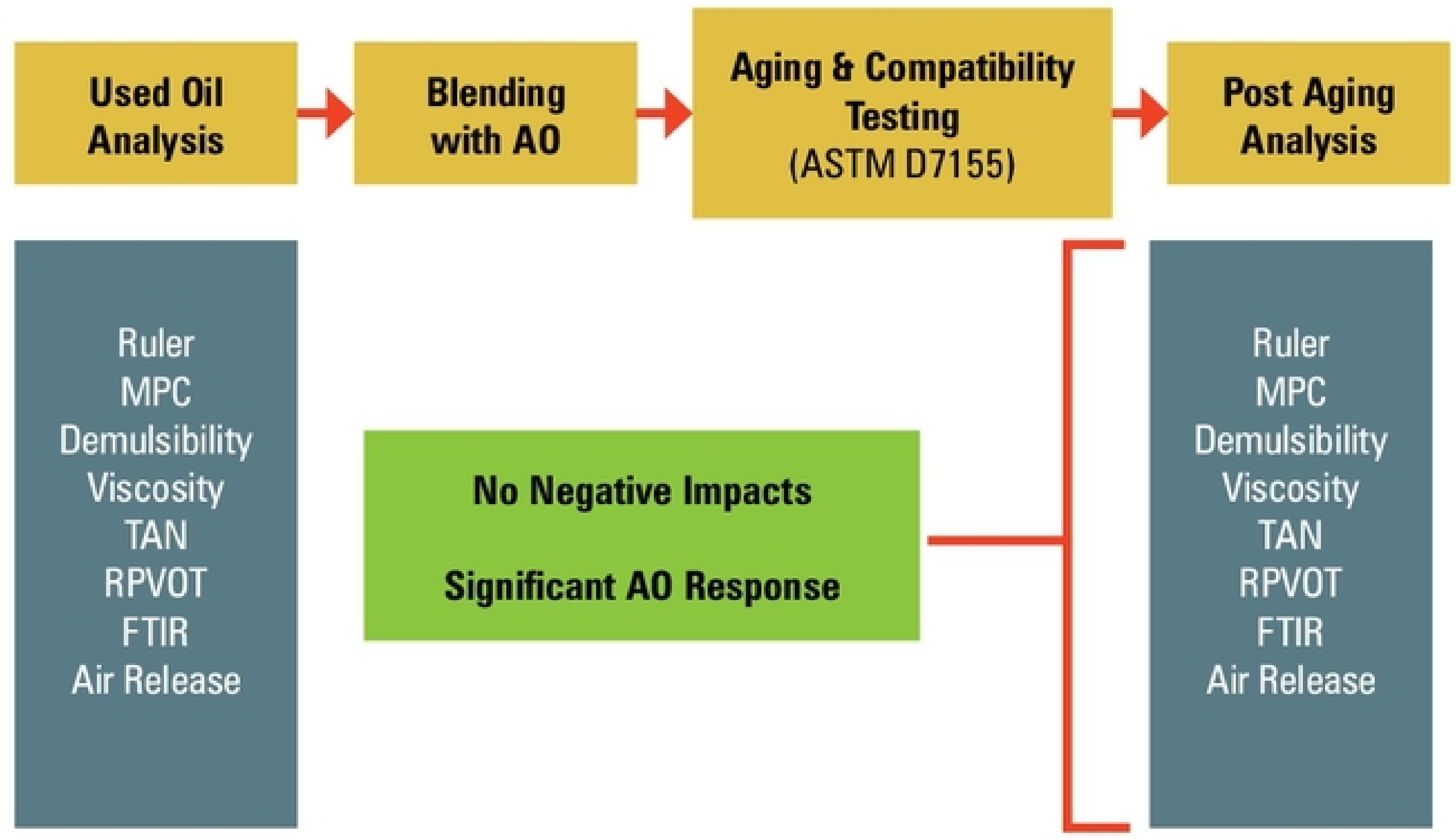
HOW TO DOUBLE TURBINE OIL LIFE

BY GREG LIVINGSTONE AND JO AMEYE

Sacrificial antioxidants play a critical role in determining the life and performance of turbine oils. The vast majority of the time when these oils are changed, the base stock is still healthy but the fluid is condemned because of low oxidative stability. Simply replacing the antioxidants in an in-service turbine oil instead of dumping and recharging the system with new fluid can provide significant cost savings, risk reduction and performance benefits. However the process is far from simple.

Qualifying Oils for AO Addition

An oil is considered to be qualified if no adverse effect is detected in up-front laboratory testing once antioxidants have been reintroduced to the in-service oil and if a significant antioxidant response is measured. Antioxidant compatibility is determined by ASTM D7155.



Source: Fluitec International

Turbine Oils Are Assets

Most organizations consider lubricants to be expenses, a thought carried over from our personal lives because vehicle oil changes are considered to be one expense of owning a car. However, oil used in rotating equipment that delivers long-term benefits to organizations can rightly be considered an asset.

Considering an oil to be an asset instead of an expense is a subtle but important perspective change in lubricant management. Asset managers go to great lengths to maximize the life of their investments, as should those who are managing oil programs.

Anything that can be done to safely extend the life and maximize the performance of lubricating assets provides significant value to an organization. Maintaining oils in a contaminant-free condition, with optimum levels of additives, is a strategy that many companies use to extend the life of their lubricant assets.

Most commercially available turbine oils consist of 98 to 99 percent base stock and approximately 1 to 2 percent additive. This sliver of additive content plays a critical role in fluid performance, especially the antioxidants.

In the vast majority of cases, a turbine oil at the end of its life has depleted its antioxidants, but the base oil molecules are still healthy. Careful replacement of the antioxidants in in-service turbine oils can extend their useful life.

Oil Degradation

Oil degradation begins at the molecular level. However, chemical changes to oil molecules don't usually result in performance problems until the chemical alterations cause physical problems that impact the mechanical performance of the equipment.

In rotating equipment, the first physical symptom created by oil degradation is deposit formation. These high molecular weight deposits can cause a host of reliability challenges, such as sticking valves, elevated bearing temperatures, reduced oil flow and lower heat exchange rates.

In well-formulated turbine oils, the first impact of oxidation is the depletion of antioxidants. The suggested condemning limit for rust and oxidation inhibited (R&O) oils is when the antioxidant concentration drops to 25 percent of its original value.

But consider the following questions: What if an oil is not only kept clean and dry, but the depleted antioxidants are replenished on a timely basis? What if the oil degradation products and depleted additives are removed before they can accumulate and cause problems?

Theoretically, it is possible to transform an in-service oil into a "fill-for-life" fluid that can last for the life of the equipment. Done correctly, additive replenishment removes a significant amount of the human factor by eliminating oil changes and flushes.

Additive replenishment represents an opportunity to lower the risks associated with managing oils. As any operator will tell you, however, oil is cheap compared to the cost of equipment. Therefore, it is critical that additive replenishment be done in a safe manner that eliminates the potential for any adverse impact to lube performance.

Low-Risk Additive Replenishment

Re-inhibiting depleted additive components into lubricants is often discouraged by oil manufacturers – for good reasons. There are multiple consequences to incorrectly adding additives into in-service oils.

In many respects, replenishing antioxidants has more variables to consider compared to formulating new lubes; so, it is understandable that oil manufacturers may not be comfortable with this process. In ad-

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dition, additive replenishment may not be consistent with an oil manufacturer's marketing strategy. However, once oil is delivered to a site and placed into service, it becomes the plant's asset, and it is up to the user to determine the optimum way to maintain the fluid.

Oil analysis plays a critical role in determining an oil's potential for antioxidant replenishment. One benefit of this analysis is to evaluate the impact that antioxidant replenishment has on the in-service oil. Also, since no two oils are the same, each reservoir should be qualified independently for antioxidant replenishment. Following this qualification procedure eliminates the risk of introducing antioxidants to in-service oils.

Once an oil is qualified, an antioxidant concentrate called Boost AO can be added. Boost AO concentrates are custom-formulated to replenish the antioxidant package of in-service oils. Multiple Boost AO recipes are available, designed to treat various formulations of turbine and compressor oils.

The antioxidant systems are solubilized in a synthetic base carrier fluid. This allows the concentrate to be pumped directly into the reservoir of an operating turbine or compressor without special blending equipment.

The side benefit of the synthetic carrier fluid is that it imparts excellent solubility characteristics to the in-service oil, improving its deposit control. In addition, adding Boost AO often significantly improves demulsibility and foam control.

Determining Candidate Oils

Qualification tests are important to determine an oil's candidacy for antioxidant replenishment; however, they don't measure the long-term performance of the freshly introduced antioxidants. Accelerated aging tests can be used to validate the depletion rate of the newly introduced antioxidants. The rate of antioxidant depletion in treated oils versus unused oils also can be compared.

An accelerated aging test called the Turbine Oil Performance Prediction (TOPP) test has been developed to study the behavior of turbine oils in an accelerated oxidative environment. The test was designed so that samples could be analyzed throughout the test to determine the fluid time-dependent conditions.

The test conditions are beyond the scope of this article. However, samples are taken weekly and analyzed for viscosity increase and performance in the Rotating Pressure Vessel Oxidation Test, Membrane Patch Colorimetry varnish potential test and Ruler tests. All visual observations are also reported. Depending upon the application, additional tests such as demulsibility, air release, foam and elemental analysis are added to the test slate. Fluitec has used this testing protocol to estimate the performance of dozens of turbine oil formulations and has found good correlation with field performance.

For example, a TOPP aging test evaluation of an in-service turbine oil showed that the rate of antioxidant depletion of the oil treated with Boost AO was similar to that of the unused oil in the same test. At the end of the test, the unused oil experienced a 69 percent reduction in amine antioxidants compared to a 53 percent reduction in the in-service oil treated with Boost AO.

Improved deposit control was also observed. At the end of the test, new oil had an MPC varnish potential of 62 compared to 55 for the in-service oil with Boost AO. It is interesting to note as well that the in-service oil with Boost AO had outstanding RPVOT retention compared to the new oil.

Field tests of turbine oils in large frame gas turbines have confirmed the laboratory results. One oil in particular had 100,000 operating hours on it, quite remarkable considering the thermal and mechanical stress experienced in a gas turbine. The power plant

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management objectives are to exceed 200,000 operating hours on its initial charge of turbine oil. With multiple antioxidant treatments, it is possible to expect the oil to last even longer.

Doubling the service life of turbine oils through antioxidant replenishment can avoid the cost of multiple oil changes. For a 6,000-gallon system, this equates to savings in excess of U.S. $100,000 per oil change for oil replacement and flushing.

The extraction, manufacture, transportation, handling and disposal of new turbine oil carries an environmental burden as well. Each of these steps requires an energy input that produces associated carbon dioxide emissions. Prolonging oil life greatly reduces the carbon footprint of an installation.

Fill-for-Life Oils?

Turbines and compressors are potential applications for converting lubricants into fill-for-life fluids because their primary mode of degradation is oxidation. Fill-for-life is possible in these applications if the antioxidants can be carefully replenished and the degradation products removed.

There are multiple other applications, such as engine oils, where the base oil undergoes significant damage during its life. Filtration or adding new chemistries to these oils will not correct base oil damage. Fill-for-life is not feasible in these cases.

Many other additive chemistries are used in fully formulated turbine and compressor oils, such as rust inhibitors, foam suppressants and extreme pressure additives. These additives are trickier to add to in-service oils because of the potential for overtreatment. Much more in-depth analysis is needed before considering the addition of these additive components.

In summary, in-situ antioxidant replenishment represents an opportunity to significantly extend the life of turbine and compressor oils. The most important aspect of considering antioxidant replenishment is up-front laboratory testing. This allows each reservoir to be properly qualified for the addition of antioxidants and identifies any potential adverse reactions, helping to remove risk from the process.

Antioxidant replenishment is not the solution for all lubricant applications. Turbines and compressors, however, are applications where antioxidant replenishment should be considered, provided appropriate qualification has been done. Replenishing antioxidants takes a fraction of the financial resources required when replacing the turbine oil and flushing a system. If done properly, the risk of replacing depleted antioxidants is lower than performing an oil change and flush. Extending the life of a nonrenewable resource also supports a company's environmental sustainability objectives.

Reducing the cost and operational risk in an environmentally sustainable way is in line with all companies' corporate objectives. With these benefits, it is easy to see how antioxidant replenishment will be the primary turbine oil maintenance strategy in the future. Ultimately, many of the oils currently in use in turbines and compressors have the potential to be converted to fill-for-life lubricants, saving the industry millions of dollars. □

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