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How to Select and Service a Turbine Oil

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Background

Over 100 tons of steel, rotating at 3600 rpm, are supported by plain bearings on a cushion of oil that is thinner than a human hair. In power plants around the world, the same fluid dynamics take place day-in and day-out without much notice. Lost revenue at seasonal peaks can be counted in millions of dollars. Consider the following example: At an average utility, the combined factors of revenue rate of $50/megawatt(MW)-hr and peaks above $1,000/MW hr demonstrate how turbine oil selection could amount to $600,000 per day in lost revenue, based on a 500 MW facility.

This article describes the key elements to consider when selecting a turbine oil for steam, gas, hydro, and aero-derivative turbines. Oil supplier services and commitment to the customer should also be evaluated as part of the selection process.

Have the Right Tool for the Job

It is important to have an understanding of the physical and chemical characteristics of turbine oils compared to other lubricating oils before embarking upon the selection process.

Steam, gas, and hydro turbines operate on a family of lubricating oils known as R&O oils (Rust & Oxidation inhibited oil). Turbine equipment geometry, operating cycles, maintenance practices, operating temperatures, and potential for system contamination present unique lubricating oil demands versus other lubricating oils like gasoline and diesel engine applications.

Utility steam and gas turbine sump capacities can range in size from 1,000 to 20,000 gallons, which drives the economic incentive for a long-life lubricating oil. Low turbine oil makeup rates (approximately five percent per year) also contribute to the need for high-quality, long-life lubricants. Without significant oil contamination issues, turbine oil life is primarily dictated by oxidation stability. Oxidation stability is adversely affected by heat, water aeration, and particulate contamination. Antioxidants, rust inhibitors, and demulsibility additives are blended with premium quality base stock oil to extend oil life. Lube oil coolers, water removal systems, and filters are installed in turbine lubrication systems for the same purpose.

Unlike most gasoline and diesel engine oil applications, turbine oil is formulated to shed water and allow solid particles to settle where they can be removed through sump drains or kidney loop filtration systems during operation. To aid in contaminant separation, most turbine oils are not additized with high levels of detergents or dispersants that clean and carry away contaminants. Turbine oils are not exposed to fuel or soot and, therefore, do not need to be drained and replaced on a frequent basis.

Recommended Performance Characteristics of Turbine Oil Vary by Application for Steam, Gas, Hydro, and Aero-Derivative Turbines

Steam Turbines

A well-maintained steam turbine oil with moderate makeup rates should last 20 to 30 years. When a steam turbine oil fails early through oxidation, it is often due to water contamination. Water reduces oxidation stability and supports rust formation, which among other negative effects, acts as an oxidation catalyst.

Varying amounts of water will constantly be introduced to the steam turbine lubrication systems through gland seal leakage. Because the turbine shaft passes through the turbine casing, low pressure steam seals are needed to minimize steam leakage or air ingress leakage to the vacuum condenser.

Condensed steam is generally channeled away from the lubrication system, but inevitably some water will penetrate the casing and enter the lube oil system. Gland seal condition, gland sealing steam pressure, and the condition of the gland seal exhauster will impact the amount of water introduced to the lubrication system. Typically, vapor extraction systems and high-velocity downward flowing oil create a vacuum, which can draw steam past shaft seals into the bearing and oil system. Water can also be introduced through lube oil cooler failures, improper powerhouse cleaning practices, water contamination of makeup oil, and condensed ambient moisture.

In many cases, the impact of poor oil-water separation can be offset with the right combination and quality of additives including antioxidants, rust inhibitors, and demulsibility improvers.

Excess water may also be removed on a continuous basis through the use of water traps, centrifuges, coalescers, tank headspace dehydrators, and/or vacuum dehydrators. If turbine oil demulsibility has failed, exposure to water-related lube oil oxidation is then tied to the performance of water separation systems.

Heat will also cause reduced turbine oil life through increased oxidation. In utility steam turbine applications, it is common to experience bearing temperatures of 120˚F to 160˚F (49˚C to 71˚C) and lube oil sump temperatures of 120˚F (49˚C). The impact of heat is generally understood to double the oxidation rate for every 18 degrees above 140˚F (10 degrees above 60˚C).

A conventional mineral oil will start to rapidly oxidize at temperatures above 180˚F (82˚C). Most tin babbited journal bearings will begin to fail at

250˚F (121˚C), which is well above the temperature limit of conventional turbine oils. High-quality antioxidants can delay thermal oxidation, but excess heat and water must be minimized to gain long turbine oil life.

Gas Turbines

For most large gas turbine frame units, high operating temperature is the leading cause of premature turbine oil failure. The drive for higher turbine efficiencies and firing temperatures in gas turbines have been the main incentive for the trend toward more thermally robust turbine oils. Today's large frame units operate with bearing temperatures in the range of 160˚F to 250˚F (71˚C to 121˚C). Next-generation frame units are reported to operate in even higher temperature ranges. Gas turbine OEMs have increased their suggested limits on RPVOT — ASTM D2272 (Rotation Pressure Vessel Oxidation Test) and TOST — ASTM D943 (Turbine Oil Oxidation Stability) performance to meet these higher operating temperatures.

As new-generation gas turbines are introduced into the utility market, changes in operating cycles are also introducing new lubrication hurdles. Lubrication issues specific to gas turbines that operate in cyclic service started to appear in the mid-1990s. Higher bearing temperatures and cyclic operation lead to fouling of system hydraulics that delayed equipment start-up. Properly formulated hydrocracked turbine oils were developed to remedy this problem and to extend gas turbine oil drain intervals. Of note, Exxon Teresstic GTC 32 and Mobil DTE 832 products have demonstrated excellent performance for almost five years of service life in cyclically operated gas turbines where conventional mineral oils often failed in one to two years.

Hydro Turbines

Hydro turbines typically operated on ISO 46 or 68 R&O oils. Demulsibility and hydrolytic stability are the key performance parameters that impact turbine oil life due to the constant presence of water. Ambient temperature swings in hydroelectric service also make viscosity stability, as measured by viscosity index, an important performance criterion.

Aero-Derivative Gas Turbines

Aero-derivative gas turbines present unique turbine oil requirements that call for much higher oxidatively stable lubricating oils. Of primary concern is the fact that the lube oil in aero-derivative turbines is in direct contact with metal in temperatures of 400˚F to 600˚F (204˚C to 316˚C). Sump lube oil temperatures can range from 160˚F to 250˚F (71˚C to 121˚C). These compact gas turbines utilize the oil to lubricate and to transfer heat back to the lube oil sump. In addition, their cyclical operation imparts significant thermal and oxidational stress on the lubricating oil. These most challenging conditions dictate the use of high purity synthetic lubricating oils. Average lube oil makeup rates of .15 gallons per hour will help rejuvenate the turbo oil under these difficult conditions.

Current technology turbine oils for Aero-derivative, land-based power generation turbines are described as 5 cSt turbo oils. Aero-derivative turbines operate with much smaller lube oil sumps, typically 50 gallons or less. The turbine rotor is run at higher speeds, 8,000 to 20,000 rpm, and is supported by roller element bearings.

The generator bearing sets in these units will use an ISO 32 R&O or hydraulic oil. The lower pour points of a hydraulic vs. an R&O oil may dictate the use of a hydraulic oil in cold environments.

Synthetic turbo oils are formulated to meet the demands of military aircraft gas turbo engines identified in Military Specification (MIL) format. These MIL specifications are written to ensure that similar quality and fully compatible oils are available throughout the world and are referenced in OEM lubrication specifications.

Type II turbo oils were commercialized in the early 1960s to meet demands from the U.S. Navy for improved performance, which created MIL-L (PRF) — 23699. The majority of aero-derivatives in power generation today deploy these Type II, MIL-L (PRF) — 23699, polyol ester base stock, synthetic turbo oils. These Type II oils offer significant performance advantages over the earlier Type I diester-based synthetic turbo oils.

Enhanced Type II turbo oils were commercialized in the early 1980s to meet the demands from the U.S. Navy for better high-temperature stability. This led to the creation of the new specification MIL-L (PRF) — 23699 HTS. Since the 1980's, Mobil Jet Oil 291 was commercialized in 1993 as the first 4th generation turbo oil to satisfy present and advanced high temperature and high load conditions of jet oils.

Writing a Turbine Oil Procurement Standard

Steam, gas, and hydro turbine oils are a blend of highly refined or hydroprocessed petroleum base oils, usually ISO VG 32 and 46 or 68. Lubricant suppliers have developed turbine oils to meet the varying demands of turbines in propulsion and power generation applications. These formulations were developed to meet turbine OEM specifications.

Many turbine OEMs have moved away from specific turbine oil brand name approvals due to enhanced technologies in their turbines and corresponding improvements in turbine oils.

OEMs have identified suggested or recommended lube oil performance test criteria and typically stipulate that an oil known to perform successfully in the field may still be used even if all recommended values have not been satisfied. Industry standard lube oil bench tests can provide great insight into the performance and life expectancy of turbine oils. However, turbine OEMs and oil suppliers generally agree that past successful performance of a particular oil under similar conditions is the best overall representation of quality and performance.

Regardless of the type or service of a turbine oil, the quality of the base stocks and additive chemistry will be a major factor in its longevity. High-quality base stocks are characterized by higher percentage saturates, lower percentage aromatics, and lower sulfur and nitrogen levels. The performance of additives must be extensively tested. They must also be blended into the oil in a tightly controlled process.

The key to a superior turbine oil is property retention. Some turbine oil formulations have been found to present good lab test data, but can experience premature oxidation because of additive dropout and base stock oxidation. Again, lube oil laboratory analysis can support your efforts to determine turbine oil longevity, but direct field experience should take precedence. Note, turbine oil suppliers will offer “typical” lube oil analysis data to help assess predicted performance. Typical data is used because lubricating oils vary slightly from batch to batch because of minor base stock variations.

Utility steam and gas turbine oils can be either conventional mineral-based (Group 1) or hydroprocessed (Group 2). High-quality conventional mineral-based oils have performed well in both steam and gas turbine service for more than 30 years. The trend toward higher efficiency, cyclically operated gas turbines has spurred the development of hydroprocessed, Group 2, turbine oils.

Most hydroprocessed turbine oils will have better initial RPVOT and TOST performance than conventional turbine oils. This oxidation stability performance advantage is suited for heavy duty gas turbine applications. The oxidation performance advantages of a hydroprocessed turbine oil may not be necessary in many less demanding steam and gas turbine applications. Conventional mineral-based oils are known to have better solvency than hydroprocessed oils, which can provide better additive package retention and increased ability to dissolve oxidation products that could otherwise potentially lead to varnish and sludge.

Compatibility testing between turbine oil brands should also be addressed when writing a turbine oil specification for systems not available for a complete drain and flush. Clashing additive chemistries or poor in-service oil quality may prohibit the mixing of different and incompatible turbine oils. Your oil supplier should provide compatibility testing to confirm suitability for continued service. This testing should address the condition of the in-service oil compared to various possible blends with the proposed new oil. The in-service oil should be tested for suitability for continued service in testing described later in this article. Then a 50/50 blend should be tested for oxidation stability (RPVOT ASTM D2272), demulsibility (ASTM D1401), foam (ASTM D892, Sequence 2), and the absence of additive package dropout as witnessed in a seven-day storage compatibility test.

Turbine Lube Oil System Flushing

Turbine lube oil system flushing and initial filtration should be addressed in conjunction with the selection of the turbine oil. Lubrication system flushing may either be a displacement flush after a drain and fill, or a high velocity flush for initial turbine oil fills. A displacement flush is performed at the time of a turbine oil replacement and a high velocity flush is designed to remove contaminants entering from transport and commissioning a new turbine.

Displacement flushes, using a separate flush oil, are done to remove residual oil oxidation product that is not removed by draining or vacuum. A displacement flush is conducted by utilizing lubrication system circulation pumps without any modification to normal oil circulation flow paths, except for potential kidney loop filtration. This flush is typically done based on a time interval to facilitate the removal of soluble and insoluble contaminants that would not typically be removed by system filters.

Most turbine OEMs offer high velocity flushing and filtering guidelines. Some contractors and oil suppliers also offer flushing and filtering guidelines. Often during turbine commissioning, these guidelines are scaled back to reduce cost and time. There are common elements of a high-velocity flush that are generally supported by interested parties. There are also some elements of a procedural nature that may differ and should be addressed on a risk vs. reward basis.

Common elements of mutual agreement in high-velocity flushing are as follows:

- Supply and storage tanks should be clean, dry, and odor-free. Diesel flushing is not acceptable.
- Two to three times normal fluid velocity should be achieved with external high-volume pumps or by sequential segmentation flushing through bearing jumpers.
- Removal of oil after flush should be completed to inspect and manually clean (lint-free rags) turbine lube oil system internal surfaces.

- High-efficiency by-pass system hydraulics should eliminate the risk of fine equipment damage.

Possible supplemental or alternative elements of a high-velocity flush are as follows:

- Use of a separate flush oil to remove oil soluble contaminants that can impact foam, demulsibility, and oxidation stability.
- Need to filter the initial oil charge at a level consistent with the filtration specification.
- Thermal cycling of oil during the flush.
- Pipe line vibrators and the use of rubber mallets at pipe elbows.
- Installing special cleanliness test strainers and sampling ports.
- Desired cleanliness criteria for flush buy-off:
  - Lab ISO 17/16/14 to 16/14/11 acceptable particulate range;
  - Use of on-site optical particle counters;
  - 100-mesh strainer, no particles detectable by naked eye;
  - Millipore patch test.

Up-front planning and meetings with construction, start-up, oil supplier, and the end user should be scheduled in advance to build consensus on these flushing procedures.

A good practice for turbine oil performance documentation is to take a 1-gallon sample from the supply tank and then a second gallon sample from the turbine reservoir after 24 hours of operation. The recommended testing is described later in this article.

Lube Oil Analysis for Performance Evaluations of New Turbine Oils and In-Service Monitoring

Consistent and correct sampling procedures are essential and should be performed while the system is in operation. Important considerations include sample location, sampling hardware, bottle cleanliness, and flushing. The following sampling locations are listed in order of preference, but equipment configuration can limit location choices:

1. Bearing header return lines to the sump.
2. Sump dip sample.
3. Lube oil pump discharge upstream of system filters.
4. Sump bottom drain as last resort, but flush well; it could take more than 55 gallons to get a representative sample.

Lube oil analysis is a tool used to predict the performance of new or in-service oils. Lube oil analysis should also be used to determine compatibility with other lubricating oils in top add applications. It should be understood that lube oil analysis offers a snapshot of certain measurable parameters. In-service oil analysis intervals are recommended monthly, quarterly, and yearly on a test-by-test basis. With most lube oil analysis testing, the data trends offer the most insight on equipment and lubricant performance.

Combination test packages described below should be conducted depending on whether the application is for new turbine oil evaluations, in-service condition assessments, or compatibility testing. ASTM D4378-97 “Standard Practice for In-Service Monitoring of Mineral Turbine Oils for Steam and Gas Turbines” is a power generation industry standard for turbine oil analysis and includes the listing of suggested alarms and limits. Many ASTM D4378-97 warning limits and test frequencies are outlined in the following discussion of in-service turbine oil tests.

Viscosity ASTM D445 and Viscosity Index D2270

Viscosity is the most important characteristic of a turbine oil because of the tight clearances in journal and thrust bearings. Turbine blade clearances are critical to power plant efficiency and reliability. Blade clearances are directly impacted by lubricant viscosity. Changes in oil viscosity can result in unwanted rotor positioning, both axially and radially. Axial movements will directly impact turbine blade efficiency and can lead to blade damage. Radial movements caused by changes in viscosity can result in “oil whip,” where the rotor does not settle into one radial position. Oil whip is often identified in vibration testing.

Unless the oil has been contaminated or severely oxidized, viscosity should remain consistent over years of service. ASTM D4378-97 proposes a five percent change from the initial viscosity as a warning limit. Testing for viscosity should be conducted on a quarterly basis, at a minimum.

The Viscosity Index (VI) is an indication of an oil’s resistance to viscosity change with change in temperature. Most gas and steam turbine OEMs require a turbine oil VI of at least 90, which is met by most turbine oil suppliers. VI for turbine oils should not vary in-service and, therefore, need not be tested for condition assessments.

Rotation Pressure Vessel Oxidation Test (RPVOT) — ASTM D2272

RPVOT was developed for the monitoring of in-service oils to warn of a loss in oxidation stability. Oxidation is driven by heat and exposure to contaminants like water. As a turbine oil degrades, it forms weak organic acids and insoluble oxidation products that adhere to governor parts, bearing surfaces, and lube oil coolers. A severely oxidized turbine oil may form varnishes on hot bearing surfaces that retard heat transfer and can overheat heat journal bearings. In addition, severely oxidized oils can foul turbine control elements and heat exchangers.

This accelerated oxidation test is an industry standard for identifying oxidation stability problems with in-service turbine oils. ASTM D4378-97 "Standard Practice for In-Service Monitoring of Mineral Turbine Oils for Steam and Gas Turbines" identifies an RPVOT decline to 25 percent of the initial new oil RPVOT value with an increase in Acid Number (AN) as a warning limit. Many turbine OEMs simplify this by using the 25 percent of initial RPVOT without reference to AN. Some OEMs also list a 100 minute minimum RPVOT. Waiting for an increase in AN could present the risk of turbine bearing seizure if the turbine oil cannot be replaced in a timely manner.

The so-called "bleed and feed" method of turbine oil rejuvenation is suitable to extend the life of the turbine oil for a limited time. It should be recognized that a severely oxidized lubricant would reduce the PRVOT beyond that of the new to in-service oil mix ratio. The severely oxidized oil will act like a catalyst to rapidly consume the antioxidant package in the new turbine oil.

Efforts to readditize a severely oxidized turbine oil with oxidation inhibitor can put equipment at risk. An oil that has a RPVOT value below 100 minutes has more than likely diminished its inherent base stock oxidation stability, making readditizing a nonpractical solution. In such cases, readditization will temporarily boost RPVOT, but the diminished nature of the base stock may sharply reduce the time frame before heavy varnishes and sludges are formed.

In steam and gas turbines, RPVOT testing should be conducted on an annual basis. Some utilities time the test just before scheduled outages. An increased frequency is recommended as the turbine oil approaches 25 percent of its initial value.

Turbine Oil Stability Test (TOST) ASTM D943

TOST indicates expected turbine oil life by subjecting the test oil to oxidation catalysts that increase sludge and acid formation. This test was developed to evaluate anticipated new turbine oil anticipated performance. Because it is impossible to simulate actual in-service conditions in a lab, correlation between test results and actual field performance is difficult. Most turbine OEMs utilize TOST in their specifications to screen out high-risk turbine oils. This is an accelerated oxidation test so actual operating service should be much longer than test report hours.

Current gas turbine OEM specifications for TOST range from 2,000 to 4,000 hours with new gas turbine technology specifications at 7,000 hours. All TOST reporting above 10,000 is done through non-ASTM test modifications that may not correctly represent a turbine oil's performance. Reporting of TOST values greater than 10,000 hours is not possible within ASTM D943 procedures due to the limited initial 300 ml test oil sample volume that is depleted during AN testing.

TOST testing can take longer than a year, so it is impractical as an in-service oil test.

Water by Karl Fischer Titration — ASTM D1744

Testing for water is important to minimize the risk of the possible undetected turbine oil oxidation and rust formation. Excessive water will also alter an oil's viscosity (up or down depending on conditions). Studies also warn that water levels above 250 ppm in hydrogen-cooled generator windings may lead to stress corrosion cracking of generator rotor retainer rings. Water in turbine oil in warm storage tanks can promote the spread of microbial growth that will foul system filters and small-diameter gauge and transducer line extensions.

ASTM D4378-97 identifies 1000 ppm or 0.1 percent of water as a warning level, while some gas and steam turbine OEMs have identified 500 ppm. In hydrogen-cooled generators, an upper limit of 250 ppm should be maintained.

Testing for water should be conducted on a quarterly basis, at a minimum.

Acid Number (AN) — ASTM D664

Sharp increases in AN may indicate contamination or a severely oxidized oil. Organic acids formed by oxidation can corrode bearing surfaces and should be addressed in a timely manner.

ASTM-4378-97 offers guidelines of 0.3 to 0.4 mg KOH/g above the initial value as an upper warning level. Many oil analysts view an upward movement in AN as small as 0.1 as worthy of concern.

Testing for AN should be conducted at least on a quarterly basis.

ISO Cleanliness Code 4406

Turbine journal bearing clearances and hydraulic servovalve clearance dictate the need for clean oil. Excessive bearing wear and servovalve sticking can result if tight cleanliness standards are not maintained.

An OEM average turbine oil cleanliness level is ISO 18/16/13 or an NAS 1638 cleanliness level of 7 is desirable. The three-range number ISO cleanliness code correlates to concentrations of particles larger than 4, 6, and 14 microns. Turbine OEMs offer specific guidelines on recommended cleanliness levels.

Testing for ISO cleanliness should be conducted on a quarterly basis at the very least.

Rust ASTM D665 A

Rust particles act as oxidation catalysts and can cause abrasive wear in journal bearings. Rust inhibitors are normally kept at proper levels through makeup and can plate-out on metal surfaces for added rust protection. Rust inhibitors can impact water separation so field readditization is generally not recommended.

In-service oil testing should be conducted with distilled water as identified in D665 A, not synthetic sea water D665 B. The synthetic sea water test is appropriate for new oil condition assessments and for service in marine environments. ASTM D4378-97 considers a “light fail” as a warning limit.

Testing for rust should be conducted on an annual basis if the lube oil system is exposed to water.

Demulsibility ASTM D1401

Water shedding characteristics are important to lube oil systems that have had direct contact with water. The ability to separate water by natural density difference and remove it through bottom drains will improve a turbine oil’s oxidation stability. Demulsibility can be compromised by excessive water contamination and minor engine crankcase oil contamination. Crankcase engine oil concentrations as low as 300 ppm or 0.03 percent have been proven to degrade demulsibility. This means that heavy-duty engine oil additives containing Calcium, Zinc, and Magnesium may appear at single-digit ppm levels when mixed with a turbine oil and cause problems with demulsibility. Again, turbine oil transport tankers should be clean, dry, and odor-free before accepting the turbine oil load.

ASTM does not offer warning limits for demulsibility. Some turbine OEMs identify levels of 3 ml emulsion after 30 minutes on new oils. In-service oil warning limits of 15 ml or greater of emulsion in 30 minutes should serve as a fair warning limit. The impact of demulsibility depends on the system residence time and anticipated levels of water contamination. Lube oil analysis demulsibility can show failure in the lab, but with sufficient residence time, the system oil may shed water at an acceptable rate that does not impact turbine oil performance. Small sumps with lower residence times will require better demulsibility performance than larger sumps.

Testing for demulsibility should be conducted on an annual basis if the lube oil system is exposed to water.

Foam ASTM D892 Sequence 2

A turbine oil sample will often test for foam higher than turbine OEM initial suggested levels, but typically present no field foaming issues because of the low position of the lube oil pump suction. If the foam level in the turbine sump is six inches or less and does not overflow the sump or cause level monitoring errors, the turbine oil foam should not be a concern. Lube oil at the turbine sump surface should show at least one clear area (no bubbles) and larger breaking bubbles should be seen at this interface.

ASTM D4378-97 offers warning limits of tendency 450 ml with a stability of 10 ml. Foam tendency is the foam volume measured in a graduated cylinder after five minutes of pushing air through the lube oil sample. Stability represents the volume amount after 10 minutes of settling time has elapsed. A foam stability of less than 5 ml is a good indication that foam bubbles are breaking and the turbine should not experience foam operational problems.

When addressing foam problems, cleanliness, contamination or mechanical causes should be investigated before field de-foamant readditization can be considered. Excessive readditization can result in an even greater problem with increased air entrainment. Dirt is a leading cause of foam, so ISO cleanliness should be tested for a likely cause.

Testing for foam should be conducted only when foaming presents an operational problem and for product compatibility testing.

Air Release ASTM D3427

Some steam and gas turbine OEMs specify air release limits in their initial oil specifications. These limits can be as low as four minutes, which is not a problem for most ISO 32 turbine oils, but can be an obstacle for ISO 46 turbine oils. In turbines with small sumps and minimal residence time, entrained air mixtures could be sent to bearings and critical hydraulic control elements.

Air release on turbine oils should not vary with in-service time and, therefore, may not need to be tested for condition assessments.

FZG Gear Test — DIN 51354

Turbines with geared shaft connections to the generator often require antiwear or extreme pressure additives to support gear tooth loading. Industry standard testing for gear load performance is the FZG Gear Test, with results reported as Failure Load Stage (FLS). Typical R&O ISO 32 turbine oils carry an FZG failure load stage of 6 or 7. ISO VG 32 R&Os with antiwear or extreme pressure additives can give an FZG failure load stage of 10, which meets all major turbine OEM specifications.

FZG Gear Tests on turbine oils should not vary with in-service time and, therefore, need not be tested for condition assessments.

Flash Point — ASTM 92

Flash point testing is done primarily to confirm product integrity from contamination.

ASTM D4378-97 identifies a drop in 30˚F (17˚ on a Celsius scale) from the original oil viscosity as a warning limit.

Flash point testing should be conducted only if product contamination from a different oil is suspected.

Lube Oil Analysis Test Packages

Turbine oil lube oil analysis test packages should be assembled in a manner that provides pertinent, cost effective information. Specific turbine oil test packages for regular trend analysis and suitability for continued use are described below:

Regular Trend Analysis (Monthly / Quarterly)

- Viscosity ASTM D-445
- Water by Karl Fischer Titration ASTM D-1744
- Acid Number ASTM D-664
- ISO Cleanliness Code 4406
- ICP Metals

Suitability for Continued Use (Annual)

- Viscosity ASTM D-445
- RPVOT ASTM D-2272
- Water by Karl Fischer Titration ASTM D-1744
- Acid Number ASTM D-664
- ISO Cleanliness Code 4406
- Rust ASTM D-665 A
- Demulsibility ASTM D 1401
- Foam ASTM D-892 Sequence 2
- ICP Metals

On-site Checks

Often the most valuable and timely information is right in your hand at the time of sampling. Don't pass up this great opportunity to assess key performance parameters on your turbine oil. The use of clear, clean sample containers will allow for quick and easy quality checks as identified below:

Color

Unusual and rapid darkening can indicate contamination or excessive degradation.

Odor

Sour smelling oil can indicate contamination or excessive degradation.

Air

Air bubbles in the body of the lube oil sample should clear in fifteen minutes.

Foam

After a vigorous shake, foam from the surface should clear in 10 minutes.

Water

Turbine oil sample should be transparent. If you cannot read printing through a clear sample container, then water levels above 300 ppm may be present.

Solids

Look for solids settling out as signs of external and internal contamination.

Conclusion

With proper testing, trending of lube oil analysis reports over time will demonstrate a turbine oil's ability to perform. In the evaluation of prospective turbine oils, the most significant performance measurement is lubricant property retention. For turbine reliability assurance, the initial performance properties must be supported by field experience. Property retention should be confirmed through case studies, customer testimonials, and in-house experience.

Knowledge of your turbine oil and its limitations will set the stage for years of reliable service. Keys to this knowledge include: the right tool for the job, the proper flushing procedures, an appreciation for high-quality base stocks and additives, and a solid understanding of lube oil analysis for new turbine oil evaluation and in-service oil condition monitoring.

Daily emergencies and pursuit of key power plant performance operating metrics are often obstacles in gaining knowledge on turbine and plant lubricating oils. Fortunately, some oil suppliers recognize this fact and will support their clients with training, trouble-shooting, equipment inspections, and most aspects of plant-wide lubrication engineering. So, don't just buy a turbine oil — buy the turbine oil supplier.

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