Metals Detected in Oil Analysis – Spectroscopy and Root Cause Analysis

Wear Metals:

IRON (Fe): Iron is the most commonly use material of construction and the most commonly found wear metal in used lubricants. Elemental iron is usually found in the form of cast iron, carbon steel, and high alloy steels such as is used in shafts, cams, and valves. Most machinery cases are manufactured from cast iron. Most roller bearing rolling elements and races are manufactured from carbonized steel. Most gears are also manufactured from carbonized steel. Most machinery shafts, cams, and valves are manufactured from high alloy or stainless steels. These high alloy steels contain trace amounts of nickel, chromium, and sometimes, titanium.

C0PPER (Cu): Copper is almost always found in the form of an alloy, usually brass (copper and zinc) or bronze (copper and tin). These high copper alloys are referred to as 'Yellow Metals'. Some AW and EP additives can leach and/or corrode copper from these metals. Copper is also used in some cooler exchangers and can leach into the lubricant. A few, mostly gear lubricants, contain copper as an anti-wear additive.

TIN (Sn): Tin is a common alloying metal used in Babbitt sleeve bearing overlays. Most Babbitt alloys used in industry are tin based, IE, tin will be the major alloy component. Another source of tin can be leaching from solder joints.

LEAD (Pb): Lead is also an alloying metal used in Babbitt sleeve bearing overlays. Most Babbitt metal is Tin based, however, in electric motors and engines, most Babbitt metal is lead based, IE, lead will be the major alloy component. Other sources of lead include leaching from solder joints, corrosion resistant paints used on the inside of cases (older equipment), and sealing compounds.

ALUMINUM (Al): Aluminum is often used as a primary material of construction for cases and engine blocks. Aluminum can also be an alloying metal as in aluminum bronze. Many sleeve bearings and bushings are overlaid with aluminum. Aluminum is also found in some sealing compounds

CHROMIUM (Cr): Chromium is most often used as an alloying metal in high alloy and stainless steels. Chromium is also used as a plating metal such as chrome plated rings. Trace amounts of chromium with higher amounts of iron usually indicate shaft wear.

NICKEL (Ni): Nickel is also an alloying metal in high alloy and stainless steels. Trace amounts of nickel with higher amounts of iron usually indicate shaft wear.

TITANIUM (Ti): Titanium is also an alloying metal in high alloy and stainless steels. Trace amounts of titanium with higher amounts of iron usually indicate shaft wear. Titanium can also indicate turbo-charger wear.

FOR MORE INFORMATION, CONTACT MRT LABORATORIES
305 Nebraska Street | South Houston, TX 77587 | (877) 930-4060 | info@mrtlaboratories.com
www.mrtlaboratories.com

ZINC (Zn): Zinc is an alloying metal in brass and some bronze metals. Trace amounts of zinc may be seen spectrographically in severe brass or bronze wear situations. Zinc is usually found as an additive.

ANTIMONY (Sb): Antimony is an alloying metal in lead based Babbitt metals. Trace amounts of antimony may be seen spectrographically in severe lead based Babbitt bearing wear situations. Antimony is usually found as an additive.

SILVER (Ag): Silver is only used in some EMD drives as a bearing overlay.

Additive Metals:

CALCIUM (Ca): Calcium is an anti-corrosion additive. It is found in high concentrations in engine oils, and never found in R&O (Rust and Oxidation) lubricants. It is the primary additive in most engine oils that provides acid neutralization. Generally, the higher the calcium amount in a new engine lubricant, the higher the Total Base Number, or level of protection against corrosive acid build-up. Calcium can be found as high as 4000 or 5000 parts per million (ppm) range in some high-base diesel engine oils, but generally found in the 500 - 800 ppm range in today's gasoline engine oils.

MAGNESIUM (Mg): Magnesium, like calcium, is an anti-corrosion additive. It neutralizes acids. Magnesium also provides some anti-wear properties. It is never found in R&O oils. In industrial Anti-Wear (AW) and Extreme Pressure (EP) industrial lubricants, magnesium is usually found below 150 ppm in new lubricants. In Engine oils, magnesium may be 300 ppm or higher, depending on the formulation and base number.

BARIUM (Ba): Barium provides tremendous anti-wear (AW) and some extreme-pressure (EP) properties, but is found in only a few specialty lubricants. When found, it is usually below 300 ppm in new lubricants.

PHOSPHORUS (P): Phosphorus is an anti-wear, anti-corrosion additive. It can be found alone, or with zinc as part of a ZDDP additive package. Phosphorus can be found over 1200 ppm in some diesel engine oils. In industrial AW and EP lubricants, it is usually under 500 ppm.

ZINC (Zn): Zinc provides anti-wear properties. It is also part of the ZDDP additive package with phosphorus, where it is generally found at or near the same level as phosphorus. When found without phosphorus, it is generally found below 200 ppm.

MOLYBDENUM (Mo): Molybdenum, or 'moly', is an anti-wear and extreme pressure additive. It is generally found in gear oils and some engine oils. It can also be found as molybdenum di-sulfide, a solid

lubricant additive. It can be found as high as 5000 ppm in some specialty gear oils, but is usually in the 100 ppm range.

FOR MORE INFORMATION, CONTACT MRT LABORATORIES

305 Nebraska Street | South Houston, TX 77587 | (877) 930-4060 | info@mrtlaboratories.com

www.mrtlaboratories.com

ANTIMONY (Sb): Antimony is also an EP lubricant found in some Gear oils. Generally is it found below 100 ppm.

SILICON (Si): Silicon is most often found as a contaminant, however, in some engine and gear oils it is used as an anti-foam additive. As an additive, it is most often found below 20 ppm.

BORON (B): Boron is most often found as a contaminant from cooling water incursion, some gear and engine oils use boron to provide both anti-wear and detergent properties. When found as an additive, it is generally found less than 300 ppm.

COPPER (Cu): Copper is usually found as a wear metal, however, a few lubricants have a copper based anti-wear package. These lubricants will generally have less than 300 ppm copper present.

SODIUM (Na): Sodium is usually considered a contaminant, however, sodium is also found as an incidental additive as a result of the metallic salt additives. In some AW and EP lubricants, sodium may be found as high as 100 ppm.

POTASSIUM (K): With very few exceptions, potassium present in lubricants indicate cooling water. A few gear lubricants, however, use potassium as an anti-corrosion additive. When found as an additive, it will generally be in the 150 ppm range.

Contaminant Metals:

SILICON (Si): Silicon is the most common metal on earth. Sources of silicon as a contaminant include airborne dirt and dust, sand, grease, sealant, cooling water, coatings, and many others.

BORON (B): Boron is an anti-corrosion and detergent found as an additive in most coolant corrosion inhibitor packages. It is primarily water-borne. When found as a contaminant, it almost always indicates coolant incursion.

SODIUM (Na): Sodium is primarily a water-borne contaminant. Sources include cooling water, utility and potable water, sea and flood water, and other water sources. Sodium is one of the indicators of coolant incursion.

POTASSIUM (K): Potassium is an anti-corrosion additive in most coolants, including cooling tower water inhibitors and glycol coolants. Other sources of potassium include sea water and flood water. Potassium as a contaminant in most industrial lubricants almost always indicate coolant incursion.

MAGNESIUM (Mg): Magnesium is primarily an additive. When found as a contaminant it is usually a result of cooling tower water incursion.

FOR MORE INFORMATION, CONTACT MRT LABORATORIES
305 Nebraska Street | South Houston, TX 77587 | (877) 930-4060 | info@mrtlaboratories.com
www.mrtlaboratories.com

PHOSPHORUS (P): Phosphorus is primarily an additive. When found as a contaminant it is usually a result of Boiler or Cooling Tower water incursion.

CALCIUM (Ca): Calcium is primarily an additive. When found as a contaminant it is usually a result of cooling tower water incursion. Another common source is dust from shell roads.

VANADIUM (V): Vanadium is a metal found in crude oil, fuel oils, and some lower quality diesel fuels. When found in engine oils, fuel dilution is indicated.

FOR MORE INFORMATION, CONTACT MRT LABORATORIES
305 Nebraska Street | South Houston, TX 77587 | (877) 930-4060 | info@mrtlaboratories.com
www.mrtlaboratories.com