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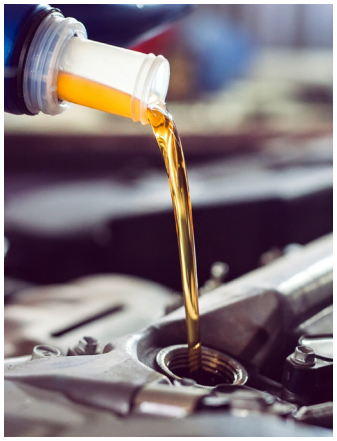
Application Note #1903

Used Oil Analysis with Portable XRF

X-ray fluorescence (XRF) spectrometry is a powerful analytical tool which provides comprehensive wear metal, contamination, and additive analysis in oils. Portable XRF is complementary to the laboratory techniques of Inductively Coupled Plasma Emission (ICP) and Rotating Disc Electrode Optical Emission (RDE) spectrometry.

Portable XRFs are fast, multi-element analyzers which not only are easy to use, but can also be taken anywhere the analysis of oils is needed. This includes maintenance depots, on location at motorsport events, at on- or off-shore mining operations, aboard maritime vessels, at power generation sites and at industrial or petrochemical plants. It can even be used on a production line or in a laboratory.



Portable XRF analysis of used oils enhances preventative maintenance programs. Trend analysis can be performed to determine which elements are increasing. Trends can indicate which part of the engine is breaking down which means replacement and/or repairs can be performed to avoid catastrophic failure. Typical analyses include oil properties, base oil and additives; contaminants; and wear debris from machinery.

Bruker's portable XRFs are the accurate and reproducible tools of choice for quick analysis of wear metals in lubricating oils, filter media particle analysis, quality control, development of oil blends, and for sulfur in fuel analysis.

Wear Metals in Used Oil

Wear metals in used oil samples are tiny particles of metal suspended in the oil which are formed by friction.

Indicator Element	Engine	Transmission	Hydraulics
Al	Pistons, bearings	Pumps, thrust washers	Bearings, thrust plates
Ti	Gas turbine parts, paint		
Cr	Rings, liners, exhaust valves, shaft plating, stainless steel	Roller bearings	Shaft
Fe	Cylinder liners, rings, crankshaft, valve train, oil pump gear	Gears, disks, bearings, shaft	Rods, cylinders, gears
Ni	Valve plating, crankshaft, camshaft	Roller bearings, shaft	
Cu	Lube coolers, main and rod bearings, bushings, turbo bearings	Bushings, clutch plates, lube coolers	Bushings, thrust plates, lube coolers
Pb	Main and rod bearings, bushings, lead solder	Bushings (bronze)	Bushings (bronze)
Sn	Piston flashing, bearing overlay, bronze, Babbit metal	Bearing cage	
Ag	Wrist pin bushings, silver solder	Torrington needle bearings	Silver solder

Additives in Lubricants

Today, almost all commercial lubricants contain chemical additives. Depending on lubricant type, additive concentrations range from 100 ppm to over 10% of formulated oil by volume. For example, sulfur, phosphorous and molybdenum are common components of extreme-pressure additives.

Elemental Indicators of Additives in Oil		
Element	**Engine**	**Typical %**
Mg	Detergent dispersant	0 – 0.3
Ca	Detergent dispersant	0 – 0.3
P	Anti-wear additive	0 – 0.15
Zn	Anti-wear additive	0 – 0.2
Ba	Synthetic lubricant additive	0 – 1
Mo	Friction reducer	0 – 5
S	Friction reducer	0 – 1

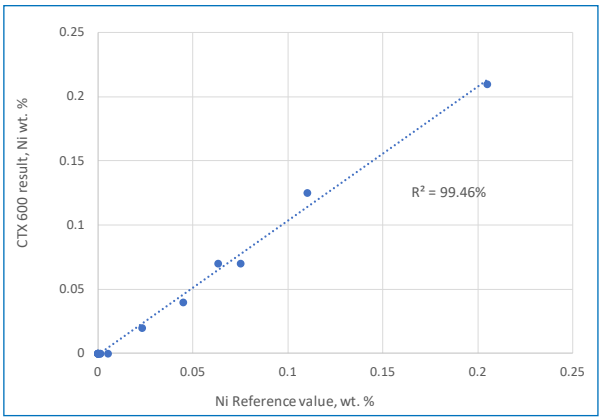
Contaminants in Oil

Contaminants don't just come from wear metals or additives. They can also come from dirt, antifreeze, and even seawater in an offshore environment. It's important to monitor them for preventative maintenance.

Other Contaminants in Oil	
Element	**Engine**
Na, Cl	Salt water
Si	Dirt
Si, K, Ca	Dirt and airborne contaminant
Na, K, B	Antifreeze coolant leakage

Portable EDXRF Metals in Oil Calibration

The Metals in Oil Calibration is for multi-elemental analysis of oil based liquid samples measured in a sample cup with 3µm ETNOM™ film. The standard calibration includes 15 elements correlated using a 2-phase calibration which covers most typical wear metals and oil additives (Mg, Al, Si, P, S, Ca, Ti, V, Mn, Fe, Ni, Cu, Zn, Mo, and Pb). It can be customized to include additional elements. The effective measurement range depends on the element. In practice, the minimum concentration that can be reliably analyzed is determined by the Limit of Quantification (LOQ), which in ideal conditions is 3.3 times the LOD (10 σ).



Correlation of Ni reference samples measured by CTX 600 for 60 sec

Portable EDXRF for Oil Analysis

Bruker's light-weight, portable CTX™ 800/600 models or the handheld S1 TITAN™ 600/800 models are optimized with the Metals in Oil Calibration for ready-to-go testing. The CTX is safety interlocked and self-contained. A fitted backpack carry case for easy transport up ladders is available. The S1 TITAN is an open-beam handheld which provides the additional benefit of being agile enough for in-situ measurements. It can be used for liquids with an available desk top stand.

Both have the same engine: Rh X-ray tube, SDD detector and SharpBeam™ geometry for high performance, speed and sensitivity. They measure elements from Mg (12) to U (92). They both have touchscreen operation, an internal camera, wireless communication, and run on battery or AC power. Both can also perform Positive Material Identification (PMI) checks of in-service engine room alloys or incoming alloy materials if configured with an Alloy Calibration.

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