RULER® Technology
Remaining Useful Life Evaluation Routine

"Portable Condition Monitoring Technology for your Lubricants and Greases"

The RULER is the instrument by excellence to bring added value to your on-site oil condition monitoring programs.
As a fully portable technology it will enable you to screen the condition of your lubricant by monitoring and trending its oxidative health, before excessive stress will start to degrade the lubricant and result in equipment damage and/or failure.
This technical paper will cover different technical subjects related to the RULER technology and we invite you to read them.

1. Features and Benefits for an On-site oil condition monitoring program
2. What is the link between Maintenance programs and the Remaining Useful Life (RUL) of a lubricant?
3. Features of the RULER instrument
4. For which lubricants can the RULER® be used?
5. RULER Data interpretation
6. How to contact us?
1. Know your benefits for On-site Oil condition monitoring (OCM) programs

“Power Generation plant has improved through its 2-years old on-site OCM, its overall efficiency with 3%, by reducing their downtime costs, as well maintenance and spare parts costs.”
Press Release, June 2003

In modern maintenance strategies, OCM is vital for understanding and predicting the lubricant degradation of in-service industrial lubricants (lubricant condition-monitoring and diagnostics program).

Therefore, during the last decade maintenance programs driven by Condition Based Monitoring programs, have proven to be valuable for cost reduction and cost control programs (Reliability Based Maintenance - RBM).

This consists of monitoring, controlling and trending the vital physical and chemical parameters like viscosity, antioxidants, oxidation on-set, water, and particulate contamination, resulting in proactive information for condition based oil changes, and enhancing on-site decisions.

When will your CBM program be positioned as a cost saving or cost control program?

- Right balance between off-site and on-site oil analysis
- Utilize the information to enhance actions
- Lubricant incoming batch quality control
- Exchange data with other techniques like vibration
- Remaining Useful Life of your lubricants = key parameter for modern and high performing lubricants
2. What is the link between Maintenance and Remaining Useful Life of Lubricants?

With the implementation of new maintenance strategies based on RBM (supported by competent oil analysis training programs) the information revealed by lubricant oxidative health monitoring (oxidation) contributes specifically to the proactive root cause failure detection, by monitoring the remaining activity of antioxidants.

By monitoring the consumption of the antioxidants during their service life, directly related to the lubricants Remaining Useful Life, operators will manage the potential safeguard for lubricants against oxidative stresses (before the onset and propagation of oxidation, and one of the major reasons of lubricant degradation).

As the oxidation process is a chemical reaction between oxygen and the base-oil (hydrocarbon chain) this oxidation reaction results in the formation of reactive oxidative compounds, which will themselves start to attack the oil base stock and form polymers. Chemically this reaction is better known under the formation of oil insoluble sludge, varnishes and other deposits, and will directly result in a significant increase of viscosity.

Fundamentally the antioxidants main function will be to react with the reactive oxidative compounds by neutralizing them. By industrial standards this is referred to as the “oxidation stability”, and will extend the operating life of the oil.

So, during use of the fluid the antioxidants (AO) will be depleted until a certain critical level is reached at which the fluid start to degrade / polymerize at a higher rate. At this point the fluid reached its useful life. In order to estimate the Remaining Useful Life (RUL) of a fluid it is therefore important to know its critical antioxidant concentration (see figure 1 below).

![Fig.1: plots of the percent – RUL, viscosity (@40°C), and Total Acid Number vs. hours of stressing time and RUL at 175°C.](image)

How will the RULER be successfully integrated into your Condition Monitoring Program?

Through time-series testing, the Remaining Useful Life of a lubricant can be tracked from test to test, enabling the end-user to identify "normal" trends for a given engine or other equipment. Variations from this normal trend can be indicative of changes in operating conditions causing accelerated oxidation. Consequently, determinations can be made to predict when rapid
changes in the base stock are likely to occur, and decisions can be made regarding oil changes or additive reinforcement to extend the Useful life of the lubricant.

### ACT BEFORE REACTION

RULER® tests are performed to be part of Trending programs
- **T**ests performed in a few minutes
- **R**equires no chemical expertise
- **E**nables exchange with other lubricant test programs
- **N**ew oil as reference and base-line
- **D**ecision based on the RUL of your lubricant

**RULER = ASTM approved test**
- D 6810 – measurement of phenolic antioxidants in lubricants
- D 6971 – measurement of phenolic and aminic antioxidant in lubricants

### 3. Features of the RULER instrument

The RULER® is a fully portable instrument that measures the antioxidant levels of lubricants and greases in seconds.

- **PORTABLE**
- **QUICK & EASY TEST**
- **DATA STORAGE & EXCHANGE**
- **POWERFUL SOFTWARE**

- **E**asy in operation – for a wide range of applications
- **A**ccurate Results – for Proactive Oil Management Programs
- **S**upported by Windows CE Software - Easy and Fast.
- **E**xport of Data – real time measurement and data treatment
- **S**aving Costs – know the lubricants RUL and increase equipment uptime

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<thead>
<tr>
<th>Portable</th>
<th>Practical</th>
<th>Predictive</th>
<th>Proactive</th>
<th>Proenvironmental</th>
</tr>
</thead>
<tbody>
<tr>
<td>RULER Technology</td>
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The main features you can find into the RULER® instrument are listed below:

- Test capability for Antioxidant and Acid Number measurement
- Compact and completely portable (dimensions: 2.36”H x 4.08”W x 9.74”L) – 1.5 lbs
- Easy to use software powered by Windows CE
- Super flex touch screen - 320 * 240 pixels backlit LCD
- Data Storage for over 100 tests
- Quick and easy data-communication to personal computers
- Long life lithium-ion battery with backup reserve and fast charge circuit
- Fully tested for harsh and industrial environments
- RULER® Data Management Software – R-DMS®

R-DMS®, version 1.1, is a Windows® based software designed for RULER® CE320 models to enable users downloading RULER field data from the CE320 field unit to a PC. With R-DMS®, the user can maintain large databases, trend time-series testing (figure below), view multiple tests, and export data to other database formats.

What’s the principle of working behind the RULER®?

The RULER® test can be performed with any lubricant containing at least one antioxidant species. The test vial (electrolytic cell) is prepared by mixing an oil sample with a solvent and a solid substrate. The solvent separates the antioxidant from the oil, as the vial is shaken vigorously. The sample is now ready for analysis, and the electrode may be inserted into the test vial.

The instrument uses voltammetric techniques, which consists of a controlled voltage ramp through the electrode inserted into the diluted oil sample. As the voltage potential increases the antioxidants become chemically excited, causing the increasing oxidation current to reach a peak, and then decrease as voltage potential continues to increase. (see figure below)

In the voltage/current relationship:
- The voltage potential range is related to
the identification of the type of antioxidant

- And the current peak height indicates the concentration of the antioxidant

The RULER® displays a RUL number representing the concentration of the antioxidants being monitored. Each test compares the RUL number of used oils to a standard RUL number of a fresh oil sample of the same brand and formulation.

4. **For which lubricants can the RULER® be used?**

- RULER® measures a wide range of antioxidant additives in used and new lubricants from hydraulics, pump systems, gearboxes, compressors, transmissions and circulating lubricating systems (including steam & gas turbine lubricants), jet engines, and other combustion engines.
5. RULER® Data interpretation

When using the RULER® technology for oil condition monitoring purposes, it is important to realize that the test is not finished once the RULER® analysis is done. A very important step in lube oil analysis programs will be data interpretation, in order to enable operators to take corrective actions, if necessary.

To facilitate and enhance users for quick and easy data interpretation, Fluitec International has made following software available at your choice:

- The RULER® CE320 software working under Windows CE environment – see fig. 4
- The RULER® R-DMS version 1.1. software for data downloading, export and trending facilities (see figure 5)
- The TNC-R-Server ActiveX software package for use of RULER in laboratory environment, to enhance quick and automatic data transfer between laboratory databases and RULER CE320

6. How to contact us?

Fluitec International is committed to developing, manufacturing and providing customers around the world with innovative, reliable and easy to use oil condition monitoring solutions that meet everyday lubrication maintenance needs. Fluitec combines dedication and expertise with global resources to provide customers with the vital information they need to effectively manage condition-monitoring programs covering a broad range of industries and applications.

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