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Oil condition monitoring in-house:

A practical example from the paper industry

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In this article, a specific case study concerning eralytics processes will be used to demonstrate the strengths of companies incorporating oil condition monitoring technology in an in-house capacity to streamline operations and ensure a sustainable, self-contained maintenance strategy on their equipment.

Introduction

The relevance and benefits of oil condition monitoring as part of predictive maintenance in industrial environments are undisputed. A wide range of service providers and experts are available to support industrial companies in carrying out the various activities involved, from data analysis to the resulting actions. Alternatively, industrial companies can take responsibility for some parts or the entire process themselves.

By bringing oil condition monitoring in-house, companies get immediate access to results, eliminating the delays associated with third-party providers, and enabling rapid response to emerging maintenance issues, protecting against costly downtime and disruption.

Another benefit of in-house oil condition monitoring is that it fosters a culture of skills development and knowledge retention in maintenance teams. By training staff to carry out oil condition monitoring, the company promotes a deeper understanding of the condition of the equipment and encourages proactive maintenance practices from within. This approach not only improves confidentiality and data integrity, but also ensures a sustainable, self-contained maintenance strategy that adapts and evolves to meet the needs of the organisation.

Introduction of the industrial plant

The paper mill in question can look back on a hundred-year history of paper production. The company is specialised in producing high-quality, multi-coated fine papers and label papers, serving premium publications worldwide. Annually, it produces a significant amount of paper and pulp for internal use.

Figure 1: *Exemplary representation of a paper machine.*

Overall, the paper mill exemplifies a blend of historical expertise and modern innovation, contributing significantly to both the local economy and environmental sustainability.

From a sustainability and reliability perspective, a team of several professionals attaches great importance to proactively assessing the condition of the systems. In addition to evaluating vibration data and recording the technical condition of the system, the subject of oil condition monitoring has also been a top priority for many years.

Overview of the structure

The entire site has been structured into almost 100,000 objects in a hierarchical structure. It was proven to be most sufficient to have 7 different levels:

- Organisation
- Segment
- Site
- Location
- Asset
- Component
- Sampling point

The lowest level "Sampling point" (SP) is the object where potential oil samples are taken, and measurement data is stored. In total there are approximately 65,000 objects in the category of a sampling point. Oil samples are taken at 500 sampling points on a regular basis in frequencies between 6 and 12 months. This is organised in 9 measurement campaigns which also organise sampling sequence, responsibilities and required measurement parameters.

Implemented setup

There has been a technical solution in place since 2010. This was upgraded at the end of 2024 with ERALAB OCM, a system for oil condition monitoring developed and distributed by eralytics GmbH, a manufacturer of laboratory analysers based in Vienna, Austria.

More specifically there are four analysers and one software solution in use:

ERASPEC OIL – the portable FTIR spectral lubricant analyser for fully automated determination of important parameters for the aging and chemical condition of oil, like oxidation, nitration and water content. Total Acid Number (TAN) and Total Base Number (TBN) can be predicted with a predefined chemometric model. The application for industrial lubricants in the paper mill focuses only on the prediction of the TAN. To improve the chemometric model, 20 samples were added with known reference values.

ERAVISC X – the compact and robust kinematic viscometer is for testing of high-precision kinematic viscosity and density at any temperature between 15 °C and 100 °C. In this case samples are mainly measured at 40 °C but in some cases the Viscosity Index (VI) is also determined.

ERAOIL – the stand-alone rotating disc electrode spectrometer (RDE-OES) analysing wear metals, additives, and contaminants in all kinds of operating liquids, such as lubricating oils, fuels, coolants, and process water.

For the present application, 26 typical elements are determined with a maximum concentration of 1000 ppm. The typical detection limit (LOD) in the range of 1 ppm is also completely sufficient for practical purposes.

ERACOUNT XS – the small ISO 4406 laser particle counter which measures with laboratory precision from a relatively small amount of sample.

ERATEST FERRO – the ferrous debris analyser for determining the total content of ferromagnetic wear particles in oils and greases.

ERASOFT OCM – the software to support the operator in essential parts of the management, operation and maintenance of technical facilities.
In the area of preventive maintenance, particular significance is attached to oil condition monitoring. The software has been installed on several local clients and the database is located on a central server, where regular backups are also created. Different user levels have been defined to allow user-specific access.

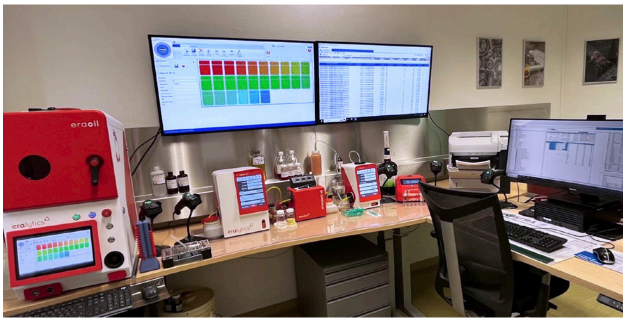


Figure 2: *ERALAB OCM analysers for in-house oil condition monitoring.*

Data migration

The existing data from the previous instrumentation was taken over in full and included the following categories:

- Object and master data including structure
- Measurement campaigns with assignment of the sampling points
- Historical samples with measured data in numerical form
- Historical measurement reports as PDF

The transfer of data was provided in the form of comma-separated text files (CSV) and via Microsoft™ Excel files. The import into the database was carried out via the generation of SQL commands with the help of Microsoft™ Excel's feature called Power Query.

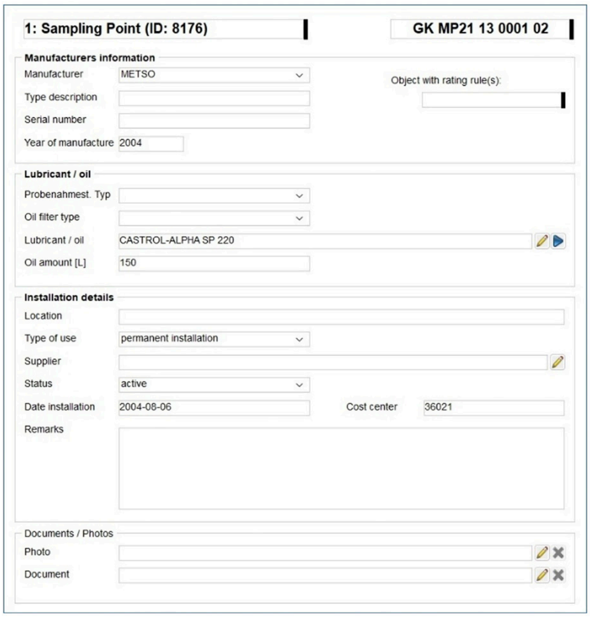


Figure 3: *"Gearbox S2BV - 400JP" - Example of a Sampling Point (SP).*

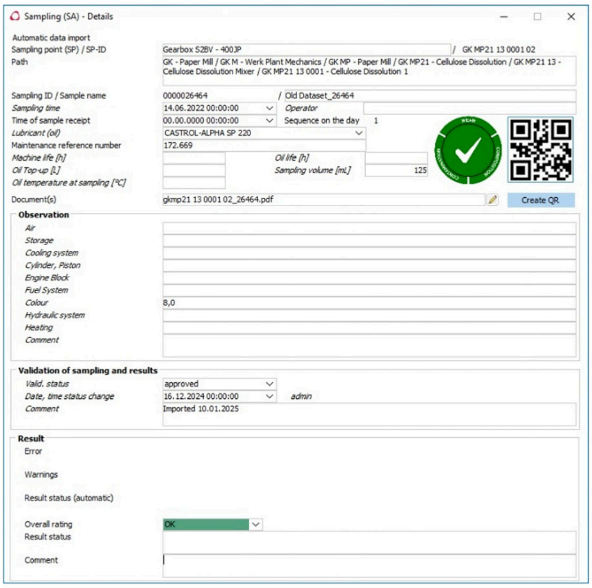


Figure 4: *"Gearbox S2BV - 400JP" - Example of a sample taken 14th June 2022 with basic data and a link to a historical PDF report.*

This function follows the "Extract, Transform, Load (ETL) process" and enables conversion of a wide variety of data into a desired and structured form using the "M" scripting language. The ETL process remains repeatable and can be easily adapted. The data was therefore transferred directly into the database and the PDF files were linked via a relative path.

Oil Condition Monitoring (OCM) process

The paper mill follows a common approach, from planning sampling to defining actions based on the latest results, including historical data and fresh oil information.

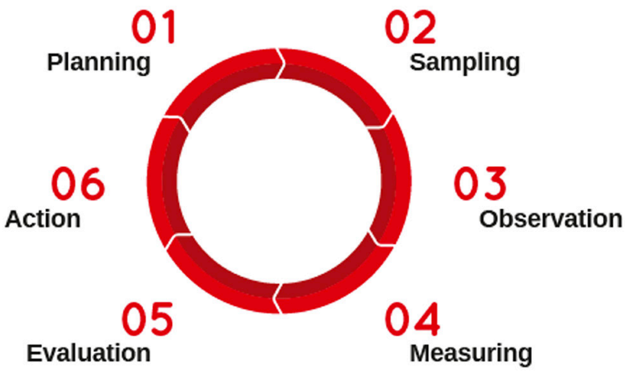


Figure 5: *Process of oil condition monitoring.*

Planning (01)

Planning is carried out via the nine measurement campaigns, in which the respective sampling points are organised with regard to the planned term, responsibility and frequency. The necessary measurement parameters are defined for the individual sampling point, which can later be displayed via queries about the open measurements.

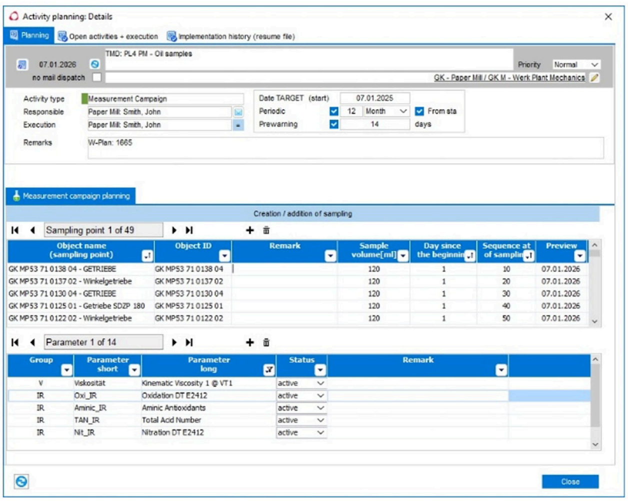


Figure 6: *Example of a 'Measurement Campaign' with listed SP.*

Sampling (02)

If a measurement campaign becomes due, the responsible operator will be notified via email or in the software. Initial samples will be generated automatically with a new 10-digit Sampling ID and its corresponding QR-code. The sampling labels for the bottles can be printed or a sampling form can be used as an option to note down any required information during the sampling process.

Figure 7: *Labels with Sample ID and QR code.*

Observation (03)

The whole sampling process is also supported by a mobile device, which is synchronised with the database. This enables the operator to identify the SP and to collect information and observation directly on this mobile device. The mobile device offers the option of photographing the sample bottle and the cap. All data is synchronised between the mobile application and the database as soon as the mobile device gets a network connection.

Measurements (04)

As soon as the samples are in the laboratory, measurements can be taken on the measuring devices.

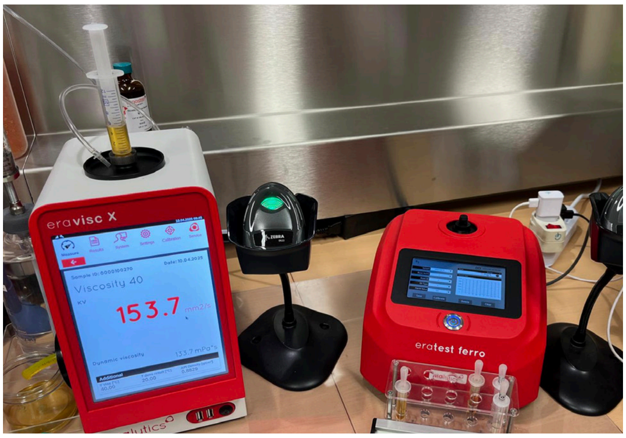
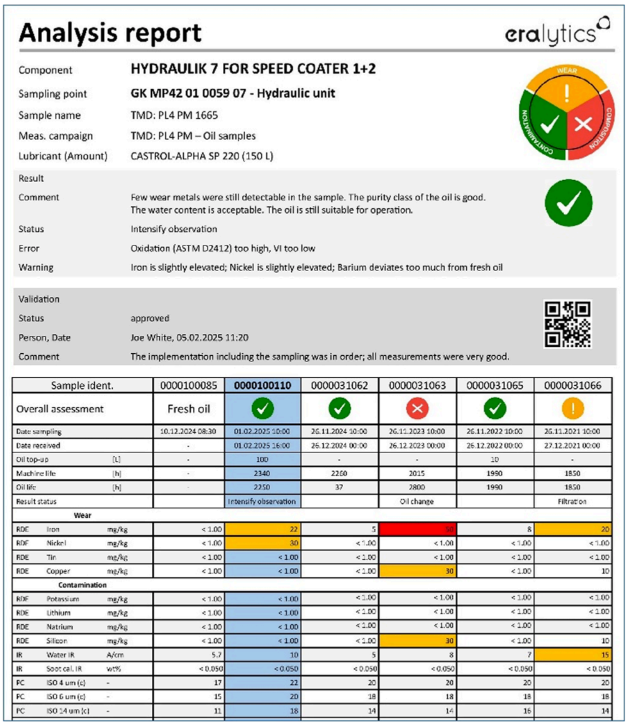


Figure 8: *ERAVISC X and ERATEST FERRO with individual bar code scanner.*

Infrared spectroscopy and kinematic viscosity are determined for all samples. Particle counts are usually determined for hydraulic oils and ferromagnetic wear is usually determined for gearboxes. The measurement of elements present with the RDE-OES is not carried out automatically, but on an event-driven basis.

The link between measurement results and samples is realised via the Sample ID. Therefore, before performing a measurement the QR code on the sample bottle needs to be scanned by a bar code scanner at the instruments.



Analysis report

eralytics

Component	HYDRAULIK 7 FOR SPEED COATER 1+2
Sampling point	GK MP42 01 0059 07 - Hydraulic unit
Sample name	TMD: PL4 PM 1665
Meas. campaign	TMD: PL4 PM – Oil samples
Lubricant (Amount)	CASTROL-ALPHA SP 220 (150 L)
Result	
Comment	Few wear metals were still detectable in the sample. The purity class of the oil is good. The water content is acceptable. The oil is still suitable for operation.
Status	Intensify observation
Error	Oxidation (ASTM D2412) too high, VI too low
Warning	Iron is slightly elevated; Nickel is slightly elevated; Barium deviates too much from fresh oil
Validation	
Status	approved
Person, Date	Joe White, 05.02.2025 11:20
Comment	The implementation including the sampling was in order; all measurements were very good.

Sample ident.			0000100085	0000100110	0000031062	0000031063	0000031065	0000031066
Overall assessment			Fresh oil					
Date sampling			10.12.2024 08:30	01.02.2025 10:00	26.11.2024 10:00	26.11.2023 10:00	26.11.2022 10:00	26.11.2021 10:00
Date received			-	01.02.2025 16:00	26.12.2024 00:00	26.12.2023 00:00	26.12.2022 00:00	27.12.2021 00:00
Oil top-up		[L]	-	100	-	-	10	-
Machine life		[h]	-	2340	2260	2015	1990	1850
Oil life		[h]	-	2250	37	2800	1990	1850
Result status				Intensify observation		Oil change		Filtration
Wear								
RDE	Iron	mg/kg	< 1.00	22	5	50	8	20
RDE	Nickel	mg/kg	< 1.00	30	< 1.00	< 1.00	< 1.00	< 1.00
RDE	Tin	mg/kg	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
RDE	Copper	mg/kg	< 1.00	< 1.00	< 1.00	30	< 1.00	10
Contamination								
RDE	Potassium	mg/kg	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
RDE	Lithium	mg/kg	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
RDE	Natrium	mg/kg	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
RDE	Silicon	mg/kg	< 1.00	< 1.00	< 1.00	30	< 1.00	10
IR	Water IR	A/cm	5.7	10	5	8	7	15
IR	Soot cal. IR	wt%	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
PC	ISO 4 um (c)	-	17	22	20	20	20	20
PC	ISO 6 um (c)	-	15	20	18	18	18	18
PC	ISO 14 um (c)	-	11	18	14	14	16	14

Figure 9: *A section of a typical report with fresh oil, evaluation and with historic data.*

Evaluation (05)

After all measurements are done, the operator reviews the collected dataset. If all the required samples have been evaluated, a report will be generated or measured data checked directly in the data window.

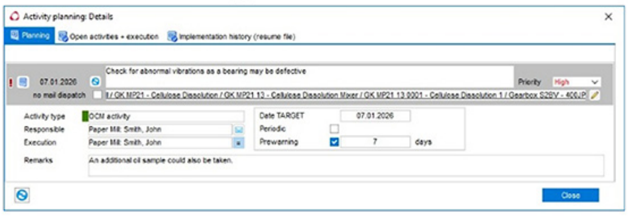


Figure 10: *Definition of activities linked to specific objects including responsibilities.*

At this point reports are typically printed together with historical data and reference values coming from the fresh oil. If values exceed any warning or error level, these cells are marked with color and a summarising evaluation symbol is displayed.

1.1. Actions (06)
In the final step of the oil condition monitoring process actions are defined. Based on all information and measurement data available, the system recommends corrective actions for this component or asset. Finally, the operator can schedule specific actions like ‘oil change’ to responsible professionals including notification via email and in the software application.

After the activity is concluded and marked as done, it is stored in the implementation history for future reference.

Specific example
In addition to the normal sampling cycle, an oil sample from a tank with a huge amount of hydraulic oil for a cooling, hydraulic system and also the bearing lubrication as part of the Nipco-Roll was examined for metal particles. Damage with possible abrasion had already been confirmed, but the technicians wanted to know if the brass bearing could also be affected by abrasion. After the element analysis with RDE-OES (ERAOIL) showed an increased copper content of 59 ppm and a zinc content of 44 ppm, damage to the brass bearing was the obvious cause.

Figure 11: *Hydraulic system for cooling and bearing lubrication as part of the Nipco-Roll.*

Conclusion
The implementation of an advanced in-house Oil Condition Monitoring (OCM) system at a particular paper mill has proven to be a practical and effective approach for predictive maintenance. By upgrading to the ERALAB OCM system, the facility has successfully enhanced its ability to detect and address potential failures in lubrication systems, thereby improving operational efficiency, reducing downtime, and extending equipment life.

The structured hierarchical organisation of assets and the integration of five state-of-the-art analysers with a centralised ERASOFT OCM software solution ensure seamless data acquisition, processing, and analysis. The automated sampling process, QR-code-based tracking, mobile-enabled observations, and synchronised databases improve reliability and accuracy, minimising human errors.

The OCM workflow, from planning and sampling to evaluation and corrective actions, ensures a systematic approach to oil analysis. Automated alerts, color-coded reports, and trend evaluations enable maintenance teams to make data-driven decisions efficiently. Furthermore, by incorporating historical and fresh oil data, the system allows for more accurate condition assessments and trend analysis, leading to proactive maintenance strategies rather than reactive interventions.

In summary, this case study demonstrates that in-house oil condition monitoring, supported by advanced analytical instruments and digital integration, delivers significant operational benefits. The approach not only enhances the reliability and sustainability of industrial processes but also fosters a culture of technical expertise within the maintenance team, ensuring long-term adaptability and performance optimisation.

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