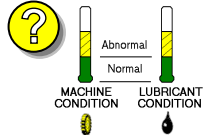


ABNORMAL



ID: E-6310



DDC 12.7L 370 HP Series 60 Engine, Bus # 6310

12/27/02
1:33:56

Unit Type: DD_DE020 Detroit Diesel 12.7L Engine, Diesel

Oil Type : PE_003 Pennzoil Long Life Heavy Duty SAE 15W-40 PO: CHM-E

Sampled : 07/25/02

Shipped : 07/28/02

Received: 07/29/02

Printed: 07/30/02

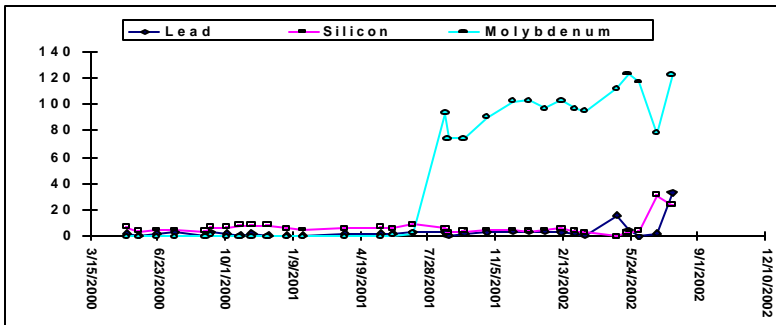
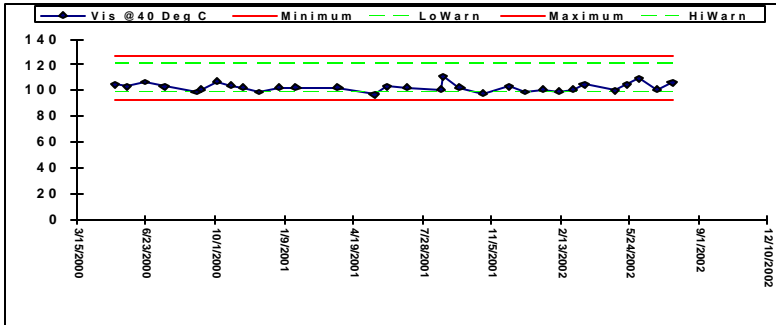
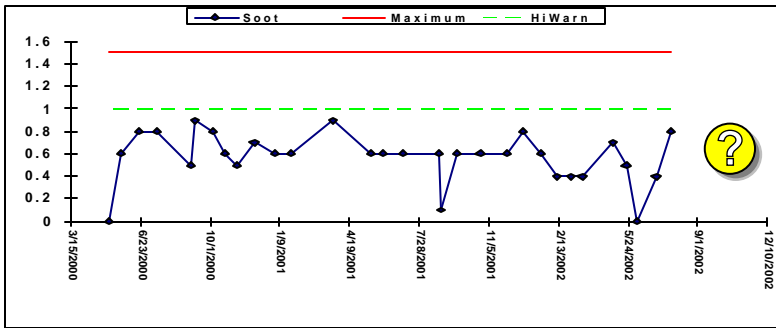
Lab Number : Q67031

ABNORMAL: Abnormal test results are present.



Lead content exceeds alarms. Silicon value is high. Check air intake system for leaks. Drain oil and change filter(s). Resample at your regular sampling interval.

DIESEL ENGINE OIL SAMPLE REPORT



Lab Number	Minimum	Maximum	Ref Oil	Q54128	Q56577	Q60694	Q64209	Q67031
Sample Date			09/13/00	05/03/02	05/21/02	06/06/02	07/03/02	07/25/02
Unit Time				0	11600	0	709467	724655
Oil Time				0	0	0	0	0
Metals								
Iron ppm		81	1	36	17	3	9	36
Aluminum ppm		4	1	2	<1	<1	<1	<1
Chromium ppm		7	<1	2	1	<1	<1	1
Copper ppm		25	<1	2	1	<1	1	3
Lead ppm		9	<1	**16	5	<1	2	**33
Tin ppm		4	<1	3	1	<1	<1	2
Nickel ppm		4	<1	<1	<1	<1	<1	<1
Silver ppm		4	<1	<1	<1	<1	<1	<1
Silicon ppm		20	<1	<1	3	4	**31	**23
Sodium ppm	<1	10	<1	6	3	2	2	3
Boron ppm		465	64	94	158	86	65	
Zinc ppm	1047	1571	1309	1400	1577	1447	1451	1390
Phosphorus ppm		1059	1360	1185	1273	1045	1132	
Calcium ppm		2806	3460	3697	3343	2559	3535	
Magnesium ppm		380	160	34	38	301	37	
Barium ppm	<1	10	<1	<1	<1	<1	<1	
Molybdenum ppm	<1	10	<1	112	123	**117	78	**122
Vanadium ppm	<1	10	<1	<1	<1	<1	<1	
Soot % wt.		1.5	<0.1	0.7	0.5	<0.1	0.4	0.8
Oxidation Abs/cm		30	<2	13	13	7	14	16
Water FTIR % Vol		0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Sulfination Abs/cm		30	<2	14	12	3	7	18
Percent Fuel % Vol		5.0	<2.0	<2.0	*2.4	2.0	*3.8	<2.0
Percent Glycol % Vol		0.20	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Vis @40 Deg C cSt	93.5	126.5	116.3	100.4	104.4	109.4	100.7	106.2

Evaluated By: Misty J. Trumpower,

For questions about this report, please call 888 HER-GUTH (437-4884) between 8:00 am and 5:00 pm PST. A Technical Support Representative will be glad to help you.

These results are submitted pursuant to our current Terms, Conditions and Limitations and Laboratory Pricing Policy. No responsibility or liability is assumed for the manner in which these results are used or interpreted.

Top Center - At the top center of the report the color-coded word "Normal", "Abnormal", or "Critical" is displayed to provide instant recognition of the sample status. Below the status are two color-coded thermometers that indicate the status of the machine and the lubricant.

Unit - Information in the box in the upper right hand corner of your report reflects information you have given us regarding Unit ID, Unit Type and Time, Fluid Type and Time, Purchase Order, Received Date, Print Date and Pages.

Recommendations - Directly below the Unit information are the laboratory recommendations displayed under three sub-headings. STATUS is a verbal confirmation of the status. PROBLEM is the problem(s) that have been detected by the analysis. RECOMMENDATION are the Data Analysts suggested course of action.

Data Matrix - Along the right side of the report are the test results for the sample(s) for this Unit ID. The left hand column displays the test name. Additional columns for Minimum, Maximum, and Reference Oil are next, if they are available to us. If this is not the first sample for this unit, a number of previous sample histories are next, depending on the availability of space. Finally, the column on the far right is the data from the current sample. Highlighted data should be noted, and may need attention.

Graphs - At the left side of the report are the graphs of selected data. If this is the first sample for this unit, there are no histories of data to trend. In that case, a single bar graph showing relative levels of test results based on industry averages is shown. If this is a subsequent sample, three graphs are used to display highlighted data, or if none, default graphs.

Metals ICP: Spectrochemical data is reported in parts per million.

Iron - Cylinders, liners, pistons, rings, valves, valve guides, anti-friction bearings, gear train, accessory gear drives, shafts, clutch plates, rust.

Aluminum - Pistons, bearing, blower/ turbos, pump vanes, thrust washers.

Chromium - Compression rings, chromate from cooling system, anti-friction bearings, shafts.

Copper - Bearings, bushings, thrust washers, valve guides, injector shields, oil cooler core tubes, some clutches. Additive in some oils, anti-seize and gasket compound.

Lead - Bearings, plating, leaded gear lubes, leaded gasoline.

Tin - Bearings, plating.

Nickel - Shafts, valves, anti-friction bearings.

Silver - Silver solder, wrist pin bushings (EMD).

Silicon - Sand, dirt, dust, also contained as Silicone in new oil as anti-foam agent, low concentrations. Also anti-freeze and gasket sealant compounds.

Sodium - Contained in some new oils. Also, contamination from anti-freeze or salt water.

Boron - Contained in some new oils. Also contamination from anti-freeze.

Zinc - Contained in many new oils as an anti-oxidant, anti-corrosive, and anti-wear agent.

Phosphorus - Contained in many new oils. Normally associated with Zincdithiophosphate. May be chlorinated phosphorus additive for anti-wear characteristics.

Calcium - Contained in many new oils. Primarily dispersant/detergent.

Magnesium - Contained in some new oils as dispersant/detergent. Can replace typically aluminum components when used in aircraft.

Barium - Contained in some new oils as an additive.

Molybdenum - Contained in some new oils as an additive.

Vanadium - By-products of heavy fuel oil and occasionally a wear metal.

Cadmium - Contained in some new oils as an additive.

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Manganese - Contained in some new oils as an additive.

Titanium - Contained in some alloys.

Additional Testing Data: Samples receive different tests depending on the type of equipment and program objectives. Some of the tests you will see are:

% Fuel Dilution - Percent fuel contained in oil sample - Excessive fuel generally enters the oil system through leaking injectors, seals, fuel fittings, pumps or incorrect choke adjustments. Fuel dilution can also increase due to poor combustion characteristics.

Total Solids are solids and semi-solid particulates contained in the oil sample. They are generally excessive oxidation resins, and/or combustion by-products (carbon). Typical sources of oxidation resins are high operating temperatures and/or extended oil drain intervals. Blow-by products can be caused by poor mechanical efficiency. Items such as incorrect injector and ignition valve timing, air to fuel ration, or abnormal wear in piston ring and cylinder regions cause excessive blow-by.

Water - This is % (or ppm if Karl Fischer test used) water found in the oil sample. Typical sources are condensation and internal cooling system leaks.

Viscosity (Vis) is reported in centistokes at 40C or 100C. Viscosity measures the oils resistance to flow. Thinning may come from excessive fuel dilution or the addition of lighter (less viscous) oils. Thickening generally represents higher total solids or addition of heavier (more viscous) oils.

TAN (Acid Number) is the measurement of the weak acid formation in the oil. The higher the TAN the more acidic constituents are present in the oil. Lower or high operation temperatures, extended oil drain intervals and poor time combustion can form them.

TBN (Total Base Number) is the measurement of the reserve alkalinity of the oil's additive package. The lower the TBN in relationship to the new oil, the less its ability to clean the system and suspend contaminants.

Soot - The Soot value is the amount of infrared light that is absorbed by lubricant solids and semi-solids. Soot is particularly useful to determine blowby.

OXID (Oxidation) - Oxidation is the amount of infrared light absorbed by lubricant oxidation. It is the amount of oxidation that has occurred in the lubricant.

SULF (Sulfination) - Sulfination is the amount of infrared light absorbed by harmful sulfur compounds.

NITR (Nitration) - Nitration is the amount of infrared light absorbed by harmful nitrogen compounds.

GLY (Glycol) - The % glycol found in the oil is evidence that there is an internal coolant leak.

Particle Count - The particle count data is the concentration of particles in the sample. Classified by micron ranges (size), it is particularly helpful in trouble shooting hydraulic systems.

ISO Rating - This is the industry standard representation of particle contamination found via particle count data. It is reported as 2 numbers, separated by a '/', associated with particles in the >5um and >15um regimes.

Aqueous Metals - Aqueous analysis of metals in the sample is done by acid reduction and reconstitution. This allows capture of large particles that would escape the aspiration process used in traditional ICP methods.

DR Ferro DL (Density Large Particles) - The DL reading is the concentration of ferrous particles above 5 microns in size.

DR Ferro DS (Density Small Particles) - The DS reading is the concentration of ferrous particles below 5 microns in size.

DR Ferro WPC (Wear Particles Concentration) - The WPC reading is the total of ferrous wear particles found in the sample.

Analytical Ferrography - The microscopic analysis of wear particles to determine the mechanisms of wear taking place. This report is on a separate second page.

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