



## Tables on Oil Analysis



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**Oil Analysis Important Tables**

Table 1 : ISO 4406 :99 Fluid Cleanliness Standard

ISO 4406 CODE	Number of Particles	
	From	To
26	320,000	640,000
25	160,000	320,000
24	80,000	160,000
23	40,000	80,000
22	20,000	40,000
21	10,000	20,000
20	5,000	10,000
19	2,500	5,000
18	1,300	2,500
17	640	1,300
16	320	640
15	160	320
14	80	160
13	40	80
12	20	40
11	10	20
10	5	10
9	2.5	5
8	1.3	2.5
7	0.6	1.3
6	0.3	0.6

Table 2 : Fluid Cleanliness Standard Comparison for New Oil

<b>Without By-Pass ISO 22/17</b>	<b>Brand New Oil ISO 17/14</b>	<b>With By-Pass Filter ISO 13/10</b>
> 5 = 29263 ppm	> 5 = 1292 ppm	> 5 = 55 ppm
> 15 = 1112 ppm	> 15 = 119 ppm	> 15 = 15 ppm
> 25 = 29 ppm	> 25 = 19 ppm	> 25 = 3 ppm
> 50 = 0 ppm	> 50 = 5 ppm	> 50 = 0 ppm
>100 = 0 ppm	>100 = 0 ppm	>100 = 0 ppm

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## Oil Analysis Important Tables

Table 3 : Sample Standard Cleanliness Target for System Applications

MACHINE / COMPONENT	ISO RATING
• Roller Bearings	16/14/12
• Journal Bearings	17/15/12
• Industrial Gearboxes	17/15/12
• Mobile Gearboxes	17/16/13
• Diesel Engines	17/16/13
• Steam Turbine	18/15/12
• Paper Machine	19/16/13
• Servo-Valve	13/12/10
• Proportional Valve	14/13/11
• Variable Volume Pump	15/14/12
• Fixed Piston Pump	16/15/12
• Vane Pump	16/15/12
• Gear Pump	16/15/12
• Ball Bearing	14/13/11
• Turbine	17/15/12

Table 4 : General Water Concentration Limits

H2O Concentration	Status	Action
• 100 - 300	• Alert	• Check seals, breathers, coolers, etc., for ingress sources, watch the trend
• 300 - 800	• Danger	• Aggressively investigate and correct the source of ingress and implement an effective water removal activities
• 800 above	• Extremely Danger	• Immediate action is required to eliminate ingress and effect removal of water to minimize damage to machine and lubricant

Note : Unit of Water concentration in PPM

## Oil Analysis Important Tables

Table 5 : Engine Problems Analyzed through Oil Analysis

Metal Traces	Limit	Engine Problem	What to Check
• Silicon	• 10 - 30 ppm	• Dirt Ingression	• Air intake system • Oil filter plugging • Oil filler cap and breather • Valve cover
• Iron (Fe)	• 100 - 200 ppm	• Wear of cylinder liner • Valve and fear train • Oil pump • Rust in the system	• Excessive oil consumption • Abnormal engine noise • Performance problem • Oil pressure • Stuck or broken piston
• Chromium (Cr)	• 10 - 30 ppm	• Piston ring wear	• Excessive oil blow-by • Oil consumption / degradation
• Copper (Cu)	• 10 - 50 ppm	• Bearing / bushing wear • Radiator corrosion	• Coolant in engine oil • Abnormal noise on operating at stall speed
• Lead (Pb)	• 40 - 100 ppm	• Bearing corrosion	• Extended oil change intervals
• Aluminum (Al)	• 10 - 30 ppm	• Piston and piston thrust • Bearing wear	• Blow-by gases • Oil consumption • Power loss • Abnormal engine noise

Table 6 : Recommended Test for different applications

Equipment	Spectro-Analysis	Viscosity	FTIR	Particle Count	Karl Fisher	TAN	TBN	Rotrode Filter
Engines	R	R	R	----	R	R	R	A
Compressor	R	R	R	A	R	----	----	R
Gearboxes	R	R	R	----	----	----	----	R
Bearings	R	R	R	A	----	----	----	R
Hydraulics	R	R	R	R	A	A	----	R
Turbines	R	R	R	R	R	R	----	R
Motor	R	R	R	----	----	----	----	R

Where : R - Require Test  
A - Advisable, provides extra details

Table 7 : Comparing Multi-grade Oil Properties

<b>BRAND (SAE 20W-50)</b>	<b>VI</b>	<b>Flash</b>	<b>Pour</b>	<b>% Ash</b>	<b>% Zinc</b>
AMSOIL	136	482	-38	< 0.50	---
Castrol GTX	122	440	-15	0.85	0.12
Exxon High Performance	119	419	-13	0.70	0.11
Havoline Formula 3	125	465	30	1.00	---
Kendall GT-1	129	390	-25	1.00	0.16
Pennzoil GT Performance	120	460	-10	0.90	---
Quaker State Dix	155	430	-25	0.90	---
Red Line	150	503	-49	---	---
Shell Truck Guard	130	450	-15	1.00	0.15
Spectro Golden 4	174	440	-35	---	0.15
Spectro Golden M.G.	174	440	-35	---	0.13
Unocal	121	432	-11	0.74	0.12
Valvoline All Climate	125	430	-10	1.00	0.11
Valvoline Turbo	140	440	-10	0.99	0.13
Valvoline Race	140	425	-10	1.20	0.2
Valvoline Synthetic	146	465	-40	<1.50	0.12
<b>BRAND (SAE 20W-40)</b>	<b>VI</b>	<b>Flash</b>	<b>Pour</b>	<b>% Ash</b>	<b>% Zinc</b>
Castrol Multi-Grade	110	440	-15	0.85	0.12
Quaker State Dix	121	415	-15	0.90	---
<b>BRAND (SAE 15W-50)</b>	<b>VI</b>	<b>Flash</b>	<b>Pour</b>	<b>% Ash</b>	<b>% Zinc</b>
Chevron	204	415	-18	0.96	0.11
Mobile 1	170	470	-55	---	---
Mystic JTS	144	420	-20	1.70	0.15
Red Line	152	503	-49	---	---
<b>BRAND (SAE 5W-50)</b>	<b>VI</b>	<b>Flash</b>	<b>Pour</b>	<b>% Ash</b>	<b>% Zinc</b>
Castrol Syntec	180	437	-45	1.20	0.1
Quaker State Sunquest	173	457	-76	---	---
Pennzoil Performax	176	---	-69	---	---
<b>BRAND (SAE 5W-40)</b>	<b>VI</b>	<b>Flash</b>	<b>Pour</b>	<b>% Ash</b>	<b>% Zinc</b>
Havoline	170	450	-40	1.40	---
<b>BRAND (SAE 15W-40)</b>	<b>VI</b>	<b>Flash</b>	<b>Pour</b>	<b>% Ash</b>	<b>% Zinc</b>
AMSOIL	135	460	-38	<0.50	---
Castrol	134	415	-15	1.30	0.14
Chevron Delo 400	136	421	-27	1	---
Exxon XD3	---	417	-11	0.9	0.14
Exxon XD3 Extra	135	399	-11	0.95	0.13
Kendall GT-1	135	410	-25	1	0.16
Mystic JT8	142	440	-20	1.7	0.15
Red Line	149	495	-40	---	---
Shell Rotella w/ XLA	146	410	-25	1	0.13
Valvoline all fleet	140	---	-10	1	0.15
Valvoline Turbo	140	420	-10	0.99	0.13
<b>BRAND (SAE 5W-30)</b>	<b>VI</b>	<b>Flash</b>	<b>Pour</b>	<b>% Ash</b>	<b>% Zinc</b>
AMSOIL	168	480	-76	<0.50	---
Castrol GTX	156	400	-35	0.8	0.12
Chevron Supreme	202	354	-46	0.96	0.11
Chevron Supreme Synthetic	165	446	-72	1.1	0.12
Exxon Superflow HP	148	392	-22	0.7	0.11
Havoline Formula 3	158	420	-40	1	---

## Oil Analysis Important Tables

Table 8 : Guidelines for determining, achieving and maintenance Target Cleanliness Levels with High Performance Filtration (Beta Ratio > 200)

Most Sensitive System Components	Low Pressure		Medium Pressure		High Pressure	
	140 Bar		140 - 210 Bar		210 Bar - up	
	ISO Target Levels	Micron Rating	ISO Target Levels	Micron Rating	ISO Target Levels	Micron Rating
<b>PUMPS</b>						
Fixed External Gears	21/17/14	25	20/16/14	10	20/16/14	10
Vane Pump	21/17/14	25	20/16/14	10	19/16/13	6
Fixed Piston	20/16/14	10	19/16/13	6	19/15/12	3
Variable Piston	19/16/13	6	19/15/12	3	18/14/12	3
<b>VALVES</b>						
Check Valves	21/17/14	25	20/16/14	10	20/16/14	10
Directional (Solenoid)	21/17/14	25	20/16/14	10	20/16/14	10
Standard Flow Control	21/17/14	25	20/16/14	10	20/16/14	10
Cartridge Valve	20/16/14	10	19/16/13	6	19/15/12	3
Proportional Valve	19/15/12	3	18/14/12	3	17/13/11	3
Servo Valve	18/14/12	3	17/13/11	3	16/12/10	3
<b>ACTUATORS</b>						
Cylinders, Vane Motors	22/18/15	25	20/17/14	16	19/16/13	6
Gear Motors	22/18/15	25	20/17/14	16	19/16/13	6
Piston Motors	20/16/14	10	19/16/13	6	19/15/12	3
Swash Plate Motors	20/16/14	10	19/16/13	6	19/15/12	3
Hydrostatic Drives	19/15/12	3	18/14/12	3	17/13/11	3
<b>LUBRICATING OILS</b>						
Paper Machine Oils	21/16/13	3	n.a.	n.a.	n.a.	n.a.
Steam Turbin Oils	20/15/12	3	n.a.	n.a.	n.a.	n.a.
Diesel Engines	19/16/13	3	n.a.	n.a.	n.a.	n.a.
Mobile Gear Box	19/16/13	3	n.a.	n.a.	n.a.	n.a.
Industrial Gear Box	19/15/12	3	n.a.	n.a.	n.a.	n.a.
Journal Bearings	19/15/12	3	n.a.	n.a.	n.a.	n.a.
Roller Bearings	18/14/12	3	n.a.	n.a.	n.a.	n.a.
Ball Gearings	17/13/11	3	n.a.	n.a.	n.a.	n.a.

- Severe conditions may include high flow surges, pressure spikes, frequent cold starts, extremely heavy duty use or the presence of water
- Two or more systems filters of the recommended rating may be required to achieve and maintain the desired Target Cleanliness Level (ISO 4406 : 99)

## Oil Analysis Important Tables

Table 9 : Commonly Recommended Oil Sampling Frequencies

Item	Machine Type	Hours
1	Diesel Engine	150
2	Transmission, differentials, final drives	300
3	Hydraulics - Mobile Equipments	200
4	Gas Turbines - industrial	500
5	Steam Turbines	500
6	Air / Gas Compressors	500
7	Chillers	500
8	Gear boxes - high speed / duty	500
9	Gear boxes - low speed / duty	300
10	Bearings - journal and rolling elements	1000
11	Aviation reciprocating engines	25 - 50
12	Aviation gas turbines	100
13	Aviation gear boxes	100 - 200
14	Aviation hydraulics	100 - 200

Table 10 : Commonly Elements Found On Oil

Item	Element	Symbol	Wear	Contam	Additive
1	Iron	(Fe)	x	x	
2	Copper	(Cu)	x	x	x
3	Chromium	(Cr)	x		
4	Tin	(Sn)	x		
5	Aluminum	(Al)	x	x	
6	Lead	(Pb)	x		
7	Silicon	(Si)		x	x
8	Sodium	(Na)		x	x
10	Boron	(B)		x	x
11	Calcium	(Ca)		x	x
12	Magnesium	(Mg)		x	x
13	Zinc	(Zn)	x		x
14	Phosporous	(P)		x	x
15	Molybdenum	(Mo)			x
16	Potassium	(K)		x	



## Oil Analysis Important Tables

Table 11 : What Different Oil Analysis Test Will Detect

OIL ANALYSIS Test	LUBE MACHINE CONDITION													
	Particle Contamination	Wear Debris Detection	Wear Debris Analysis	Abnormal Viscosity	Moisture Contamination	Additive Depletion	Oxidation Stability	Glycol Contamination	Fuel Dilution	Soot Load	Alkalinity Reserve	Wrong Oil	Thermal Failure	Corrosive Condition
Particle Count	P	S	S											
Viscosity				P	S		S	S	S	S		P	P	
TAN / TBN				S		S	P				P	S		P
FTIR Spectroscopy				S	P	P	P	S	P	P		P	S	S
Ferrous Density		P	S											
Analytical Ferrography	S		P											
RPVOT							P					S		
Moisture Tester					P									S
Elemental Spectroscopy	S	P	P		S	P		P	S			P		S
Flash Point Test				S					P			S	P	

**P = Primary Indicator      S = Secondary Indicator**

Table 12 : Limits On Oil Analysis Tests

Oil Analysis Test	Caution	Critical	Shell Limits
Cleanliness	ISO 14/11	ISO 16/13	no data
Dryness	200	600	no data
TAN	0.2	0.4	no data
Fuel	1.50%	5%	no data
Glycol	200 ppm	400 ppm	no data
Soot	2%	5%	no data
Viscosity	+ 5 %	+ 10%	+/- 20 %
RPVOT	- 30 %	- 60 %	no data
FTIR (Ox)	0.3	1	no data
Zinc	-15 %	- 30 %	no data
Calcium	-10	20%	no data
TBN	- 50%	- 75 %	2 mg KOH min
Water	100 - 300 ppm	above 300 ppm	0.10% by vol.
Metals			Shell Limits
- Iron (Fe)	100- 200 ppm	above 200 ppm	3 - 150 ppm
- Silicon (Si)	10 - 30 ppm	above 30 ppm	1 - 15 ppm
- Chromium (Cr)	10 - 30 ppm	above 30 ppm	0 - 20 ppm
- Lead (Pb)	40 - 100 ppm	above 100 ppm	3 - 50 ppm
- Aluminum (Al)	10 - 30 ppm	above 30 ppm	2 - 20 ppm
- Copper (Cu)	10 - 50 ppm	above 50 ppm	- 5 - 65 ppm