Vickers™
Proactive Maintenance

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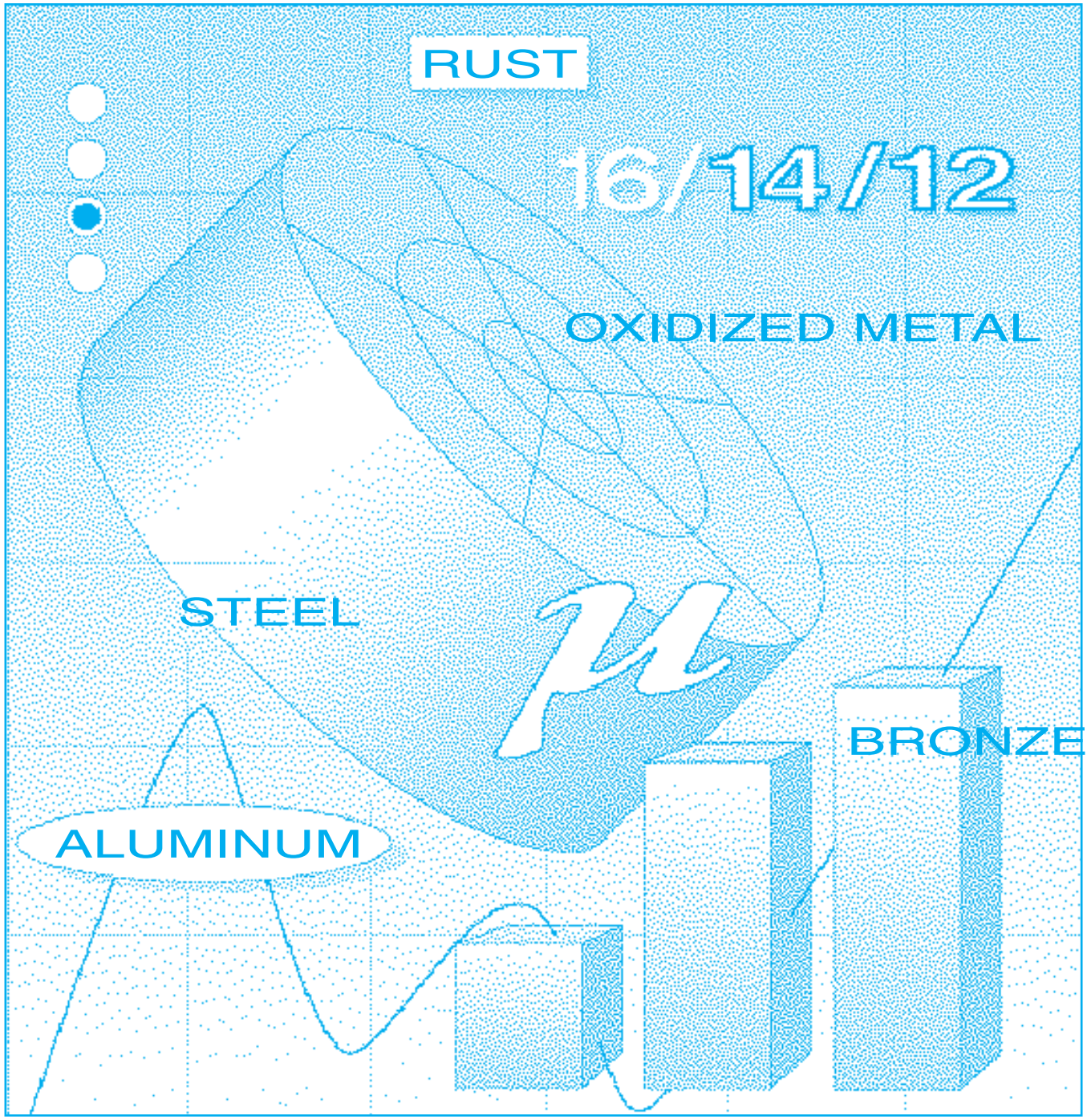
April, 2002

Fluid Analysis Service Report



VICKERS

COMPANY

Hydraulic Fluid Services 6743

CONTACT PERSON

Maintenance Manager

ADDRESS

26201 Northwestern Highway
Southfield
MI 48076

PHONE

248 354-2919

FAX

248 208-2048

SAMPLE DATE

June 1, 2000

SAMPLE NUMBER

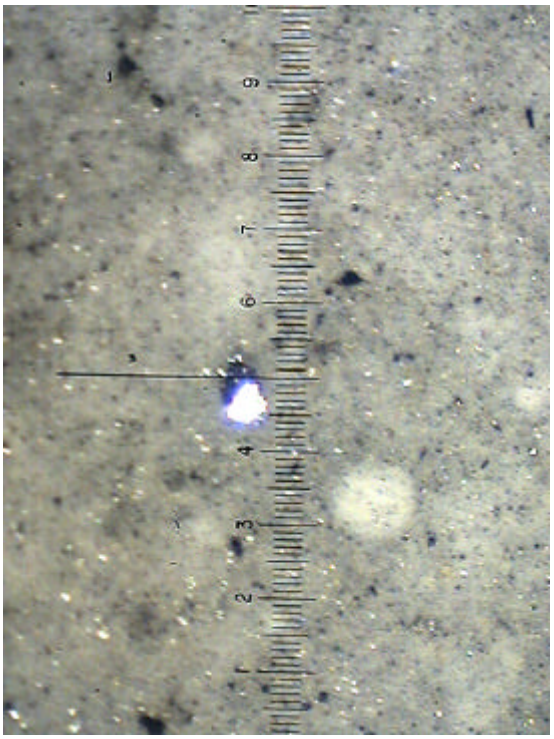
8000003

MACHINE ID #

9000001

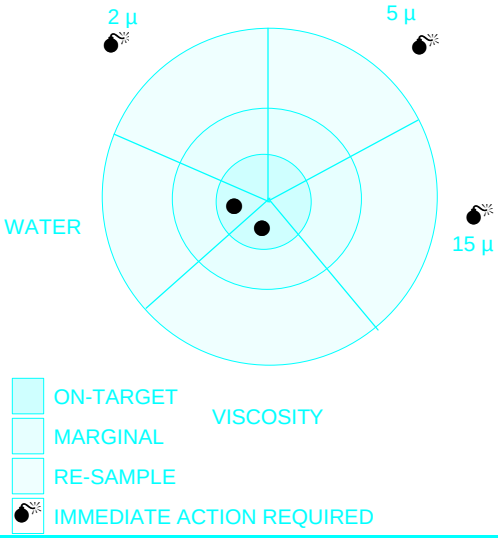
TARGET CLEANLINESS LEVEL

17/15/13



MAGNIFICATION 100 X

FLUID RESULTS



DOMINANT SIZE OF CONTAMINANTS OBSERVED

- ☑ LARGE > 50µ
- ☑ MEDIUM > 10µ
- ☑ SMALL > 5µ
- ☑ SILT < 5µ

METALLIC CONTAMINANTS

- ☐ BRONZE
- ☐ ALUMINUM
- ☐ RUST
- ☑ OXIDIZED METAL
- ☑ STEEL
- ☐ METALLIC OTHER

NON-METALLIC CONTAMINANTS

- ☑ SILICA
- ☑ FIBER
- ☐ ELASTOMER
- ☑ SILT
- ☐ FLUID ADDITIVES - OUT OF SOLUTION
- ☐ NON-METALLIC OTHER

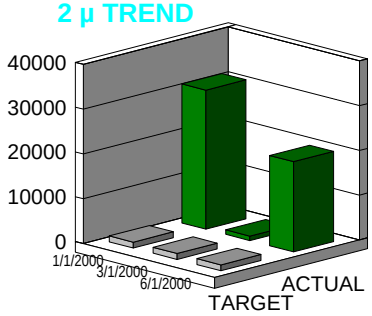
	PREVIOUS	PREVIOUS	CURRENT
DATE	1/1/2000	3/1/2000	**6/1/2000**
VISCOSITY at 100°F cSt (SUS)	68.4 (317)	68.1 (316)	**68.9 (320)**
WATER % WEIGHT	0.215 %	0.08 %	**0.012 %**
pH NOTE: pH is for water containing fluids only.			
TAN mg KOH/gm NOTE: TAN is for synthetic fluids only.	3.10	2.40	**1.89**

PHOTO ANALYSIS

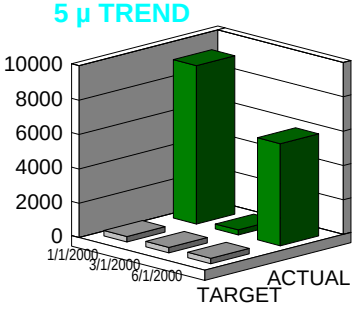
The sample contained high levels of large, medium, small and fine (silt) particles.

Contamination in the sample included Oxidized Metal (possible sources contaminated fill fluid or system piping), Steel (possible valve or pump wear), Silica (external ingression, or from process operation), Fiber (possible external ingression or from process operation) and Silt (build up of fines - possibly due to ineffective contamination control).

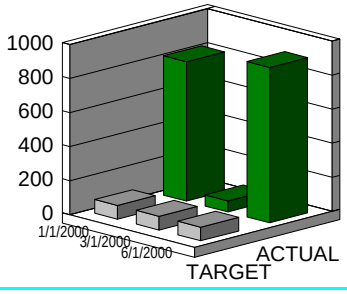
2 µ TREND



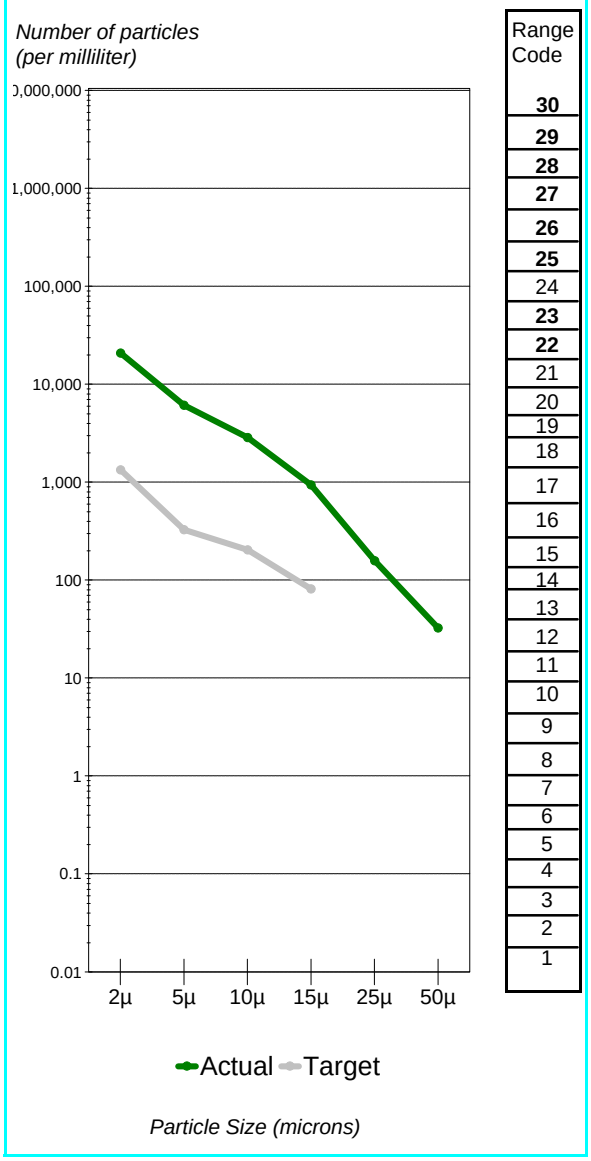
5 µ TREND



15 µ TREND



CLEANLINESS CODE



PARTICLE COUNT SUMMARY

	PREVIOUS	PREVIOUS	CURRENT
DATE	1/1/2000	3/1/2000	**6/1/2000**
>2µ	31,077	1,013	**20,157**
>5µ	9,222	290	**5,939**
>10µ	1,249	119	**2,787**
>15µ	819	65	**912**
>25µ	594	31	**154**
>50µ	12.7	6.2	**32**
CLEAN. CODE	22/20/17	17/15/13	**22/20/17**

RECOMMENDATIONS TO CUSTOMER

Sample number 8000002 had a cleanliness code of 22/20/17 , which did not meet the target cleanliness code of 17/15/13 , more efficient filtration is required. Take corrective action and re-sample to verify cleanliness level.

TAN has exceeded acceptable limits, take corrective action immediately.

SPECTROGRAPHIC ANALYSIS (ASTM D 5185)

COMPANY: Hydraulic Fluid Services 6743 MACHINE ID#: 9000001 SAMPLE NUMBER: 8000003

WEAR METALS, ADDITIVES AND CONTAMINANTS OBSERVED - PREVIOUS SAMPLE			WEAR METALS, ADDITIVES AND CONTAMINANTS OBSERVED - PREVIOUS SAMPLE			WEAR METALS, ADDITIVES AND CONTAMINANTS OBSERVED - CURRENT SAMPLE		
DATE:	1/1/2000		DATE:	3/1/2000		DATE:	**6/1/2000**	
WEAR METALS (PPM)			WEAR METALS (PPM)			WEAR METALS (PPM)		
IRON (Fe)	5	N	IRON (Fe)	3	N	IRON (Fe)	**8**	**N**
COPPER (Cu)	1	N	COPPER (Cu)	1	N	COPPER (Cu)	**0**	**N**
LEAD (Pb)	0	N	LEAD (Pb)	0	N	LEAD (Pb)	**1**	**N**
TIN (Sn)	0	N	TIN (Sn)	1	N	TIN (Sn)	**3**	**N**
CHROMIUM (Cr)	7	N	CHROMIUM (Cr)	0	N	CHROMIUM (Cr)	**5**	**N**
ALUMINUM (Al)	0	N	ALUMINUM (Al)	2	N	ALUMINUM (Al)	**0**	**N**
NICKEL (Ni)	2	N	NICKEL (Ni)	0	N	NICKEL (Ni)	**1**	**N**
ADDITIVES			ADDITIVES			ADDITIVES		
SILICON (Si)	19	N	SILICON (Si)	9	N	SILICON (Si)	**27**	**N**
ZINC (Zn)	698	N	ZINC (Zn)	675	N	ZINC (Zn)	**699**	**N**
PHOSPHORUS (P)	459	N	PHOSPHORUS (P)	461	N	PHOSPHORUS (P)	**438**	**N**
CALCIUM (Ca)	79	N	CALCIUM (Ca)	86	N	CALCIUM (Ca)	**83**	**N**
BARIUM (Ba)	2	N	BARIUM (Ba)	0	N	BARIUM (Ba)	**0**	**N**
MAGNESIUM (Mg)	0	N	MAGNESIUM (Mg)	0	N	MAGNESIUM (Mg)	**0**	**N**
BORON (B)	0	N	BORON (B)	0	N	BORON (B)	**0**	**N**

H = HIGH N=NORMAL L=LOW

UNDERSTANDING YOUR SPECTROMETRIC REPORT

This method provides the concentration (PPM or parts per million) of elements in solution in hydraulic fluids. As such, it should not be used to evaluate the performance of contamination control devices. A record of these concentrations over the operating life of a fluid system provides a guide for recognizing normal and abnormal conditions and for predicting incipient failure. Spectrometric analysis does not detect the presence (or absence) of particles larger than 10 micrometers.

These recommendations are based on trend analysis observed from many samples. Analysis can reveal wear from many sources such as:

Iron(Fe) - Pumps, valves, cylinders or oxidation
Copper(Cu) - Bushings, cylinders or oxidation
Lead(Pb) - Bushings
Tin(Sn) - Bushings, plating
Chromium(Cr) - Valve spools, cylinders or plating
Aluminum(Al) - Gear pumps, valves, fillers
Nickel(Ni) - Wear from valves or tubing
Silicon(Si) - Airborne dirt, casting fillers, coolant inhibitors
Zinc(Zn) - Oil additives or bushings
Phosphorus(P) - Oil additive
Calcium(Ca) - Oil additive
Barium(Ba) - Oil additive
Magnesium(Mg) - Oil additives or salts
Boron(B) - Oil Additive

Wear Metals and Contaminants metals Typical Values: 2-8 PPM

SPECTROMETRIC ANALYST COMMENTS AND INTERPRETATION

The Spectro analysis indicates that the additive package is present.

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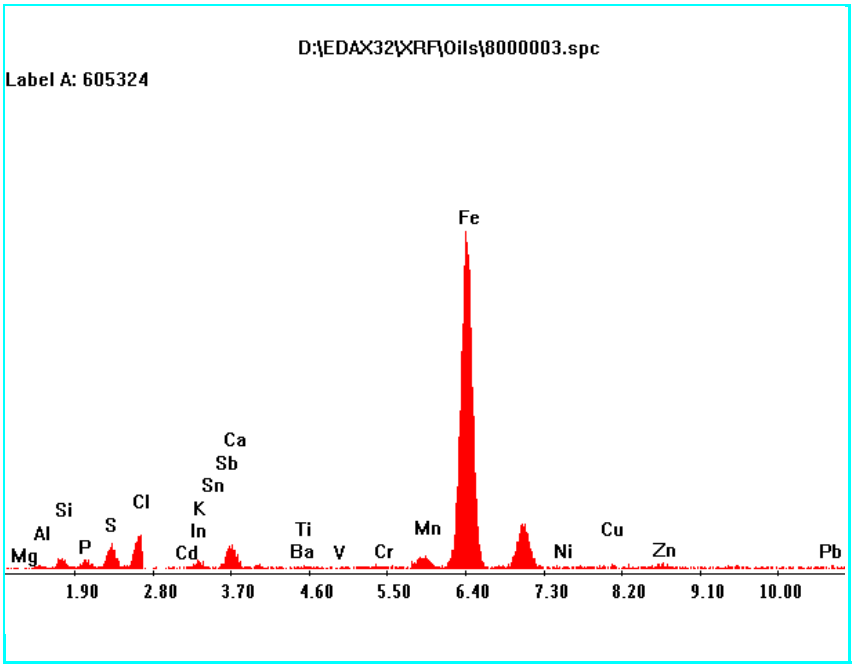
ENERGY DISPERSIVE X-RAY FLUORESCENCE (ASTM E 1508)

COMPANY Hydraulic Fluid Services 6743 MACHINE ID# 9000001 SAMPLE # 8000003

PREVIOUS	PREVIOUS 1/1/2000	CURRENT 6/1/2000
	Al 0.413 (4.19%)	Al **0.318 (3.25%)**
	Ca 0.440 (4.46%)	Ca **0.157 (1.60%)**
	Cd 0.467 (4.74%)	Cd **0.032 (0.33%)**
	Cl 0.495 (5.02%)	Cl **0.562 (5.74%)**
	Fe 0.423 (4.29%)	Fe **3.903 (39.87%)**
	In 0.444 (4.50%)	In **0.053 (0.54%)**
	K 0.438 (4.44%)	K **0.051 (0.52%)**
	Mn 0.427 (4.33%)	Mn **0.175 (1.79%)**
	P 0.437 (4.43%)	P **0.081 (0.83%)**
	Sb 0.443 (4.49%)	Sb **0.138 (1.41%)**
	Si 1.162 (11.78%)	Si **4.208 (42.98%)**
	Sn 0.449 (4.55%)	Sn **0.041 (0.42%)**
	Zn 0.442 (4.48%)	Zn **0.071 (0.73%)**
	Ba 0.457 (4.63%)	Ba
	Cr 0.422 (4.28%)	Cr
	Cu 0.592 (6.00%)	Cu
	Mg 0.130 (1.32%)	Mg
	Ni 0.418 (4.24%)	Ni
	S 0.474 (4.81%)	S
	Ti 0.454 (4.60%)	Ti
	V 0.434 (4.40%)	V



EDX SPECTRUM

Below is a guide to help establish the origin of the contaminants in your system.

Al (Aluminum) Piston and bearings, push rods, air cooler, pump housing, oil pump, gearbox castings.
Ca (Calcium) Oil additives, water, grease, dirt.
Cd (Cadmium) Bearings, platings, additives.
Cl (Chlorine) Oil additives or process contaminants.
Fe (Iron) Engine block, cylinders, gears, valve guides, wrist pins, rings, camshaft, crankshaft, oil pump, bearings and rust.
In (Indium) Flashing, synthetic oils, solder.
K (Potassium) Coolants, additives, dirt.
Mn (Manganese) Shafts and valves.
P (Phosphorus) Additives, coolants.
Sb (Antimony) Crankshaft and camshaft bearings, grease, additive.
Si (Silicon) Dirt intrusion, seal material, additive, filter material.
Sn (Tin) Bearings, connecting rods, pistons, additives.
Zn (Zinc) Neoprene seals, galvanized piping, bearings, plating, additives.
Ba (Barium) Additives, water and grease.
Cr (Chromium) Rings, cooling system leakage, chromium parts in aircraft engines, cylinder liners, crankshafts.
Cu (Copper) Bushings, injector shields, coolant core tubes, thrust washers, valve guides, connecting rods, rings, bearings.
Mg (Magnesium) Cylinder liner, gearbox housing (aircraft engines), oil additive.
Ni (Nickel) Bearings, valves, gear plating, oil additive.
S (Sulfur) Oil additives, base oil
Ti (Titanium) Alloy components in aircraft engines, paint chips.
V (Vanadium) Gears, bearings, turbine blades, valves, fuel oil, catalysts.

This analysis gives (% weight) concentrations of the elements that constitute the solid contaminants in your fluid. To better utilize this report, look for sudden changes in the trend of each element. This might be an indication of abnormal wear of components in your system that are made up of these elements.

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UNDERSTANDING YOUR FLUID ANALYSIS REPORT

TARGET CLEANLINESS (ISO 4406)

The fluid results target gives a quick overview of the condition of the sample submitted. The target measures the following five critical areas of fluid condition: 2µ, 5µ & 15µ micron particles of contamination, water content and viscosity of fluid. When the marker is in the inner circle of the target, this represents on-target fluid condition. The second ring on the target represents marginal performance. The third ring on the target indicates the need to resample the fluid because of the possible sampling error, and the last ring on the target indicates that immediate action is required (severely contaminated fluid). The Vickers target is a graphical way of understanding whether or not the fluid sample is meeting its target cleanliness level. The level of oil cleanliness required for a machine element depends primarily on its precision and in-service reliability. The size of the particles that cause the most damage in a machine element are those equal to, or slightly larger than, the clearance space between load bearing on sealing surfaces.

VISCOSITY OF A LUBRICANT (ASTM D 445)

is defined as the fluid flow rate at a specified temperature of 100°F (40°C). Its units are reported in centistokes (cSt) or Universal Seconds (SUS). The obtained value is compared to new fluid viscosity.

Typical values: 32VG: 28-35 cSt (132-164 SUS)
46VG: 41-51 cSt (191-237 SUS)
68VG: 61-75 cSt (282-348 SUS)

WATER CONTENT (ASTM D 1744)

The water % by weight determines the amount of emulsified water in the oil. Samples are analyzed per ASTM D1744 and the total water amount is reported as percent by weight. Water in the hydraulic fluid can be high due to condensation, leaking coolers, gaskets, seals of a cracked cylinder head. Typical value <= 0.07%.

pH (ASTM E 70)

Represents the strength of the acidity of the hydraulic fluid. pH is usually measured for water containing hydraulic fluids (water/glycols, invert emulsions). Typical value 8.5 - 10.5.

TOTAL ACID NUMBER {TAN} (ASTM D 974)

TAN is the amount of acid and acid-acting material constituents in the hydraulic fluid. An increase of the TAN indicates oxidation of the fluid or acid contamination. Some hydraulic fluids exhibit higher acid numbers than others.

OBSERVED SOLID CONTAMINANTS

Solid contaminants in the hydraulic fluid are observed by drawing a known volume of the fluid through a filter patch (0.8 micron pore size). The patch is then photographed through a microscope at a magnification of 100x. The picture reveals the metallic and non-metallic contaminant particles in the fluid. The photograph is then examined in order to determine the shape, size and source of contaminants. The analysis of the photograph is contained in the Photo Analysis section of this report.

AUTOMATIC PARTICLE COUNTS (ISO 11500)

This test detects solid contaminants with respect to their size distribution and quantity in the hydraulic fluid. The particle size distribution is defined by three range numbers separated by a slash (e.g. 19/17/14). The first of the three range figures corresponds to the number of particles greater then 2 microns (µ) in size, the second figure corresponds to the number of particles greater than 5µ in size, and the last figure corresponds to the number of particles greater than 15µ in size. The 5µ and the 15µ measurements indicate the level of contamination (e.g. 17/14) as defined by the ISO 4406 standard.

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