DIGITAL LUBE
OIL MONITORING SYSTEM

Real Time Lube Oil Monitoring: Digital Enterprise approach to monitor the health of the lubrication & critical parts of the equipment.
ABSTRACT

80% of All Fluid System Failures are caused by Contamination

All areas of the energy sector (refineries, gas treatment plants, power plants, the wind power industry, oil and gas extraction plants) are dependent on continuous production, where processes and technologies need to be reliable and cannot fail. Many facilities utilize rotating and fluid carrying equipment such as gear oil systems, hydraulic systems, lubrication systems and other process systems.

These systems contain sensitive components that must be treated with care so as to avoid machinery breakdowns. A significant amount of resources are devoted to checking and maintaining rotating components.

This may cause serious problems as every shutdown means loss in production. Consequently, companies are very interested in reducing these unexpected shutdowns. This is where our job begins, as our role is to reduce failures and prevent system break-down and thereby reduce the NPT- Non-productive time.

BEARING DAMAGE AFTER FAILURE

DAMAGED BEARING CUP

Nevertheless, both experience and statistics make it plain that unnecessary system faults continue to occur.
HOW CAN OIL MONITORING PREDICT FAILURES?

Lubrication oil is the most neglected component

The most important component in all hydraulic and lubrication systems is the lubrication oil that reduces friction between the rotation parts. However, there will always be a certain amount of friction, which results in wear and as a result the presence of tiny particles in the lubrication oil.

Where there is rotation, there is friction and friction inevitably generates heat and wear. Wear releases particles that the fluid transports and deposits in all other areas of the system. These particles then build up in tolerance areas, damaging valves and bearings, which in most cases are the most sensitive components.

It has been proved that 80% of all hydraulic and lubrication breakdowns are caused by contaminated oil, dirt and foreign objects in the technical systems causing -

- Wear - significantly reducing the service lifetimes of the sensitive components
- Diminished performance, unstable and irregular operation
- Breakdowns and serious damage in worst case scenarios. The consequences are often major production losses.

Even new factory units / components and new oil are contaminated. It is analysed that, in the oil in new factory units and components, a variety of damaging particles are found even though the manufacturer may have cleaned the system immediately prior to delivery. The reason for this is that it is extremely difficult to remove all contaminants with the established methods. In the same way the new oil is not always “completely pure” either.

Need for Digital Lube Oil Monitoring:

In industries having rotating & fluid carrying equipment, production downtime can equate to hundreds of thousands of lost dollars per day. Ensuring that production machinery and other critical equipment downtimes are minimized not only reduces operating and maintenance costs but also increases production revenue.

The three main approaches to plant equipment operating and maintenance are listed below. (Not mentioned the present trends). Additionally, the Electrical Power Research Institute has calculated comparative maintenance costs (in cost per horsepower) for each maintenance philosophy, also shown below.

- Reactive Maintenance - $17.00 USD per HP - Also called run to failure maintenance, an asset is run until it no longer works and is then replaced. This has the additional disadvantage of damage that could be caused to related assets (such as a gearbox failure causing a shaft to break).

- Scheduled Maintenance - $24.00 USD per HP - Perform maintenance at manufacturer recommended intervals. This philosophy is the most expensive to follow because components could be overhauled that have no need for it. Additionally, assets can still fail between maintenance cycles. Here the problem is that equipment may fail before the scheduled maintenance date or the equipment may be doing well and we are taking it for maintenance unnecessarily. As the number of rotating equipment runs into 100s and thousands in the oil industry, this is going to take a big issue of costs and down times.

- Predictive Maintenance - $9.00 USD per HP - Assets are monitored at regular intervals for any sign of degradation.

- Monitoring pumps’ condition at 30 minutes interval may fail to provide crucial information, which may subsequently lead to failures.
This digital oil monitoring can be used to produce a trend analysis of oil parameters (Temp, Moisture & Wear particles) of the asset, and maintenance can be most efficiently scheduled for known downtimes before a failure occurs.

Predictive maintenance clearly presents significant cost savings over the other two techniques, but also uptime but only for large, critical machinery. It certainly wouldn’t make sense to run a preventive maintenance program for light bulbs in your home - the cost of the program would outweigh the maintenance savings. However, in the oil and gas industry, where assets are typically in the millions of dollars each, a preventive maintenance strategy can amount to huge cost savings.

Taking a look at the unique maintenance challenges that are presented by the oil and gas industry, the case for predictive maintenance is made even stronger. Remote and dangerous locations - Oil and gas upstream assets are often spread about in difficult to reach or dangerous locations, making paying for a technician to travel to them often unfeasible or even impossible.

High plant shutdown costs - If a critical asset at a refinery fails unexpectedly, the restart time can be up to several weeks, causing millions of dollars in lost production revenue.

These factors mean that an unexpected failure translates into huge cost overruns in either lost production or the cost of technicians and transportation of replacement parts. With predictive monitoring, you can minimize both of these costs by reducing unnecessary repairs and scheduling efficient maintenance at the most opportune (least costly) times.

The predictive maintenance strategy encompasses two main monitoring styles: route-based and distributed online monitoring. A route-based system features a technician who regularly visits assets and records their conditions. With this system, you can conduct non-routine tests and gather anecdotal information that may not otherwise be available. A distributed online system, however, uses a remote data acquisition device to collect physical signals and transmit them back to a site data server for online monitoring and analysis at a central location.

In the oil and gas industry sector, a distributed digital oil online monitoring system often makes the most sense because assets are in remote and dangerous locations. With a distributed digital oil online monitoring strategy, a central office can monitor all assets across the world and deploy timely maintenance teams when necessary.

<table>
<thead>
<tr>
<th>Equipment Name</th>
<th>Critical Components</th>
</tr>
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<tbody>
<tr>
<td>Turbine</td>
<td>Bearing</td>
</tr>
<tr>
<td>Turbine Varnish</td>
<td>-</td>
</tr>
<tr>
<td>Gear box</td>
<td>Gears, bearings, bushes</td>
</tr>
<tr>
<td>Hydraulic power packs</td>
<td>Valves – servo</td>
</tr>
<tr>
<td>Cooler</td>
<td>-</td>
</tr>
<tr>
<td>Umbilical</td>
<td>-</td>
</tr>
</tbody>
</table>
Current process of Conventional Method of Oil Monitoring and Limitations

Process: Onsite sampling and sending the reports in 2 weeks’ time. Interpretation is not the prerogative job of the oil analysis companies. Periodic sampling is done only on some key equipment’s as mentioned above and this interval is again subject to if they come across any unusual behaviours of the equipment components by which time the damage is done. Digital monitoring will assist in preventing these kinds of failures.

Tech Mahindra Digital Lube Oil Monitoring Solution

Tech Mahindra’s Digital Enterprise introduces a solution that can monitor lubrication oil critical parameters online; using world class reliable sensors and is integrated with a Real Time Operating Centre for monitoring the parameters 24x7.

Approach: Our approach is based on

A) The assumption that failure-inducing stresses in equipment are reflected in one or more measurable parameters like temperature, vibration, speed, noise, pressure etc. which in turn happens because of lubrication problems.

B) The assumption that equipment belonging to the same class from the same manufacturer will have identical behavioural traits with regard to failure-inducing stresses

C) The following data about the equipment are available

- Equipment’s master data showing equipment technical parameters, deployment date and estimated abandonment date and deployment location.
- Equipment planned and breakdown maintenance data
- Equipment failure data
- Time series data reflecting equipment health in the form of temperature, speed and displacement (each of these parameters has a defined operating range) etc., which in turn correlated with efficiencies of different lubricants in use and comparison cross plots between the infer lubricant quality obtained from the study of various real time measurements and lab tested lubricant quality parameters.

Whenever one or more of the time series data for an equipment at an instance breaches the manufacturer-specified operating range or shows a dubious trend, the solution can co-relate the data with the other data (failure, time series data around the failure points, maintenance, residual life, deployment location) and with the quality of lube oils to assess the possibility of a failure in near future and the likely time frame for a failure.

How does Digital Lube Oil Monitoring works?

Tech Mahindra in collaboration with the customer will understand the feasibility of installation of censors as per OEM recommendation. Post implementation of censors at the equipment, the required parameter of the lubricant oil will be captured online from the censors. This data that is captured will be integral part of RTOC data for the purpose of analytics and prediction of any failures of components in mere future.
**Digital Lube Oil Monitoring and Benefits**

The smaller the tolerances, the higher will be the oil pumping pressures; subsequently, the greater the demand for purity of the oil and also its behaviour.

**Smaller Dimensions**

The energy sector is constantly improving technical installations to ensure greater performance and efficiency through the use of lighter installations with smaller physical dimensions. One of the consequences of this is that the tolerances in the moving parts of these installations are getting smaller and smaller.

**Increasing demands for purity**

The smaller dimension means that the demands for purity are increasing. Smaller and smaller metal fragments and other contaminants can have direct consequences for the unit. The particle count should be maintained < 2 microns that means particles 20 times smaller than can be seen with the naked eye.

<table>
<thead>
<tr>
<th>Critical Equipment</th>
<th>Oil Parameters</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Turbine</strong></td>
<td>Temperature</td>
<td>50</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>Moisture</td>
<td>0.02</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>Particle count</td>
<td>NAS 6</td>
<td>NAS 8</td>
</tr>
<tr>
<td><strong>Compressor</strong></td>
<td>Temperature</td>
<td>50</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>Moisture</td>
<td>0.02</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>Particle count</td>
<td>NAS 6</td>
<td>NAS 8</td>
</tr>
<tr>
<td><strong>Well head hydraulics</strong></td>
<td>Temperature</td>
<td>50</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>Moisture</td>
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Viscosity - < 46 + 15%

**Tangible & Intangible Cost benefits - Digital Oil Monitoring**

- Cost of scientific method of periodic oil sampling test.
- Analytic Data helps in prediction of equipment failure thereby saving major cost from break down of equipment and production loss.
Experience:
22 years of total experience in IT and Non-IT, out of which 4 years of industry experience in selling lubricants to cement, power, mining, manufacturing, granite, plastic, chemical working with major US Oil & Gas Company. This experience has helped the author in understanding the major challenges faced by companies during their operations and how lubricant plays a vital role in the operation & maintenance of any plant. The solution Digital Lube Oil Monitoring is evolved from both IT & Non-IT experiences on IOT platform to digitally monitor the health of the lubricant which in turn will predict the health of the equipment.

Experience:
A mechanical Engineer with 24 years of relevant exposure to different lubricating practices in the industry, lubricating oils, Lubrication process for various equipments and literate in the language of oil analysis thereby extracting critical reliability information from in-service lubricant analysis. Experienced in identifying a trend of the progressive lube oil condition monitoring and recommending a possible solution. Contamination control is one of my major fields of study and practice in working towards providing a proactive solution to increase the reliability of the oil lubricated equipments. Provide Training in the areas of importance of Lubrication & Mechanism, lube oils, greases, handling and storage of the lubricants, sampling and contamination control, maintaining and designing a lube room. Design a Total Lubricating management system for the relevant industry.

Certified MLA II (Machinery lubrication Analyst level II) from ICML (International Council for Machinery Lubrication). The International Council for Machinery Lubrication (ICML) is a vendor-neutral, not-for-profit organization founded to facilitate growth and development of machine lubrication as a technical field of endeavour. ICML certification exams are in accordance with ISO 18436.