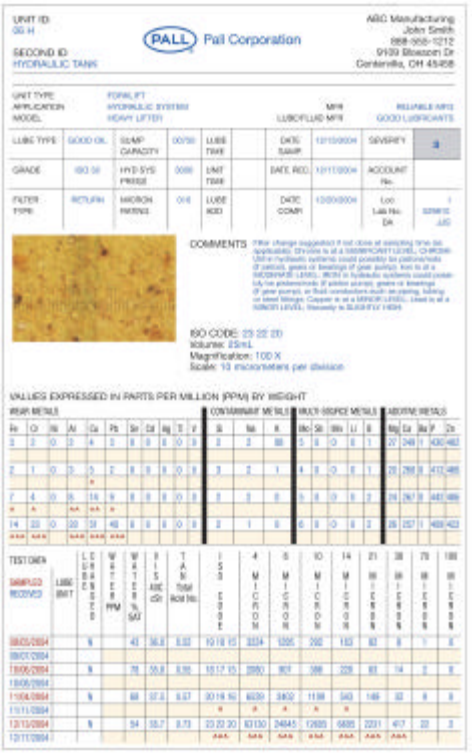
Pall Corporation

How to Read the PALLSCOPE™ Oil Analysis Report



Reading an oil analysis report can be an overwhelming and sometimes seemingly impossible task without an understanding of the basic fundamentals for interpreting laboratory results and recommendations. Referring to the report descriptions and explanations below will help you better understand your results and, ultimately, better manage a productive, cost-saving reliability program.

Customer, Equipment and Sample Information

The information submitted with a sample is as important to who is reading the report as it is to the analyst interpreting the test results and making recommendations. **Know your equipment and share this information with your laboratory.** Accurate, thorough and complete lube and equipment information not only allows for in-depth analysis, but can eliminate confusion and the difficulties that can occur when interpreting results.

Severity Status Levels:
0—Normal
1—At lease one or more items have violated initial flagging points yet are still considered minor.
2—A trend is developing.
3—Simple maintenance and/or diagnostics are recommended.
4—Failure is eminent if maintenance not performed. Occasionally, a test result can violate the S4 excursion level. But, if there is no supporting data or a clear indicator of what is actually happening within the unit, maintenance action may not be recommended. Customer may be asked to investigate all possible contamination sources, shorten sampling intervals, or simply monitor the situation very closely.

Equipment ID is each **customer's** opportunity to uniquely identify units being tested and their location.

Application identifies in what type of environment the equipment operates and is useful in determining exposure to possible contaminants.

Make note of the difference between the **Date Sampled** and the **Date Received** by the lab. Turnaround issues may point to storing samples too long before mailing or mail service problems.

Unit Type should give as much detail as possible. **What kind of** compressor, gearbox, engine, etc. influences flagging parameters and depth of analysis. Different metallurgies require different lubrication and have great impact on how results are interpreted.

Manufacturer and Model can also identify metallurgies involved as well as the OEM's standard maintenance guidelines and possible wear patterns to expect.

Lube Manufacturer, Type and Grade identifies a lube's properties and its viscosity and is critical in determining if the right lube is being used.

UNIT ID: 06 H
SECOND ID: HYDRAULIC TANK

Pall Corporation

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UNIT TYPE	FORKLIFT				MFR		RELIABLE MFG		
APPLICATION	HYDRAULIC SYSTEM				LUBE/FLUID MFR		GOOD LUBRICANTS		
MODEL	HEAVY LIFTER								
LUBE TYPE	GOOD OIL	SUMP CAPACITY	00750	LUBE TIME		DATE SAMP.	12/13/2004	SEVERITY	3
GRADE	ISO 32	HYD SYS PRESS	3000	UNIT TIME		DATE REC.	12/17/2004	ACCOUNT No.	
FILTER TYPE	RETURN	MICRON RATING	010	LUBE ADD		DATE COMP.	12/20/2004	Loc Lab No. DA	529810 JJS

Filter Types and their **Micron Ratings** are important in analyzing particle count—higher micron ratings generally mean higher particle count results.

Sump Capacity identifies the total volume of oil (in gallons) in which wear metals are suspended and is critical to trending wear metal concentrations.

Lube Time is how long the oil has been used. **Unit Time** is the age of the equipment and **Lube Added** is how much oil has been added since the last sample was taken.

The **Lab #** is assigned to the sample upon entry for processing and should be the reference number used when notifying the lab with questions or concerns.

Customer Account Number

Data Analyst Initials

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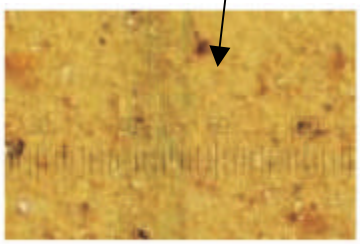
Photomicrograph

A photomicrograph representing the contamination in the sample is provided. The photo is taken at 100X magnification and can be consulted for particle identification or for comparison to previous samples or a reference database. The contamination level is expressed as an ISO 4406 code.



COMMENTS Filter change suggested if not done at sampling time (as applicable); Chrome is at a SIGNIFICANT LEVEL; CHROMIUM in hydraulic systems could possibly be pistons/rods (if piston), gears or bearings (if gear pump); Iron is at a MODERATE LEVEL; IRON in hydraulic systems could possibly be pistons/rods (if piston pump), gears or bearings (if gear pump), or fluid conductors such as piping, tubing or steel fittings; Copper is at a MINOR LEVEL; Lead is at a MINOR LEVEL; Viscosity is SLIGHTLY HIGH.

ISO CODE: 23 22 20
Volume: 25mL
Magnification: 100 X
Scale: 10 micrometers per division

Comments and Recommendations

A data analyst's job is to explain and, if necessary, recommend actions for rectifying significant changes in a unit's condition. Reviewing comments before looking at the actual test results will provide a roadmap to the report's most important information. Any actions that need to be taken are listed first in order of severity. Justifications for recommending those actions immediately follow.

Elemental Analysis

Elemental Analysis, or Spectroscopy, identifies the type and amount of wear particles, contamination and oil additives. Determining metal content can alert you to the type and severity of wear occurring in the unit. Measurements are expressed in parts per million (ppm).

Combinations of these **Wear Metals** can identify components within the machine that are wearing. Knowing what metals a unit is made of can greatly influence an analyst's recommendations and determine the value of elemental analysis.

Knowledge of the environmental conditions under which a unit operates can explain varying levels of **Contaminant Metals**. Excessive levels of dust and dirt can be abrasive and accelerate wear.

Additive and **Multi-Source Metals** may turn up in test results for a variety of reasons. Molybdenum, antimony and boron are additives in some oils. Magnesium, calcium and barium are often used in detergent/dispersant additives. Phosphorous is used as an extreme pressure additive in gear oils. Phosphorous, along with zinc, are used in anti-wear additives (ZDP).

VALUES EXPRESSED IN PARTS PER MILLION (PPM) BY WEIGHT

WEAR METALS											CONTAMINANT METALS			MULTI-SOURCE METALS					ADDITIVE METALS				
Fe	Cr	Ni	Al	Cu	Pb	Sn	Cd	Ag	Ti	V	Si	Na	K	Mo	Sb	Mn	Li	B	Mg	Ca	Ba	P	Zn
3	2	0	2	4	3	0	0	0	0	0	2	2	88	5	0	0	0	1	27	249	1	430	482
2	1	0	3	5	2	0	0	0	0	0	3	2	1	4	0	0	0	1	20	268	0	412	466
				^																			
7	4	0	8	14	9	0	0	0	0	0	2	2	0	5	0	0	0	2	24	267	0	442	486
^	^		^^	^^	^																		
14	23	0	20	51	40	0	0	0	0	0	2	1	0	6	0	0	0	2	26	257	1	409	422
^^^	^^^		^^^	^^^	^^^																		

Test Data

Test results are listed according to age of the sample—oldest to most recent, top to bottom—so that trends are apparent. Significant changes are flagged and printed in the shaded areas of the report.

Water in oil decreases lubricity, prevents additives from working and furthers oxidation.

For free water (water content above 100% saturation), the water content is determined by Karl Fischer and is reported as ppm.

For water content below saturation (dissolved water), we report the content using a Pall water sensor as percent of saturation. 100% represents the maximum amount of water a lubricant can hold prior to becoming free water (free water will generally appear cloudy).

Samples are listed by **Date Received** in the lab-oldest first. They are also assigned a **Lab Number** for easy internal tracking. Important to also note is whether or not the **Lube** has been **Changed** since the last sample was taken.

TEST DATA SAMPLED RECEIVED	LUBE UNIT	LUBE CHANGED	WATER PPM	WATER % SAT	VIS 40C cSt	TAN Total Acid No.	ISO CODE	4 MICRON	6 MICRON	10 MICRON	14 MICRON	21 MICRON	38 MICRON	70 MICRON	100 MICRON
09/03/2004		N		43	36.8	0.52	19 18 15	3224	1295	292	163	82	8	1	0
09/07/2004															
10/06/2004		N		78	35.8	0.55	18 17 15	2080	907	386	220	63	14	2	0
10/08/2004															
11/04/2004		N		68	37.5	0.57	20 19 16	6529	3402	1109	543	149	32	9	0
11/11/2004							^	^	^	^	^				
12/13/2004		N		54	35.7	0.73	23 22 20	63130	24845	12605	6605	2231	417	22	2
12/17/2004							^^^	^^^	^^^	^^^	^^^	^^^	^^^		

Viscosity measures a lubricant's resistance to flow at temperature and is considered its most important physical property. Depending on lube grade, it is tested at 40 and/or 100 degrees Centigrade and reported in centistokes.

Total **A**cid **N**umber is the amount of acid present in the lubricant. Numbers higher than that of new lube indicate oxidation or some type of contamination.

The **ISO 4406 Code** represents a range of particles greater than a size, i.e. 4, 6, 14 µm(c). Each class designates a range of measured particles per mL of sample. The actual particle counts per mL are also shown for 8 particle sizes.

Summary

Make a habit of reading your analysis reports regularly. Know your equipment and share as much information with your laboratory as possible. Understanding your reports and being able to utilize analysis results to schedule downtime and productively manage your reliability programming, is a vital part of successful predictive and preventative maintenance.