SPECTROCHEMICAL ANALYSIS

An emission spectrometer is utilized to measure the quantity of metals suspended in the lubricant. These values are represented in parts per million (PPM) by weight. The interpretation as to abnormality and source of the metals is most often dependent upon accompanying physical properties and pertinent system data (supplied by the owner / operator).

The following is only a generalization.

ELEMENT	COMMON SOURCE
IRON	SHELLS / SUPPORTS / CYLINDERS
LEAD / TIN	BEARINGS
COPPER	BEARING / TUBES / OIL LINES
CHROMIUM	RINGS / CYLINDERS / BEARINGS
ALUMINUM	PISTONS / BEARINGS / IMPELLERS
NICKEL	TUBES / CRANKSHAFT
SILVER	SOLDER / COOLER
SILICON	DIRT / SEALANT / ANTIFOAM / COOLANT
BORON	ADDITIVE / COOLANT
SODIUM	BRINE / COOLANT
PHOSPHORUS / ZINC	ANTIWEAR ADDITIVE (E.P.)
CALCIUM / MAGNESIUM	BRINE / DETERGENT ADDITIVE
BARIUM	DETERGENT ADDITIVE
TITANIUM / ANTIMONY	PUMP / BEARINGS
MOLYBDENUM	OIL / GREASE CONTAMINATION

VISCOSITY

The viscosity is the single most important property of a fluid lubricant. For optimum performance, the viscosity should be high enough to provide and maintain a hydrodynamic film between the moving surfaces at operating temperatures and yet be low enough to minimize power loss due to resistance.

The kinematic viscosity for refrigeration compressor systems is measure at 40° C and reported in units as centistokes (CST). The requested values can be compared and related to grades as defined by the International Standards Organization (ISO). The ISO grade is often indicated within the brand name of the lubricant (such as R & O 32, etc.).

Vis. @ 40° C	ISO VISCOSITY GRADE								
	22	32	46	68	100	150	220	320	460
MIN. cST	19.8	28.8	41.4	61.2	90	135	198	288	414
MAX. cST	24.2	35.2	50.8	74.8	110	165	242	352	506

Viscosity measurements for used oil is performed after the extraction of the refrigerant in a vacuum oven. Samples drawn from an operating system, which is not at equilibrium, will contain higher levels of refrigerant and require additional evacuation after testing. Sampling conditions should be noted with the samples when submitted for analysis.

As a General Guideline, a viscosity which is within the range of the upper or lower ISO grade is acceptable for continued service.

WATER CONTENT

Water content within refrigeration systems is extremely critical even in low concentrations. Water is a large contributor to many chemical reactions within the system. Because of this factor, water must be measured accurately at low levels of content. This is accomplished by the Carl Fischer Reagent Method and reported in parts per million (PPM).

New refrigeration oils require special handling to ensure against moisture contamination. An acceptable level of moisture in a new oil should be (approximately) < 75 PPM. This is one reason bulk storage of refrigeration oils is discouraged and sealed containers of lesser volume are encouraged.

Used oil in refrigeration systems should contain <100 PPM of water to ensure trouble free operation. I a sample is visually cloudy, the water content is well above acceptable level. A visually cloudy sample contains at least 0.10% by volume or 1000 PPM of water. Contamination at this level can induce burn out and / or chemical reactions such as the development of iron sulfide or phosphoric acid (within DTE type oils).

Slightly abnormal water levels can often be removed and controlled through the use / service of filter-dryers (where applicable).

TOTAL ACID NUMBER

The Total Acid Number is measured by potentiometric titration and expressed in mg/KOH required to neutralize one gram of sample. This method measures the levels of weak (organic) acids and strong (mineral) acids.

Weak acids commonly form as lubricants gradually degrade. Strong acids involve refrigerant decomposition or chemical reactions associated with exposures to high temperatures and / or moisture. Under condition of acidic contaminants or system abnormalities, rapid deterioration, sludging, and possible system failure may occur.

Wax free (WF) refrigeration oils are neutral mineral oils. The totl acid number of these new oils should be < .01. Used WF mineral type lubricants should have a total acid number of < .10.

Refrigeration oils which contain metallic additives are generally referred to as DTE lubricants. These lubricants will have a weak acid number when new and the acid number will vary according to the amount of additive present. Selection of this type of oil should be by manufacturer's specification only. The zinc dithiophosphate (anti-corrosion) additive used in these oils is subject to chemical reaction when exposed to oxygen, moisture, and high temperature. The reaction could form a phosphoric (strong) acid and induce extreme corrosion within the system.

Reference samples (new oil) are extremely important when DTE type lubricants are in service. General guidelines for DTE acid limitations are as follows:

TAN RANGE NEW OIL	UNACCEPTABLE TAN USED OIL
0.1-0.5	1.0
0.5-1.0	1.5
1.0-1.5	2.0

Mild acid conditions can be corrected using acid core filter- dryers.

DIELECTRIC STRENGTH

Dielectric strength is a measure of the ability of a fluid to withstand electric stress (voltage) without failure. The breaking point is reported in volts or kilovolts. The test is generally performed on hermetic sealed compressor units. The generally accepted "good" level is 20 KV.

INTERFACIAL TENSION (I.F.T.)

Interfacial tension is generally performed as a troubleshooting indicator when fluid failure is suspected. I.F.T. indicates the presence of hydrophillic compounds or the ability of a fluid to provide a hydrodynamic film. Dilution of an oil by sovent, water, and / or high temperature can directly affect the I.F.T.

CHLORIDES

Chloride measurement in refrigeration oils is often performed as an indicator of oxidation and strong acid (hydrochloric and sulfuric) and is reported in parts per million (PPM). The TAN provides similar information.

FERROGRAPHIC (PARTICLE) ANALYSIS

Ferrography is the newest of testing procedures utilize in predicting component wear, component identification, and chemical reactions in systems where low levels of wear and reactions are critical.

The actual particles analyzed are extracted from the oil via gravity and magnetic flux. The shape, coloring, composition, and position of the wear particles are representative of wear modes from which they evolve.

PARTICLE COUNT

Particle counts indicate the size and number of each size particle found in a selected sample. A laser is used to measure the particle size and count the number of particles of each size. Particle counts are useful in determining oil quality and oil filter efficiency.

COMMON CHEMICAL REACTIONS WITHIN REFRIGERATION SYSTEMS

Ammonia is a strong detergent, can loosen residual debris and contaminants from within a system and circulate these contaminants to critical components such as valves, bearings, etc.

Chemical reactions may be experienced due to the solubility of ammonia in water, forming ammonium hydroxide, a strong and reactive alkaline agent. In the presence of oxygen, ammonia hydroxide reacts with other chemicals to form sludges and what is commonly called coking, the formation of dark abrasive grit.

HALOCARBON REFRIGERANT

The most common reaction in systems utilizing halocarbon refrigerant is a reaction with oxygen, moisture and high temperature which causes "copper plating". This involves chemical reactions to the copper components in which copper is transferred from one component to another and the buildup results in the loss of critical clearances and damage to compressor seals.