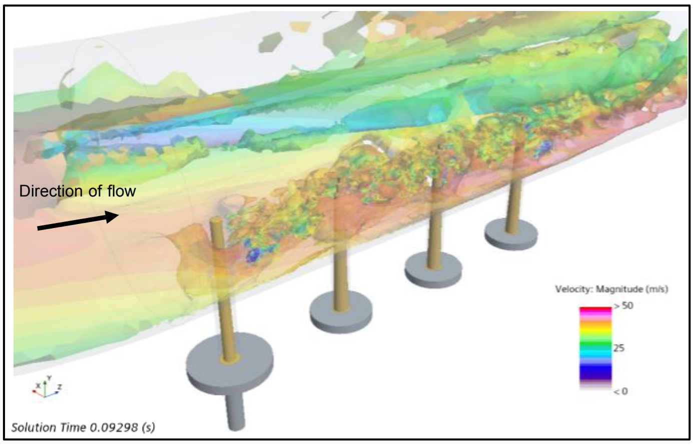

Fig 12: Vortex structures visualised by qcriterion and contoured by instantaneous velocity magnitude.

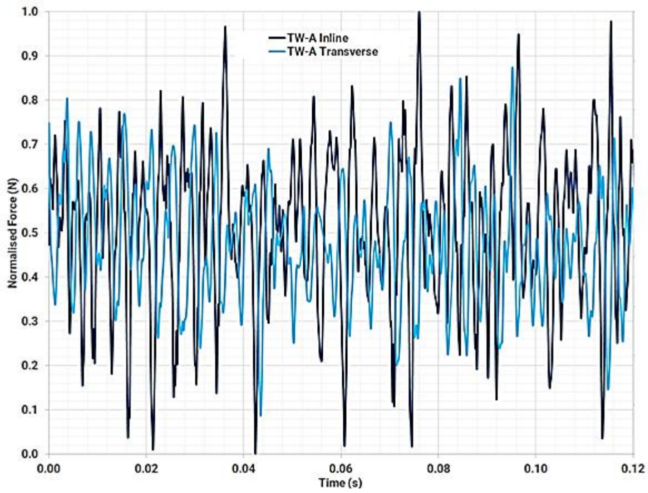

Fig 13: Unsupported thermowell force time history predicted by FSI modelling.

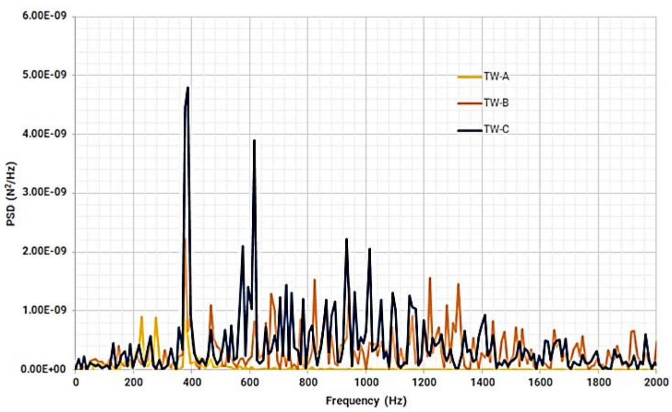

Fig 14: FFT of unsupported force history for the unsupported thermowell design.

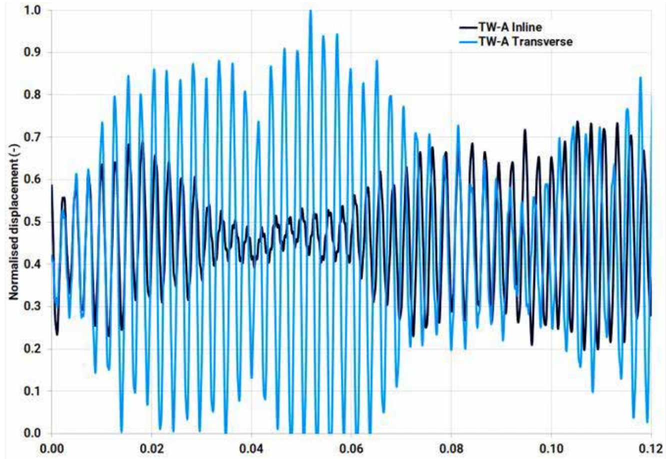

Fig 15: Unsupported thermowell displacement time history predicted by FSI modelling.

Displacement magnitudes and PSDs are significantly higher in the transverse direction. These deflections create bending stresses in the base of the thermowell. A comparison between unsupported and supported thermowell stresses is provided in Figure 17. This shows that the location of the peak stress predicted by the model coincides with the location of mechanical fatigue cracking observed in the HP Steamline thermowells (Figure 1). Including the thermowell support was highly effective in reducing bending stress ranges due to fluid excitation (Figure 18).

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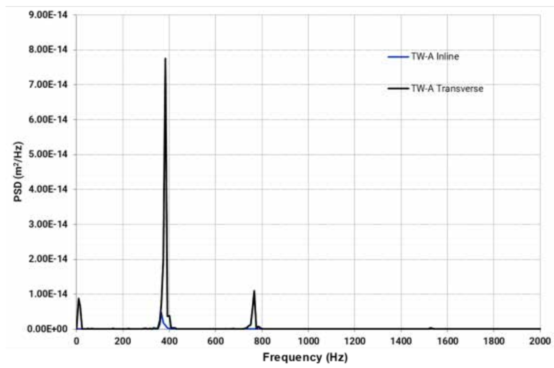

Fig 16: FFT of unsupported thermowell displacement time history.

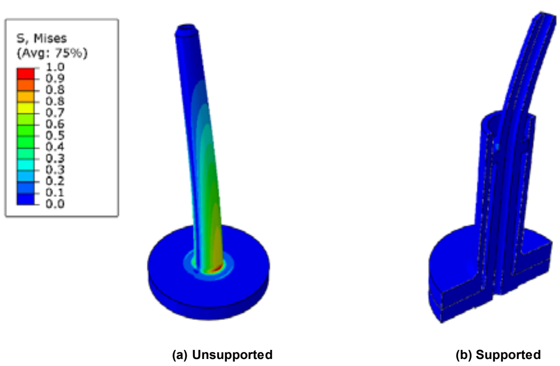

Fig 17: Comparison of FEA predicted stress distributions for unsupported and supported thermowells.

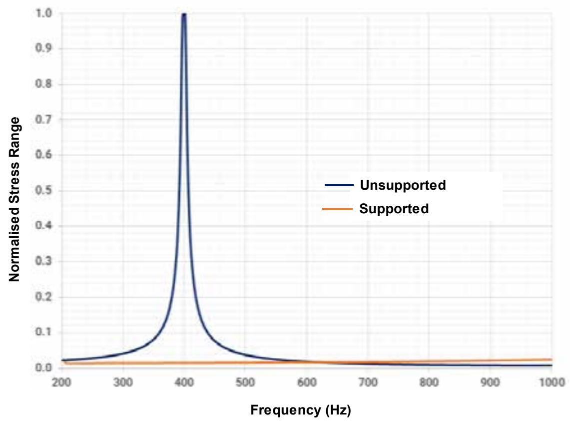

Fig 18: FEA frequency response predictions of stress range for unsupported and supported thermowells.

5. CONCLUSION

The use of computer modelling with coupled FSI (CFD and FEA) calculations provides an effective tool for the assessment of FIV. These methods remove ambiguity introduced by traditional methods which are unable to account for unsteady inlet conditions, broadband excitation, and turbulent buffeting.

The use of nonlinear simulation methods can also account for complex fluid-structure phenomena such as galloping. In this study, these tools provided greater confidence in the assessment of thermowells, and remedial measures required to achieve uprating of the HP steam line. ■

ACKNOWLEDGEMENTS

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NOMENCLATURE

U	velocity [m/s]
u	velocity vector [m/s]
ρ	density [kg/m³]
p	pressure [N/m^2]
t	time [s]
μ	dynamic viscosity [Pa·s]
x	body displacement [m]
F_b	body force per unit volume [N/m^3]
σ	Cauchy stress tensor [Pa]
x	displacement [m]
m	mass [kg]
k	stiffness [N/m]
b	damping coefficient [kg/s]
F	force [N]
f_n	natural frequency [Hz]
f_v	vortex shedding frequency [Hz]
r	radial coordinate [m]
R	pipe radius [m]
n	turbulent boundary layer coefficient
Re	Reynolds number
St	Strouhal number
CFD	Computational Fluid Dynamics
CFL	Courant–Friedrichs–Lewy
DBA	Design by Analysis
DES	Detached Eddy Simulation
FEA	Finite Element Analysis
FFT	Fast Fourier Transform
FIV	Flow Induced Vibraiton
FSI	Fluid-Structure Interaction
HP	High pressure steam lines
IAPWS	The International Association for the Properties of Water and Steam
JSME	Japanese Society of Mechanical Engineers
RANS	Reynolds Averaged Navier Stokes
PSD	Power Spectral Density

Paul Bosauder will be a speaker at the 2025 VANZ Conference.

Conference 25

FEATURE

PART TWO

Electrostatic discharge & ammonia compressor lubrication systems

Over the past 20 plus years of R&T's laboratory analysing oil samples it was always noted there was an elevated amount of dirt, organic debris, carbonised lubricant and broken oil filter glass fibres found in oil samples from ammonia compressors. Continues from Spectrum issue 114...

This page displays why the earthing straps did not have the desired effect. The image (fig.1) displays the cross section of how the filter media, galvanised steel mesh, filter core, end caps, earthing strap and exterior galvanised diffusion sheet are mounted together.

It appears from the filters analysed from turbines and compressors the non conductive media first gathers the electrostatic charge from the circulating compressor or turbine fluid.

Once the ESD charge has built up to 350 volts the ESD energy in the media can arc over to the steel mesh. Note in the image above how the steel mesh is isolated from the end caps and earthing strap so once the ESD voltage in the mesh has built up to 350 volts the mesh is arcing onto the filters core and the energy is dissipated back to earth via the earth straps onto the filter housing

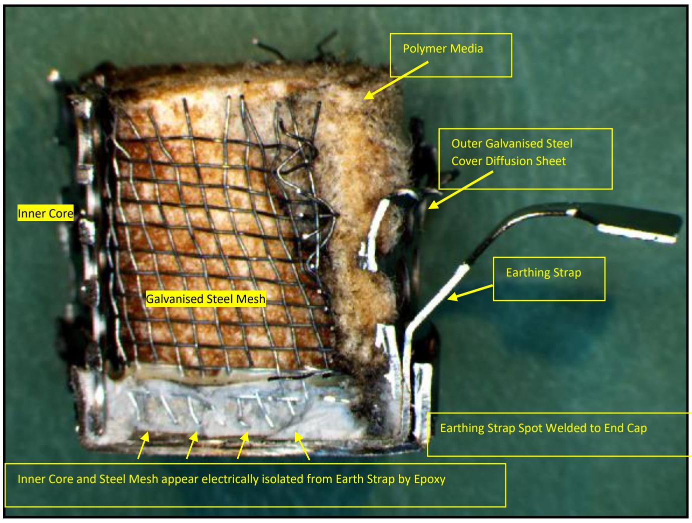

Fig.1.

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Article prepared by Rob Simmonds, Reliability Manager

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and pipe work completing the circut without further arcing. The addition of the earthing straps appears to have made a reduction in arc damaged lubricant debris.

If the steel mesh was also connected to the earthing system that would prevent the arcing occurring between the filter core and the steel mesh but the non conductive polymer media will continue to arc onto the mesh.

The change to the polymer fibre media was an excellent decision as that prevented the ESD arc damaged glass fibres from the old glass fibre media circulating around the compressors lubrication system.

Considering the good results in reducing varnished compressor fluid achieved the new replacement 5 µm Stainless Steel (SS) Mesh filtering media filter in use now on this compressor will be very interesting to analyse.

The manner in how most oil filters are assembled and constructed may have resulted in the SS mesh on the new filter being inadvertently electrically isolated from the earthing straps which most likely will result in some arcing and from what we are seeing with this filter the new one could have a better result than achieved here.

There was work completed in gas turbines with copper grids placed across the lubrication system pipe work and their results were poor but this earthed filter has made a noticeable difference and there appears that with a bit of tweaking on filter design and feed back from filter debris analysis some very useful filters may be able to be produced.

The next filter applied was an upgraded "AUSFIL Sydney CF 1456 / 5µm" galvanised steel filter with 5 µm Stainless Steel Mesh media, downstream galvanised steel mesh media pleat reinforcement layer and an outer upstream galvanised sheet strengthening and oil diffusion layer. The sample was from Compressor No. 4 at the Coles Retail

Fig.2

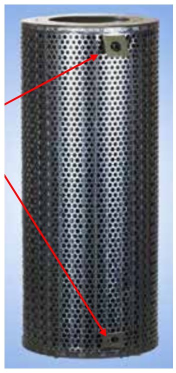


Fig.3

Ready site. The RH Image displays the filter analysed after being in use for 1 month, filter was removed on the 03/09/20 due to the filter tripping the over pressure warning. This filter was modified with the changing the media to a 5 µm stainless steel mesh and the addition of earthing straps that are to be attached to the oil filter housing earthing the outer shell of the oil filter directly to earth. The filter was opened and there was notably less damaged lubricant deposited across the filters core.

The filter was opened and the filters core was checked for evidence of ESD Arc discharge damage on the filter galvanised steel core. A sample of the filters galvanised steel core was examined for evidence that the ESD arcing was occurring in the filter and as the image (fig.4) displays there was ESD arcing continuing in the No. 4 Compressors Lubrication System notwithstanding the addition of earth straps and stainless-steel media.

The two images (fig.5) opposite, display the reason for the blocked media, fine ESD Arc Discharge carbonised compressor fluid particles have packed into the very fine 5 µm stainless steel media effectivily sealing the media off tripping the over pressure alarm.

Note how the epoxy resin has efficiently electrically isolated the stainless steel mesh from the earthed core.

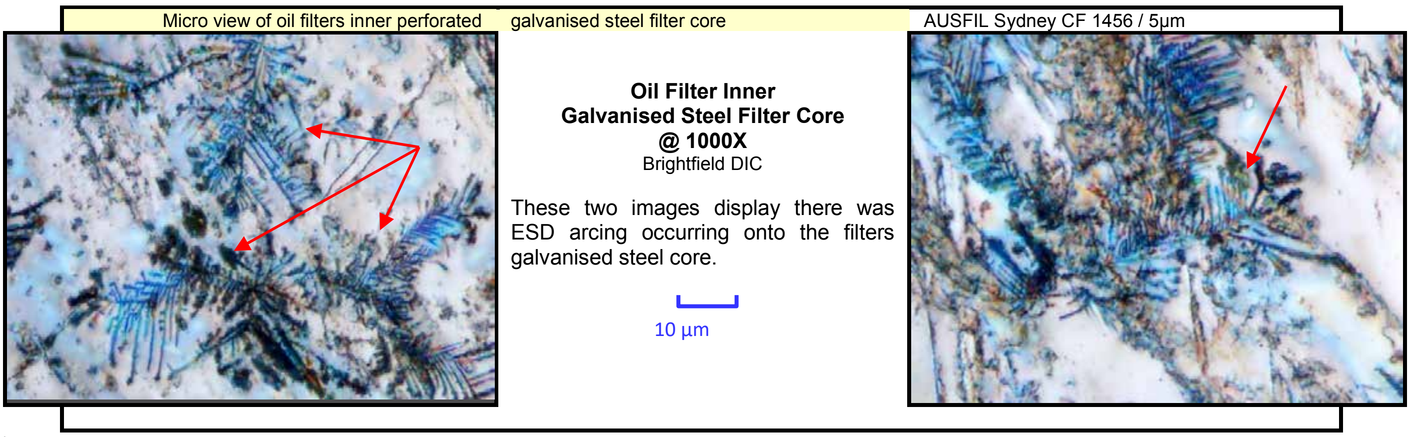


Fig.4.

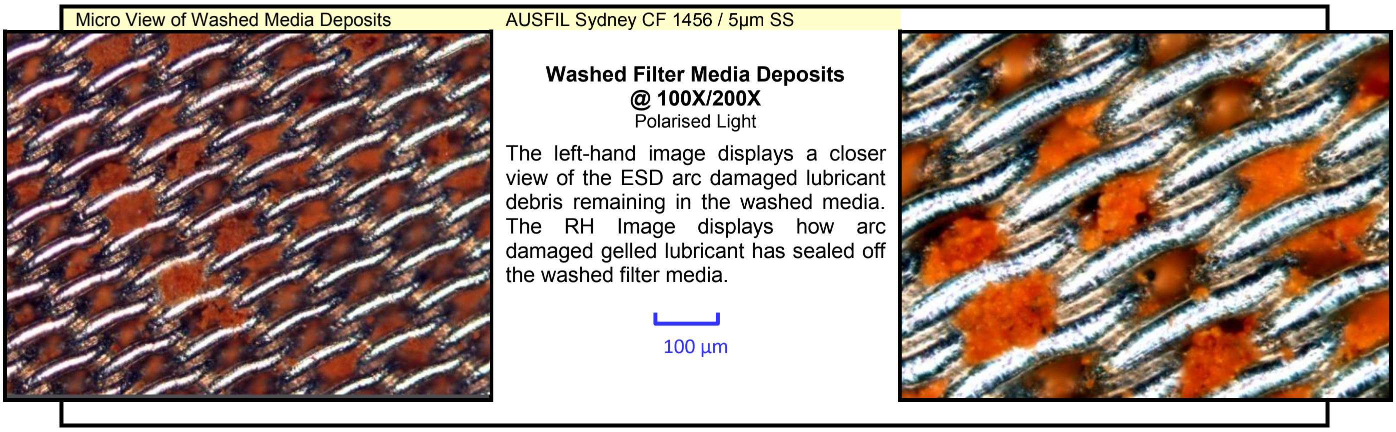
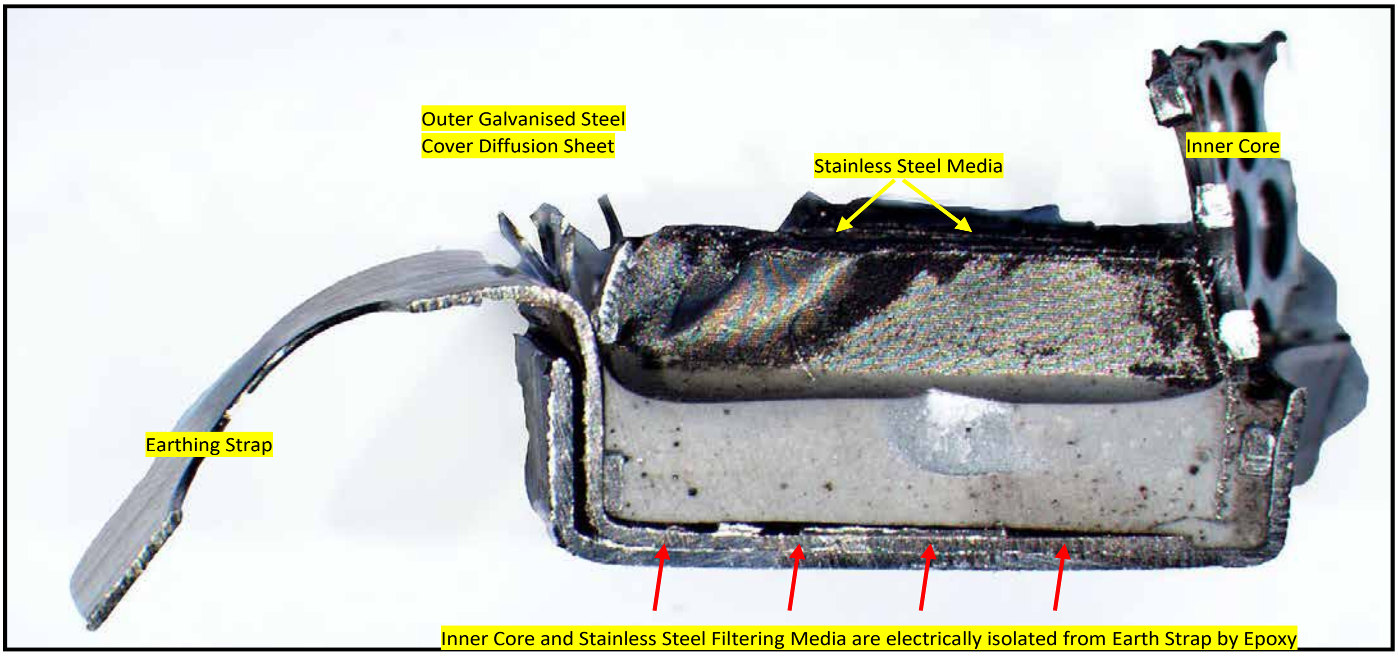


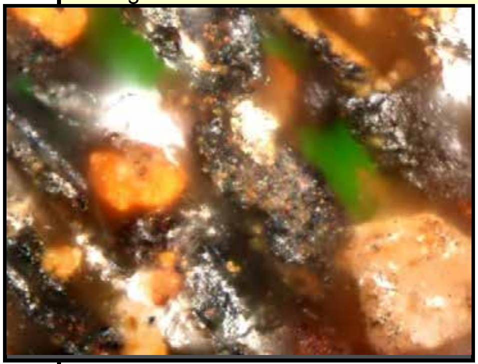
Fig.5 *Fig.6*



The above image (fig.6) displays the cross section of how the filter media, galvanised steel mesh, filter core, end caps, earthing strap and exterior galvanised diffusion sheet are mounted together.
Note how the stainless steel mesh media is isolated from the end caps and earthing strap so once the ESD voltage in the mesh has built up to 350 volts the mesh is arcing onto the filters core and the energy is dissipated back to earth via the earth straps onto the filter housing and pipe work. The next version of this 5μm stainless steel media filter will have all components welded to the filters end caps and earthing straps.

Continued over page >

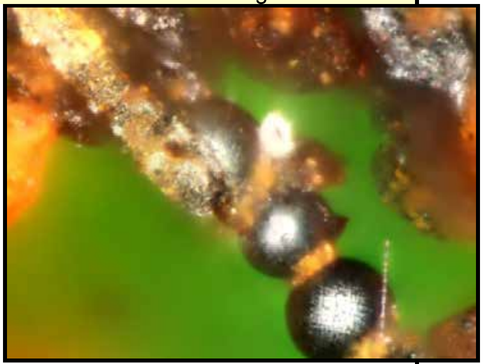
Ferrogram | AUSFIL Sydney CF 1456 / 5µm SS | Oil Filter Media Washing Solvent



ESD Damaged Lubricant
& Fine Metallic Debris
500X Sized 0.5-2500 µm
Polarised Light

The ferrograms magnets have arranged the heat damaged ferrous wear debris and the spherical particles display melting has occurred from the ESD arc discharge damage.

20 µm



Ferrogram | AUSFIL Sydney CF 1456 / 5µm SS | Oil Filter Media Washing Solvent

ESD Damaged Lubricant
& Ferrous Wear Debris
200X/500X Sized 0.5-150 µm
Polarised Light

The ferrous wear debris, aligned by the magnets is melted blue black coloured showing this debris is a result of ESD arc discharge occurring in the oil filter.

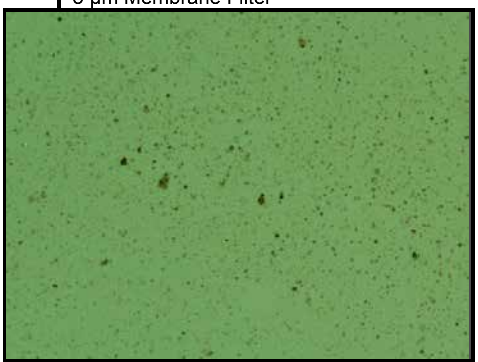
50 µm

Fig.7

As the micro images (fig.7) display there was a significant amount of ESD charging and discharging occurring on the lubrication system for this type of debris to be found in the oil filter media. The same filter was reapplied and these 4 images (fig. 8)are from the oil sample taken on the 01/09/20. Compressor running in a normal wear mode at a low to light rate of wear, images are from the oil sample taken on the 01/09/20.

The same filter was reapplied and these 4 images (fig.9)

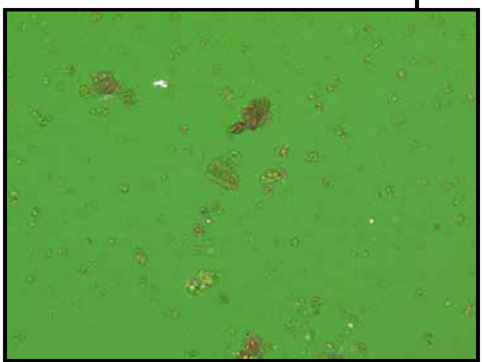
3 µm Membrane Filter | AUSFIL Sydney CF 1456 / 5µm SS



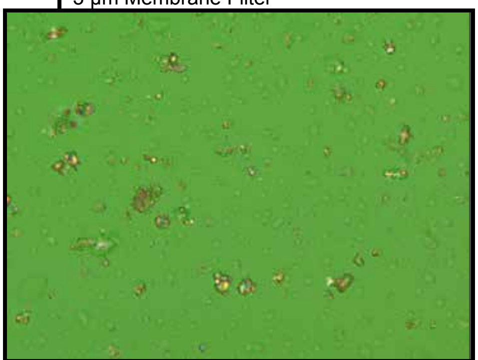
These images at 100X/500X indicate the average wear debris and contamination deposited on the analysis filter from 1 CC of the sample being forced through the 3-µm Membrane Analysis Filter.

The brightness of microscope's bottom Green/Blue light shining up through the sample provides an indication of the level of wear debris and contamination per CC of sample.

100 µm



3 µm Membrane Filter | AUSFIL Sydney CF 1456 / 5µm SS



ESD Damaged Lubricant Debris &
Fine Metallic Wear Particles
@ 500X Sized 0.5-50 µm

There was a few to light amount of ESD arc damaged lubricant and a few fine metallic particles found in the sample.

20 µm

Fig.8

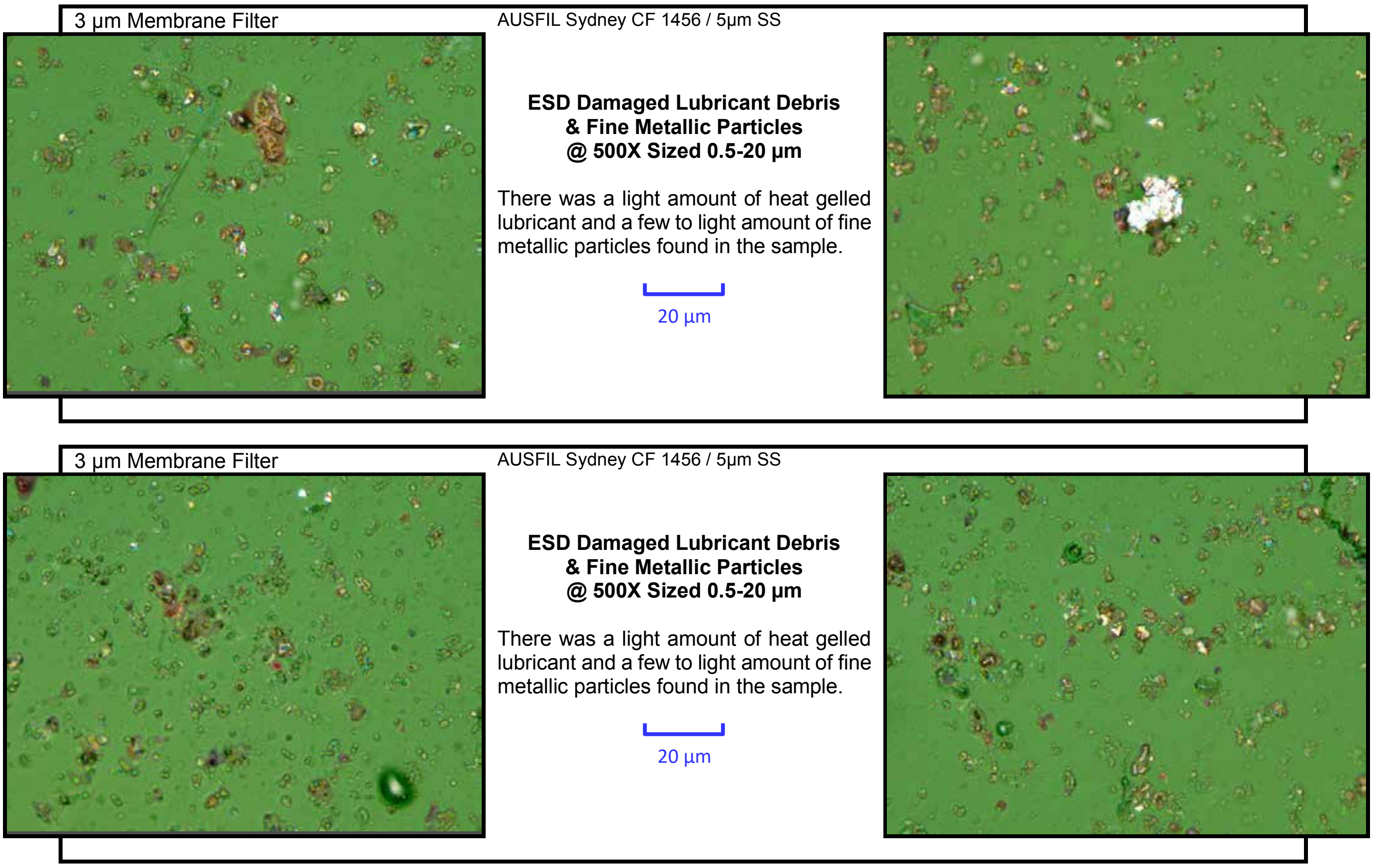


Fig.9

are from the oil sample taken on the 27/10/20. This sample from the Compressor No. 4 at Coles RR displays there has been a light increase in heat damaged lubricant in this oil sample taken on the 27/10/20 when compared with oil sample taken on the 01/ 09/20. These above images are of the contamination found in the oil sample from Compressor 4 dated the 27th November 2020 displaying the light increase in contamination found in the oil sample from Compressor No. 4 with the compressor wearing lightly in a normal wear mode.

This following filter (fig. 10) was removed on the 11/12/20 after approximately 3 months of service.
Filter type: AUSFIL Sydney CF 1456 / 5µm
Modifications: Earth Strap Tabs applied to asssist with dissipating the fluids electrostatic charge back to earth.

This is the second filter in this configuration to be applied to assist with establishing whether the modifications will signicantly reduce the ESD damage to the compressor fluid and oil filter. At this stage of this filters change over the refrigeration engineer servicing the compressors has noted a 50% reduction in damaged fluid. The new following filter that replaced this filter has all media layers in the filter electrically connected together and the earthing strap connected to earth onto the filter housing to establish if there can be a further improvement on the amount of ESD arc discharge damaged lubricant debris found in the compressor fluid samples.

Fig.10

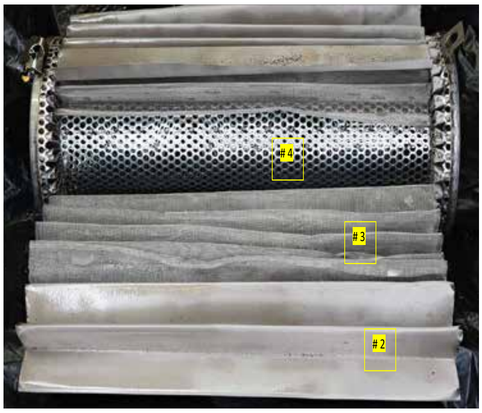


Fig.11

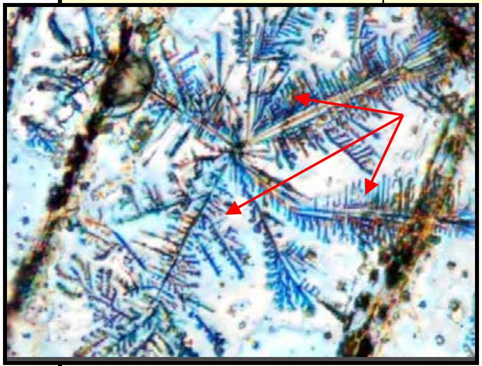
The AUSFIL Sydney CF 1456 / 5µm Filters outer cover sheet was removed.
The AUSFIL Sydney CF 1456 / 5µm Filter is a heavy-duty construction Screw Compressor oil filter with 2 layers in the filter media pack and earth strap tabs spot welded to the end caps either end of the filter.

1. The # 1 layer is the outer light weight perforated galvanised steel sheet that strengthens the filter and assists with dispersing the oil flow onto the filter media. This outer sheet is electrically connected to the zinc plated steel end cap on the filters core. The outer sheet has been removed in this image
2. The # 2 layer is the main fine filtering media consisting of a 5 µm sized stainless-steel mesh media

Continued over page >

Micro view of oil filters inner perforated galvanised steel filter core

AUSFIL Sydney CF 1456 / 5µm SS Earth Straps



Oil Filter Inner Galvanised Steel Filter Core @ 1000X

Brightfield DIC

These two images display there was ESD arcing occurring off the inner side off the filters galvanised steel core.

10 µm

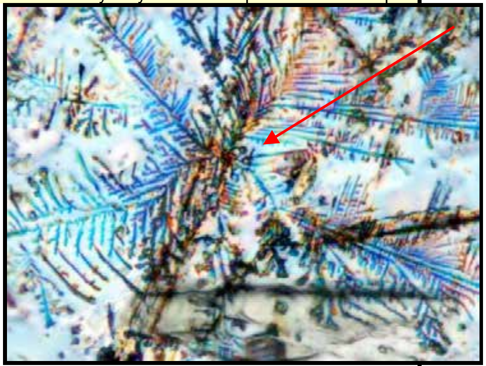


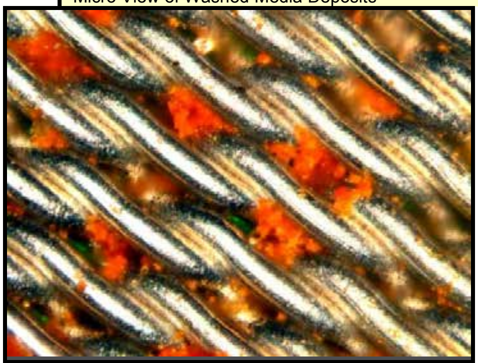
Fig.12

layer. This layer is not electrically connected to earth.

3. The # 3-layer inner media pleat reinforcement stainless-steel mesh. This layer is not electrically connected to earth.
4. The # 4 layer is the Mounted onto a zinc plated steel inner core with zinc plated metal end caps that have

Micro View of Washed Media Deposits

AUSFIL Sydney CF 1456 / 5µm SS Earth Straps

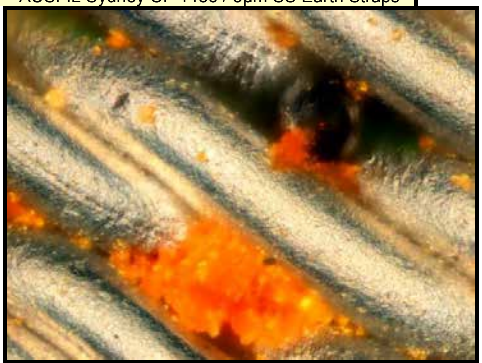


Washed Filter Media Deposits @ 200X/500X

Polarised Light

These images @ 200X/500X display a closer view of the ESD arc damaged lubricant debris remaining in the washed media. Note how the arc damaged gelled lubricant has almost completely sealed off the washed filter media.

50 µm



Micro View of Washed Media Deposits

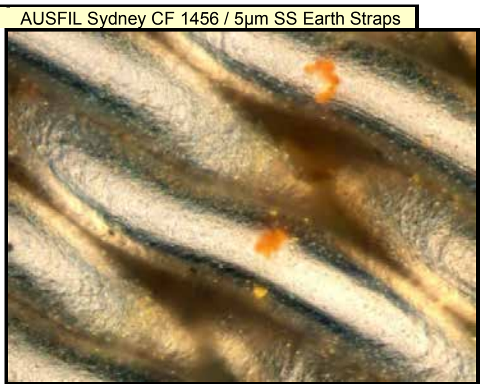
AUSFIL Sydney CF 1456 / 5µm SS Earth Straps

Inner "Clean" Side Washed Filter Media Deposits @ X500X

Polarised Light

These images display the of the inner side of the washed media. The wires used in this media are 30µm in diameter. Note the major amount of the media surface area that is taken by the media wires with < 10% of the surface able to allow fluid flow through significantly reducing the dirt holding capacity before filter blockage occurs.

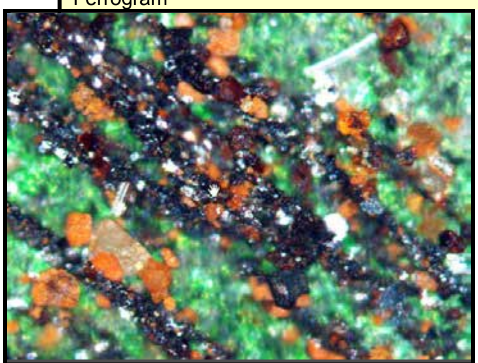
20 µm



Ferrogram

AUSFIL Sydney CF 1456 / 5µm SS Earth Straps

Oil Filter Media Washing Solvent



These images at 100X indicate the average view of the magnetic and paramagnetic components of the sample after passing a diluted 1 CC portion of sample through the Ferrogram maker. The Ferrogram Maker's magnetic field arranges the samples magnetic and paramagnetic components into the typical rows as the sample runs down the glass slide.

The microscopes bottom light shining up through the sample provides an indication as to the potential level of wear debris and contaminating particles per CC of sample.

100 µm

Fig.12

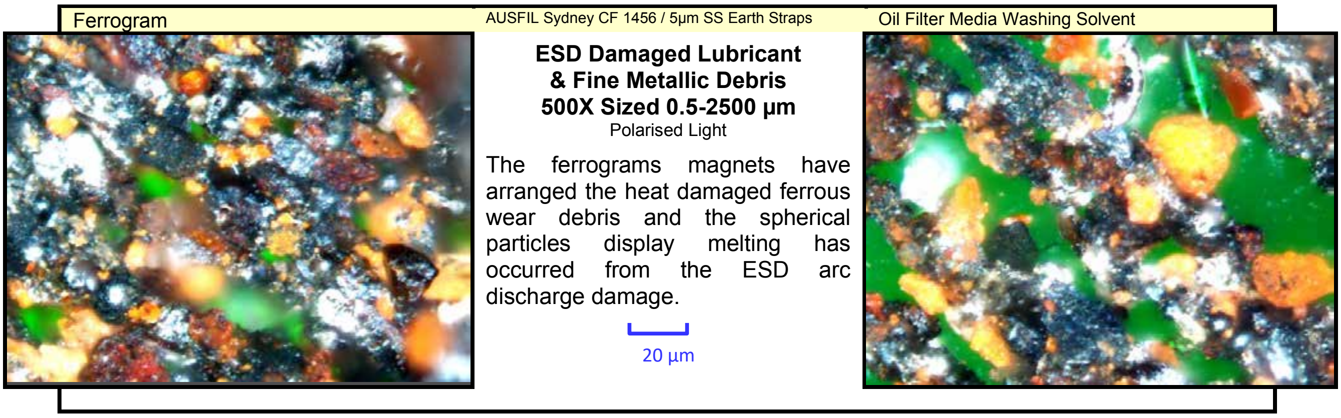


Fig.12

Fig.12

Fig.13

Fig.14

earthing strap tabs spot welded onto each end cap with the earthing straps electrically connected the earth onto the filter housing.

These images (fig.12) were taken from the filters galvanised steel core displaying that the ESD arcing had continued despite the addition of earth straps onto the filters outer cannister.

The Following filter (fig.13) is an:
AUSFIL Sydney CF 1456 / 5µm Earthing Straps & SS Earthed Media.
Modifications: Earthing Straps, Wires and Tabs applied to establish if a completely earthed filter will assist with dissipating the fluids electrostatic charge back to earth. This is the first filter in this configuration to be applied to assist with establishing whether the modifications will signicantly reduce the ESD damage to the compressor fluid and oil filter.

At this stage of this filters change over the refrigeration engineer servicing the compressors has noted a significant reduction in damaged fluid. This filter has all media layers in the filter electrically connected together with the inner and outer stainless steel cover sheet and inner core spot welded to the end caps. Plus the filters media layers have a separate earthing wire stitched between the inner media pleat support mesh and the 5 µm stainless steel mesh filtering media.

"At this stage of this filters change over the refrigeration engineer servicing the compressors has noted a significant reduction in damaged fluid."

This wire and the earthing strap are all connected to earth onto the filter housing to ensure all components in the filter are directly connected to earth to establish if there can be a further improvement on the amount of ESD arc discharge damaged lubricant debris found in the compressor fluid samples.

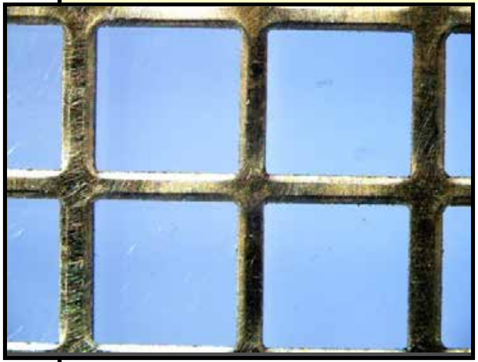
Upon removal the refrigeration engineer noted that one of the filters had sealed off with damaged compressor fluid and the over pressuring of the filter has collapsed the inner core on one filter and this filter is the filter that was analysed.

The filters outer stainless steel cover mesh (fig.13) was removed by cutting with side cutters. Note, the moderate layer of heat damaged compressor fluid coating the media. THis heat has damaged compressor fluid has

Continued over page >

Micro view of oil filters outer SS Mesh

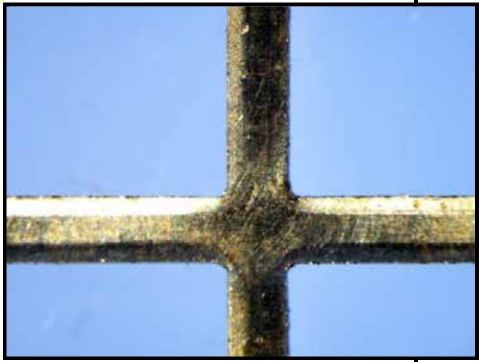
CF 1456 / 5µm with Earthing Straps and Earthed Media



Oil Filter Exterior
Stainless-Steel Mesh
@ 5X/20X
Darkfield

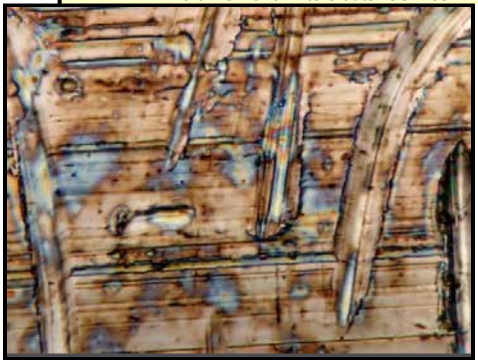
These images display micro views of the inside of the Oil Filters outer Stainless-Steel mesh to establish of there was ESD arcing occurring in the filter.

2000 µm



Micro view of oil filters outer SS Mesh

CF 1456 / 5µm with Earthing Straps and Earthed Media



Oil Filter Inner
Stainless-Steel Filter Core
@ 1000X
Brightfield DIC

These two images display there was ESD arc pitting occurring on the filters upstream outer Stainless-Steel mesh.

10 µm

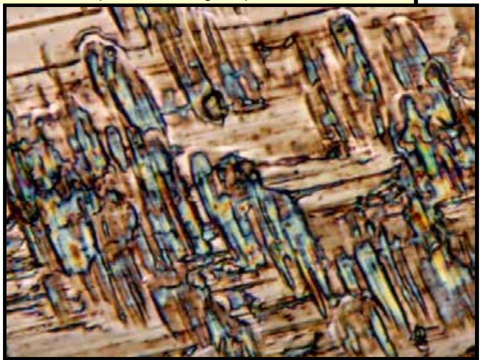


Fig.15

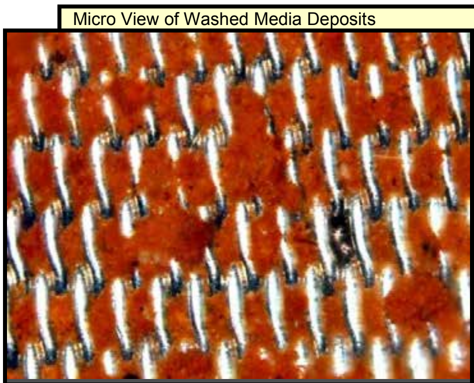
blocked the 5µm stainless steel media.

The image (fig.14) displays the opposite side of the media.

Note how when the heat damaged compressor fluid sealed off the 5µm stainless steel media, the filter was hydrauliced and crushed, collapsiing the fillters core.

Micro View of Washed Media Deposits

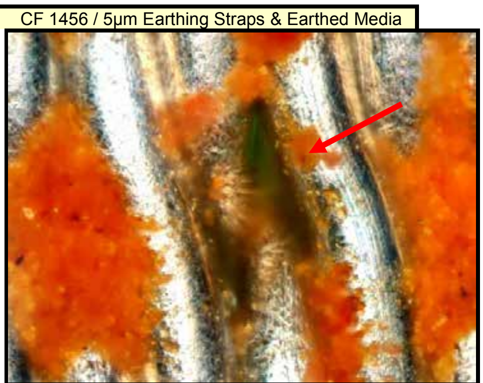
CF 1456 / 5µm Earthing Straps & Earthed Media



Washed Filter Media Deposits
@ 100X/500X
Polarised Light

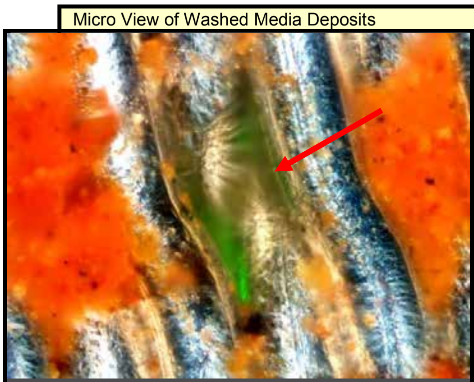
These images @ 200X/500X display a closer view of the ESD arc damaged lubricant debris remaining in the washed media. Note how in the RH Image the arcing has melted the SS 5µm Media leaving this small hole.

50 µm



Micro View of Washed Media Deposits

CF 1456 / 5µm Earthing Straps & Earthed Media



Washed Filter Media Deposits
@ 500X
Polarised Light

These images @ 500X display closer views of the difficult to image ESD arc damaged lubricant debris remaining in the washed media. Note how in the Images the arcing has melted the 5µm SS Media leaving these small holes.

20 µm

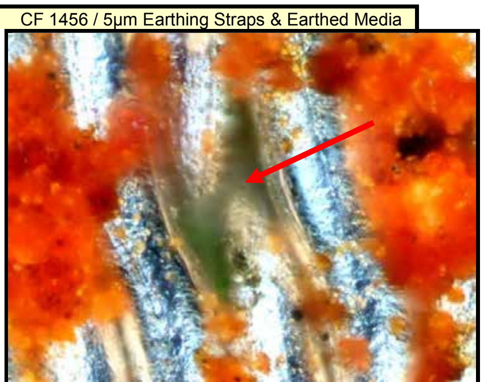


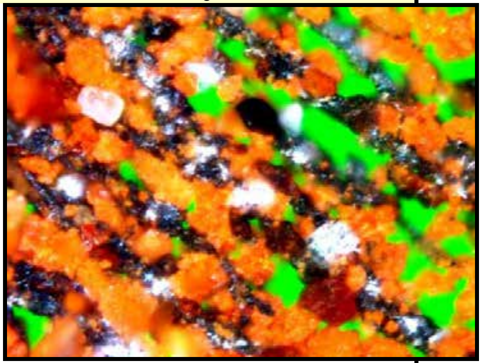
Fig.16

Ferrogram | CF 1456 / 5µm Earthing Straps & Earthed Media | Oil Filter Media Washing Solvent

ESD Damaged Lubricant
& Fine Metallic Debris
200X Sized 0.5-150 µm
Polarised Light

There was a moderate amount of heat coloured ferrous wear debris arranged into rows by the ferrograms magnets displaying melting has occurred from the ESD arc discharge damage.

50 µm



Ferrogram | CF 1456 / 5µm Earthing Straps & Earthed Media | Oil Filter Media Washing Solvent

ESD Damaged Lubricant
200X Sized 0.5-250 µm
Polarised Light

There was a moderate amount of this ESD arc discharge damaged lubricant debris as a result of ESD arc discharge occurring in the lubrication system.

50 µm

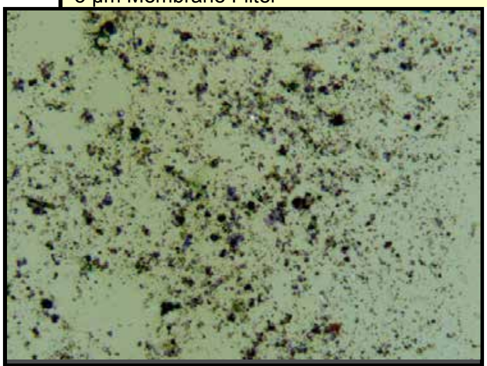
Fig.16

Subsequent Oil Sample Results

The Coles RR No 4 Ammonia Compressor was running in a normal wear mode at a low to light rate of wear. The four images below (fig.17) are from the oil sample taken on the date of 03/08/21.

Continued over page >

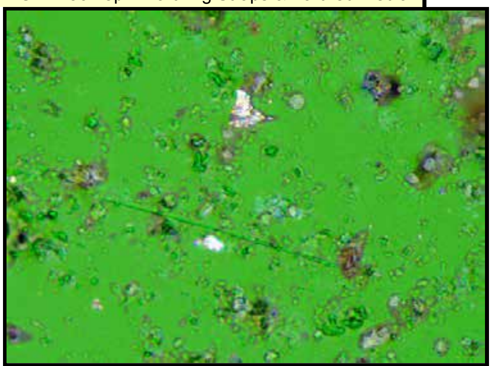
3 µm Membrane Filter | Oil Sample Dated 03/08/21 | CF 1456 / 5µm Earthing Straps & Earthed Media



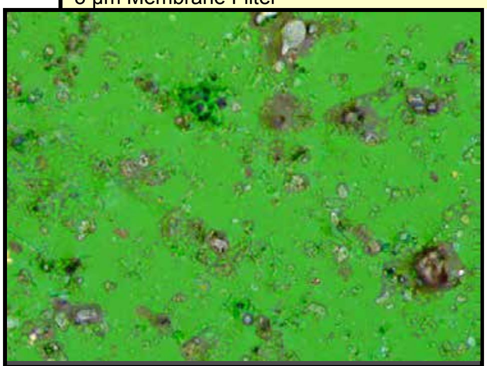
These images at 100X/500X indicate the average wear debris and contamination deposited on the analysis filter from 1 CC of the sample being forced through the 3-µm Membrane Analysis Filter.

The brightness of microscope's bottom Green/Blue light shining up through the sample provides an indication of the level of wear debris and contamination per CC of sample.

100 µm



3 µm Membrane Filter | Oil Sample Dated 03/08/21 | CF 1456 / 5µm Earthing Straps & Earthed Media



ESD Damaged Lubricant Debris
& Fine Metallic Particles
@ 500X Sized 0.5-20 µm

There was a light amount of heat gelled lubricant and a few to light amount of fine metallic particles found in the sample.

20 µm

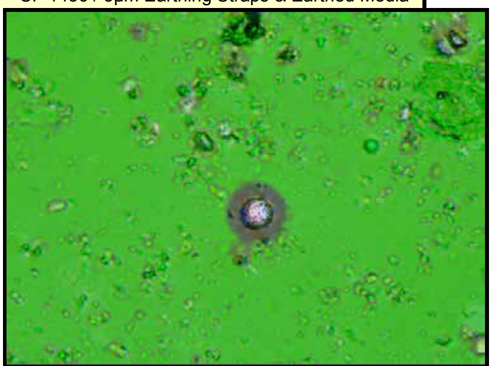


Fig.17

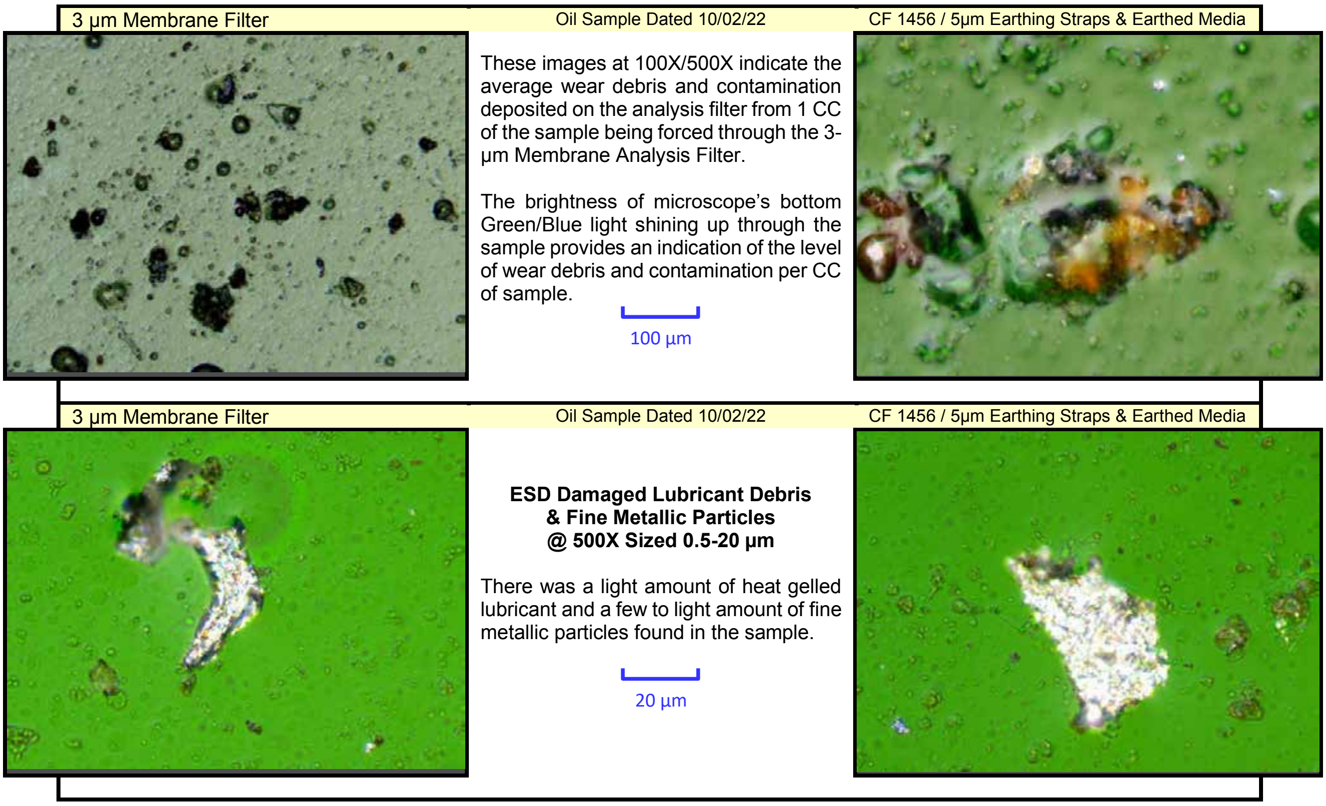


Fig.17

The above 4 images (fig.18) display the compressors oil sample taken on the 10/02/22 displaying the compressor has continued to run in a normal wear mode at a low to light rate of wear with a few to light amount of fine metallic wear debris and a light amount of ESD arc damage lubricant found in the sample with the CF 1456 / 5µm Earthing Straps & Earthed Media filter applied to the compressors lubrication system.

Results and Conclusions

This was an interesting assessment of the different filter types with thanks to Coles Retail Ready for permitting the different filter types to be run.

Also, many thanks to Australian Refrigeration Services and Ausfil Filters for providing and installing the fibre glass, polymer and stainless-steel earthed media all able to be run in the same compressor under the same conditions providing a good quality base for the different filter types comparisons.

After running the various combinations filter and media in the Coles RR Compressor No. 4 the following benefits were noted by Australian Refrigeration Services Matt Hindmarsh - Refrigeration Engineer.

Previous to the changes to the filter types used in the compressors when completing the 3 weeks service visit, compressors # 1, 2, 3 & 4 sight glasses were full with discoloured fluid and the compressors required topping up with fluid every visit. Also, the final drainage reservoirs on all of the 4 compressors would need to be drained at every 3 week service visit and over the 12 months there would be approximately 80 litres of damaged compressor fluid drained from the final drainage reservoirs from the compressors oil throwing.

After the change over to the stainless steel filters with earthing straps, although there appears to be a light amount of ESD continuing, with the hew filters on the 3 weeks service visit compressors # 1, 2, 3 & 4 sight glasses are not full of discoloured fluid and the fluid is clean and when the final drainage reservoir is checked a small amount of fluid is discharged with the compressors not requiring topping up with fluid every visit displaying reduced oil consumption and the compressor fluids are noticeably cleaner and over the 12 months there was a significant reduction in the amount of damaged compressor fluid drained with less than 20 litres drained from the final drainage reservoir from the compressors oil throwing over the 12 month period.

Rob Simmonds will be a keynote speaker at the 2025 VANZ Conference. Conference 25

Solutions on page 46

WORD BUILDER

How many words of **three or more** letters can you make using the six letters below? You can only use each letter once. Plurals are allowed, but no foreign words or words beginning with a capital.

Word scores expected...
20 - Good | 30 - Very Good | 35+ - Excellent

S	E	A	N	K	S

There's 38 possible three or more letter words to find.

There is three 6 letter words in this puzzle.

WORD LADDER

A Word Ladder has two words in the ladder, one at the top and one at the bottom. You must form a sequence of words going down. On every step of the ladder (1-6), you must unscramble and create a new word that only differs by one letter from the word above it until you reach the destination word on line 6.

Pig to Sty...

1 PIG
2
3
4
5
6 STY

SUDOKU

To solve, each number from 1 to 9 must appear once in:

- **Each of the nine vertical columns**
- **Each of the nine horizontal rows**
- **Each of the nine 3 x 3 boxes**

No number can be repeated twice in a box, row or column.

Puzzle difficulty: **Hard**

59.2% of puzzlers can solve this. Can you?

2					3	4	7	
	9			5		3	8	2
	5		4					6
						7		8
	8					2		
		4		2				
	3	1	2		6			4
	4		1	3		5		
	2		9					3

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No problem...

Head on-line to www.vanz.org.nz to find back issues of the magazine you can catch up on.

Or, simply scan the QR code below to link your device directly to the VANZ website. There you will find back issues of Spectrum available to view*.

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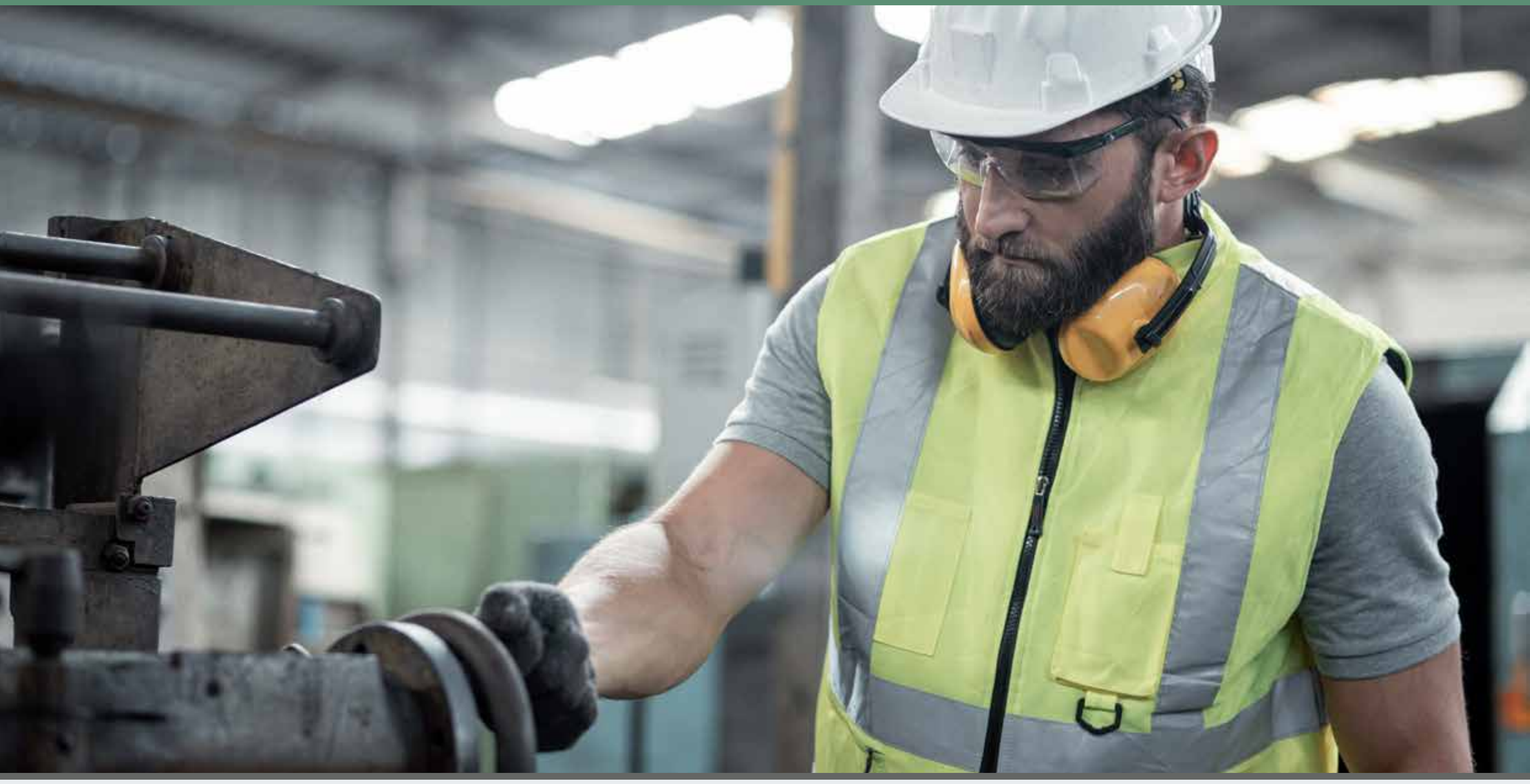
TEST YOUR KNOWLEDGE - PART 79 OF A SERIES



1. A motor runs at 1000 rpm and has a pulley of 190 mm diameter. It belt drives a fan via SPB 3500 belts. Assuming there is no slippage, what will the rotational speed of the belts be? Choose the answer that is true out of the following.
A. 2.84 Hz
B. 4.63 Hz
C. 7.34 Hz
D. The belt rotational speed cannot be calculated unless the diameter of the driven pulley is known.

2. You are out collecting data on a variable-speed machine. You notice that the peaks in the vibration spectra are less well-defined (i.e. a bit more smeared) than usual, so you collect an off-route spectrum at higher resolution to get some clarity. The result is worse. What is most-likely happening here?
A. Your vibration analyser has a fault
B. The accelerometer cable is damaged
C. The accelerometer is faulty
D. The machine speed might be fluctuating (hunting) during the period of the measurement collection.

3. Detecting rolling-element bearing defects on bearings running at slow speeds (e.g. 60 rpm) can be more challenging than on bearings running at higher speeds. What might be one of the best tools you can use in this situation?
A. A vibration analyser that provides phase information
B. A vibration analyser that provides conditioned spectral data
C. A vibration analyser that provides conditioned waveform data (e.g. peakvue or similar)
D. A screw-driver.

4. "Ski slope" refers to high levels of very low-frequency vibration signals that are spurious (i.e. not genuine vibrations). Which of the following might cause these effects?
A. The accelerometer being placed too vigorously onto the machine and insufficient time being given for it to settle before the measurement is collected
B. A faulty accelerometer cable
C. Possible moisture in the connectors
D. Any of the above could be possible causes.

5. If a vibration analyst normally uses a probe of 170 mm length for testing aluminium-bodied motors, and then swaps it to a probe that is 10% shorter, what differences might this make to the data-collection? Assume that the other dimensions of the probe remain the same.
A. Humps of energy in the spectra that were resulting from the natural frequency of the old probe might occur at higher frequencies with the new probe
B. Humps of energy in the spectra that were resulting

from the natural frequency of the old probe might occur at lower frequencies with the new probe
C. The vibration levels will be 10% higher
D. The vibration levels will be 10% lower.

6. Which of the following is true about frequency band trending?
A. The maximum peak within a band is sometimes trended
B. The overall energy level for the band is sometimes trended
C. Multiple frequency bands can be set up for a measurement point
D. All of the above.

7. In addition to frequency band trending of spectra, what other vibration measurement parameters might be trended?
A. The peak-to-peak value of a waveform
B. The crest-factor of a waveform
C. The rms value of a waveform
D. All of the above.

8. Which of the following is true about cross-channel phase analysis?
A. Only one sensor is needed
B. A tachometer is always required as a phase reference
C. Often "reference" and "roving" sensors are used
D. A and B.

9. A 500-gram steel weight is suspended from a beam by a 1-metre length of string. When displaced from its resting position and allowed to swing freely, it oscillates in pendulum fashion. If you want it to swing back and forwards at half the frequency, what would you do?
A. halve the weight
B. double the weight
C. Lengthen the string to 4 metres
d. halve the length of string.

10. "Overlap" processing is an option that can be selected on many frequency analysers and data-collectors. For measurement points where more than one average is specified, switching it off has the effect of:
A. increasing the total period of signal observation
B. decreasing data-collection time
C. Reducing the repeatability of data
D. Could be any of the above.

Check your answers on page 46 >

TEST YOUR KNOWLEDGE

Further enquiries can be directed to: Carl Townsend at Carlton Technology Ltd.
Phone: 64-6-759 1134 | Email: ctownsend@xtra.co.nz | Address: P.O. Box 18046 Merrilands, New Plymouth 4360, NZ

Anyone with an interest in the area of mechanical and electrical machine condition monitoring, to facilitate predictive asset management is eligible to join VANZ. Asset managers, reliability engineers, technicians, consulting engineers, suppliers and distributors of specialised equipment, engineering students and apprentices can all contribute and gain immensely from membership and our annual conferences.

Technology, materials and manufacturing processes are continually developing. And so too has the engineer skills and knowledge developed. Today the engineering role has evolved to where the analyst, by diligent use of multiple Condition Monitoring tools and principles, can empower Predictive Asset Management. But it is a challenging role! So much is at stake with the high cost of downtime, equipment replacement costs, and the potential safety risks. The future of the business can hinge on the Predictive Asset Management achieved by this special group of people. Yet detecting, diagnosing, and preventing these faults takes training, knowledge, skill and experience. That is why VANZ exists, and why VANZ constantly evolves!

VANZ recognises that the engineers who apply the technology are one half of the equation. Equally important are the industries and businesses served by it, with their varied experiences and evolving requirements. The size of the operation and the machinery it runs are not an issue either.

Annual conference for networking and learning

The core function of VANZ is the annual conference. Like a family reunion, over 100 people gather in a friendly environment to participate in technical presentations, round-table discussions, and at times debate. Keynote speakers from around the globe have, and continue to present technical papers at conference. And importantly local presenters add a New Zealand context. Our most recent conference in August, heralded a return to our grassroots, being held in New Plymouth.

VANZ is quite a unique society and has withstood the 'test-of-time' – and has, for many years, run an awareness day training for apprentices and trainees alongside an asset management stream for technicians, supervisors and management. It is a well respected 'track-record' which VANZ has consistently promoted for the New Zealand and Australian industry.

VANZ
VIBRATIONS ASSOCIATION of NEW ZEALAND

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For Analysts and Predictive Asset Management specialists

VANZ is a volunteer-run, not-for-profit, membership group of like-minded people from New Zealand and Australia. VANZ as an organisation evolved from a Workshop Conference held in New Plymouth in 1989. From this Workshop Conference the Vibrations Association of New Zealand was registered and the first annual technical conference was held. From this beginning VANZ has continually developed to provide a platform for people to discuss their challenges with their fellow analysts and learn from their peers and industry experts.

Did you know?

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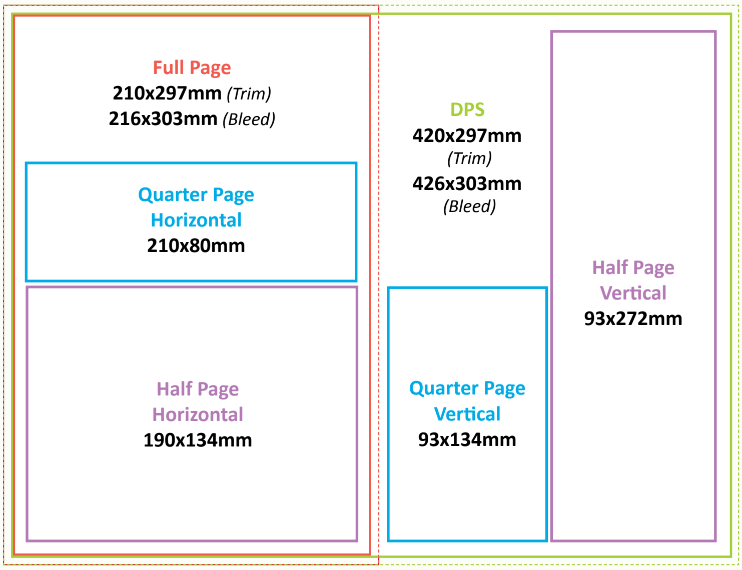


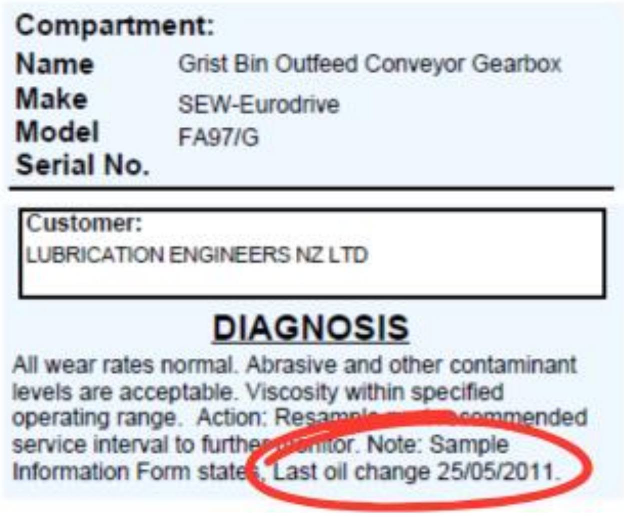
Word Ladder: 1. Pig 2. Big 3. Bag 4. Bay 5. Say 6. Sty
Word Builder: Snakes, Sneaks, Skeans
Carlton Technology Quiz 79: 1A, 2D, 3C, 4D, 5A, 6D, 7D, 8C, 9C, 10A

Are you discarding perfectly good oil?

The benefits of choosing Environmentally Responsible Lubricants

In an era where environmental awareness is crucial, the lubricant industry is emerging as an unexpected leader in sustainability.

Adopting sustainable lubrication practices is not only environmentally responsible but also economically beneficial. A well-implemented lubrication program can significantly enhance equipment uptime and efficiency, improving reliability and reducing operational costs. High-quality lubricants that can operate for longer periods lead to extended drain intervals, which in turn decreases maintenance costs and resource consumption.



Compartment:
Name Grist Bin Outfeed Conveyor Gearbox
Make SEW-Eurodrive
Model FA97/G
Serial No.

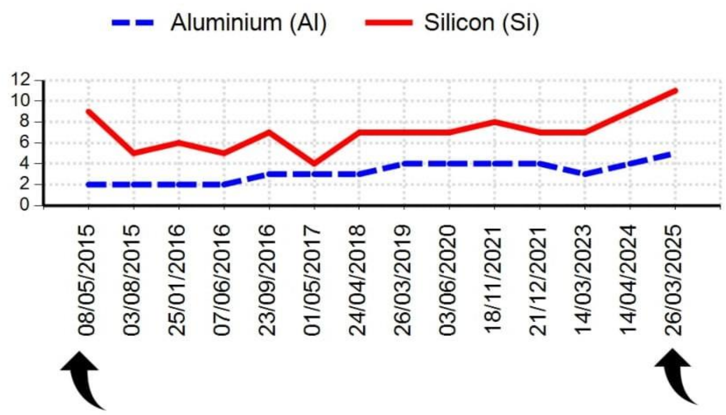
Customer:
LUBRICATION ENGINEERS NZ LTD

DIAGNOSIS

All wear rates normal. Abrasive and other contaminant levels are acceptable. Viscosity within specified operating range. Action: Resample at recommended service interval to further monitor. Note: Sample Information Form states, Last oil change 25/05/2011.

Above snapshot from a Gearbox Oil Analysis Report. Lubricant last changed in 2011 and still in operation.

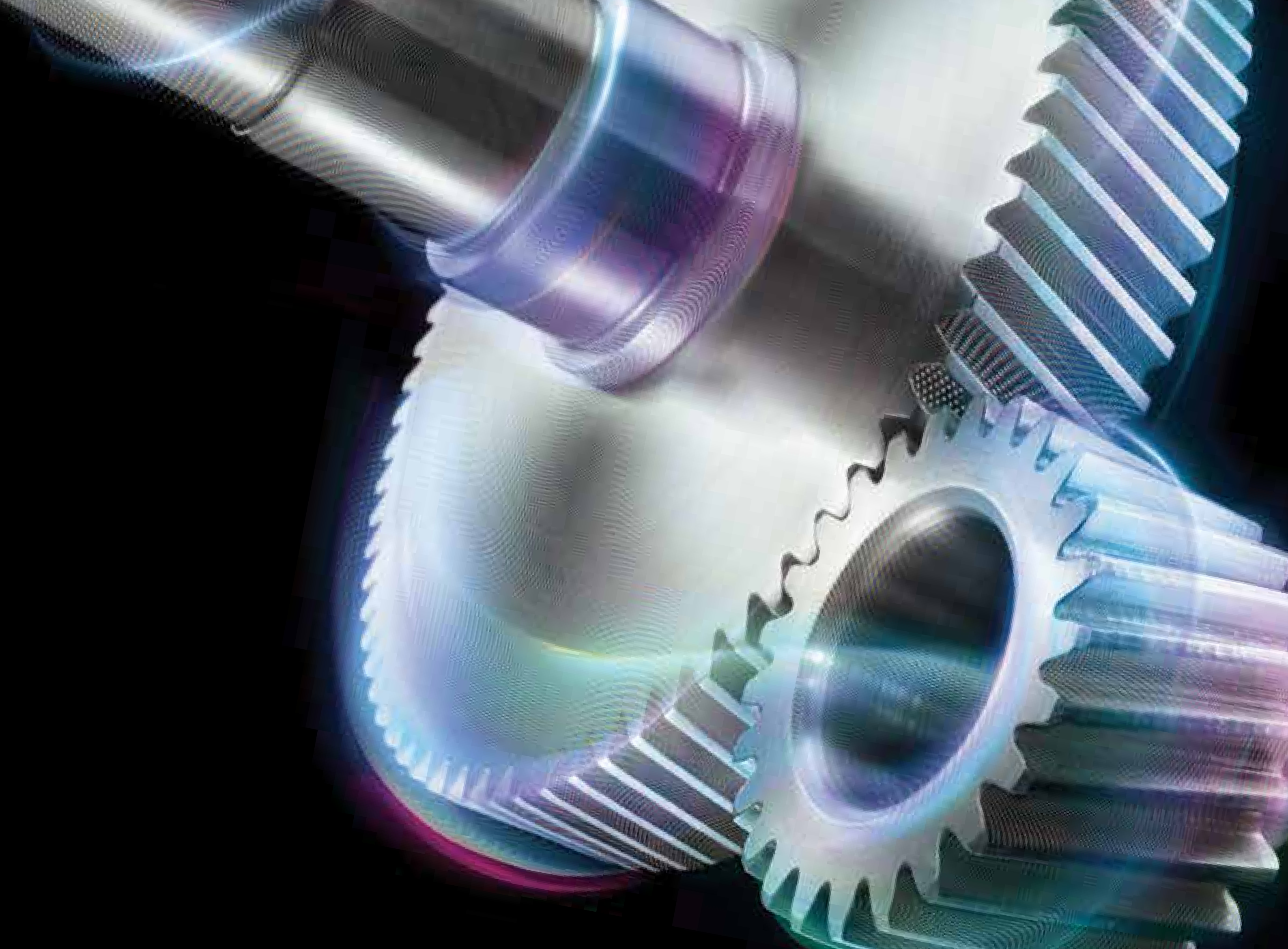
How often are you changing your oil?



Oil Analysis snapshot of Duolec Industrial gear oil LE1605 (60 Litre) in service for 10 years, filtered once using LENZ's offline filtration trolley at 3 micron filter.

Additionally, lubricants that effectively reduce friction can lead to measurable reductions in power consumption, resulting in significant energy savings and lower costs for businesses. This combination of environmental and economic advantages makes a strong case for adopting green lubricant practices across various industries.

www.lubricationengineers.co.nz



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