Tech topic

Used oil evaluation

Assess the operating condition of both the jet engine oil system and the oil

Key insight

Most engines operating satisfactorily produce wear metal levels close to

zero

Introduction

Viscosity, acid number and water are parameters that generally indicate the condition of the oil and lend themselves well to setting minimum/maximum limits. These limits are set by the equipment manufacturer or operator, not by the oil company. However, trend analysis analyzes used-oil data at periodic intervals and is useful in identifying problems early to correct and prevent them.

Used oil limits and wear metals

Used oil limits for viscosity, TAN, water and metals content are established by the engine OEM and can differ by engine models and service. Always consult with the OEM for advice on used oil limits and appropriate actions.

Wear metals are also part of the used oil analysis to indicate the changing condition of the various parts of the engine oil system. This includes oil pump, gears, bearings and other metallic parts that may rub and generate wear debris. It is important to establish a practical interval to extract oil samples from the engine so good baseline data is recorded and used for comparison purposes if failures produce increased wear metals. The interval should be tailored to the particular testing program to provide timely data for analysis.

Used oil evaluation

Metals analysis

Metals analysis is also referred to as SOAP (Spectrometric Oil Analysis Program), or JOAP (Jet Oil Analysis Program) for the military. Most engine builders prefer that metals analysis interpretation be done on the basis of changes from "established trends" rather than relative to "threshold or control limits." Each engine type utilizes different types of metals and therefore will have different/unique wear patterns. These wear patterns will be specific to each engine, rather than the type of oil, although some oils have better/poorer wear control. The SOAP process is based on the concept that if it is possible to identify and quantify wear metal trends in engine lubricants, then it is possible to determine and isolate specific internal engine component problems.

Oil parameters

Viscosity and acid numbers are analyzed to determine oil condition. Upward movement of these parameters is usually indicative of the oil being exposed to high temperature within the engine oil system, resulting in thermal or oxidative degradation. There may be carbon deposition within certain areas depending upon the source of the high temperature. These two parameters are measured and monitored as indicators of high temperature problem areas within the engine. Carbon can form on internal parts of the oil system where a "hot spot" exists and not manifest significant change in these two parameters.

Oil parameters	Limits
viscosity (VS)	+25% to -10%
acid number (TAN)	+2.0 mg KOH/g
water content (% H_2O)	1000 PPM

The limits used by most engine builders are shown in the chart. However, it is advised that movement toward those limits during a consistent monitoring program may indicate a problem is developing in the engine oil system before it exceeds one of the noted limits.

Water in the oil is monitored as a potential contaminant. In ester-based jet oils, large amounts of water combined with heat can cause hydrolysis, resulting in increased acid number. Water can enter the jet engine oil system both as an accidental contaminant or through condensation, because esters are hygroscopic and can absorb water from air. The main concern is the potential for corrosion due to acid formation.

Phosphorus measurements

Phosphorus is measured as one of the metals, but it is not an engine wear metal. It is one of the additives used in the oil that provides anti-wear capability. Its value can decrease while it is functioning normally. However, a significant decrease of over 50 percent in the first 100 hours of operation may be cause for concern. This may indicate significant metal-to-metal rubbing of moving elements, which could be an early indication of an abnormal bearing or gear failure.

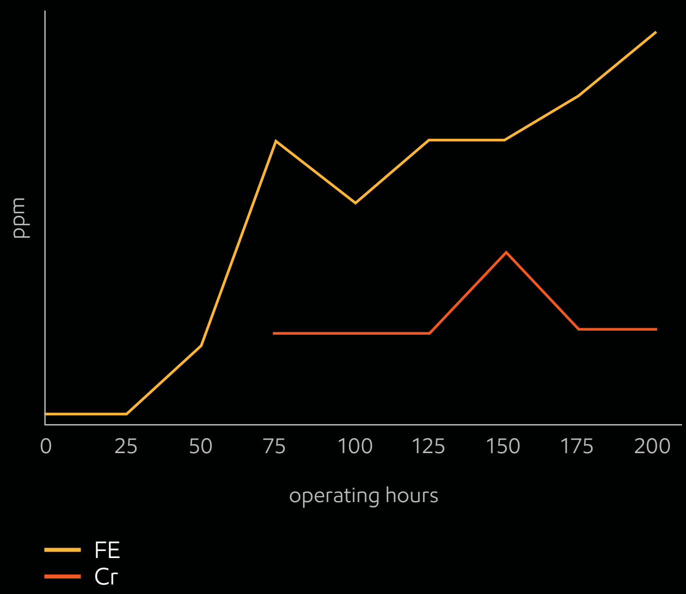
It is important to determine the level of phosphorus in new oil and to trend its value. Occasionally, an increase in measured phosphorus may indicate contamination with other phosphorus containing oil (e.g., phosphate-ester hydraulic fluid) that could have deleterious effects on the oxidation stability of the jet oil.

Used oil evaluation

Engine parameters

Analysis of metals is primarily a tool to help monitor the condition of bearings and gears of the jet engine and gearbox. ExxonMobil uses 10 PPM as a gross limit for all metals (except phosphorous) monitored in jet oils, based on the observation over 20 years that most engines operating satisfactorily produce wear metal levels close to zero. Most engines that have a wear metal result greater than 10 PPM usually have a wear anomaly. The use of an absolute limit in wear metals is not nearly as significant and useful for analyzing problems in the jet engine oil system as the trending upward or downward of a given wear metal, or a group of wear metals.

Trending is important in identifying wear or damage of bearings and gears. These results can be combined with oil filter inspection, vibration results and/or chip detector inspection. The metals monitoring helps to identify slow progressing damage to gears, bearings and spinning bearing races when the wear particles are in the 1-5 micron size.



Engine parameters	
metals analysis (SOAP)	+10.0 PPM and trend

In analyzing the wear metals results, it is important to have knowledge of the metals used in engine construction. The values of the wear metals should be plotted on a graph against engine operating hours. The most common wear metal to show movement is Iron, because most bearings have a high percentage. Depending on the bearing metal composition, if a bearing fails, many times the Iron level will increase, accompanied by another metal such as Chromium (which may be the second-highest compositional metal in the bearing).

Upward movement of Iron, Titanium and Chromium may indicate a spinning bearing outer race if the engine case is Titanium. Catastrophic failures of mechanical parts in the oil system usually generate large metal particles, which are not easily analyzed by spectrometric oil analysis, but can be analyzed by other means such as ferrography and debris analysis from magnetic chip detectors.

Silicon may indicate either dirt contamination in the oil sample or ingestion of dirt/dust in the engine inlet system. Another source can come from excessive use of Silicone-containing sealants to seal certain parts of the engine/gearbox. High levels of this type of Silicone can result in oil foaming and possible loss of lubricating qualities and heat transfer capabilities. Inspection of the engine oil filter will many times provide the answer to Silicate (dirt) or Silicone. A foam test on the used oil may be needed if Silicone contamination is suspected. The chart shows a typical trend plot of wear metals indicating possible abnormal bearing wear.

For more information

Please contact your ExxonMobil aviation sales representative.