Equipment Reliability Starts at Lubricant Delivery!

Lubricant contamination control is NOT a singular task!

I have used this slide for 20 years!

What is the cost of particulate/water contaminated lubricants?

•A study conducted by the National Research Council of Canada found that on average, 82 percent of wear problems are directly attributable to particle-induced failures such as abrasion, erosion and fatigue.

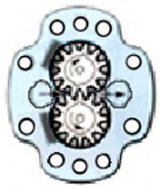
A more recent informal survey of more than 30 plants including power generation, paper, food, chemical, cement, textile and other manufacturing industries found, not surprisingly, that dust, process contamination, wear debris and moisture, are the most common contaminants.

•Of those problems not directly associated with particles, water - typically the second most failure inducing contaminant plays just as serious a role in promoting premature failure, resulting in corrosion and hydrogen-induced wear like blistering and hydrogen embrittlement.

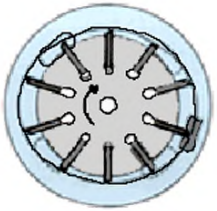
According to Caterpillar, " dirt and contamination" are by far the number one cause of hydraulic system failures."

MIT states that "six to seven % of the gross national product ($240 Billion US) is required just to repair the damage caused by mechanical wear." Wear occurs as a result of lubricant contamination.

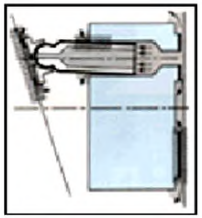
Mechanical surfaces tolerance's



Gear Pump
Dynamic Clearance
Tooth to Side Plate: 0.5 to 5 Microns
Teeth Tip to Case: 0.5 to 5 Microns

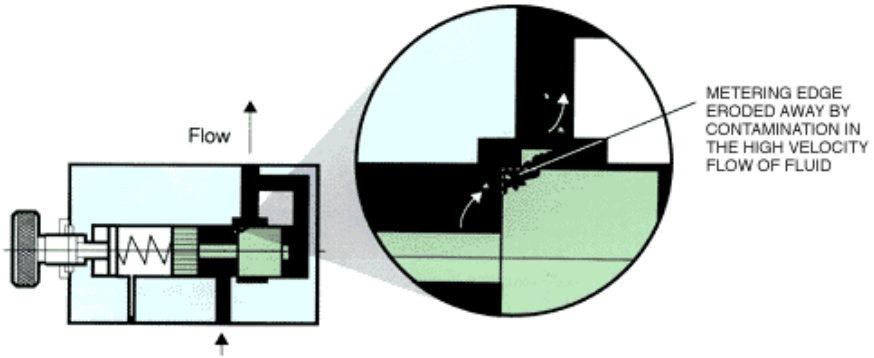


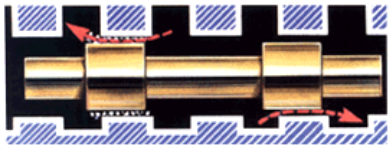
Vane Pump
Dynamic Clearance
Vane Sides 5 to 13 Microns
Vane Tips 0.5 to 1 Micron



Piston Pump
Dynamic Clearance
Piston to Bore: 5 to 40 Microns
Valve Plate to Cylinder: 0.5 to 5

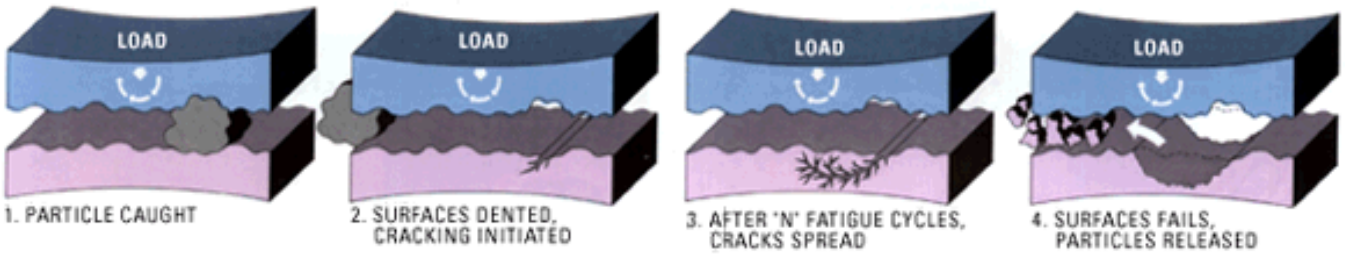
Does it just wears out over time?
If it "wore out" it is still a failure!

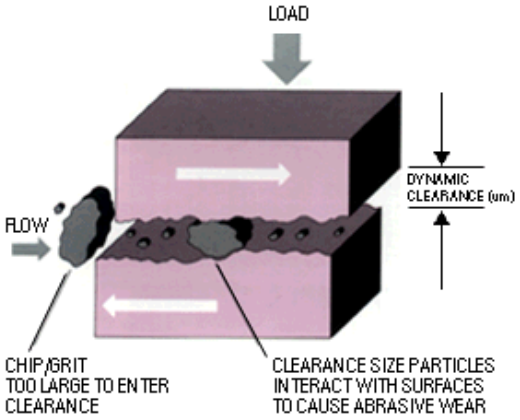




Servo valve	1 - 4µm
Proportional valve	1 - 6µm
Directional/control valve	2 - 8µm

What came first? The contaminate or the wear?





Bearing surfaces are subjected to fatigue failures as a result of repeated stressing **caused by clearance size particles trapped by the two moving surfaces**. At first, the surfaces are dented and cracking is initiated. These cracks spread after repeated stressing by the bearing load, even without additional particulate damage. Eventually the surface fails, producing a spall. Contamination reduces bearing life significantly through fatigue, abrasion and roughening of operating surfaces.

What do you see? The failure or the cause!

What you can't see will hurt you!

Typical Hydraulic Component Clearances	
Component	**Microns**
Anti-friction bearings	0.5
Vane pump (vane tip to outer ring)	0.5-1
Gear pump (gear to side plate)	0.5-5
Servo valves (spool to sleeve)	1-4
Hydrostatic bearings	1-25
Piston pump (piston to bore)	5-40
Servo valves flapper wall	18-63
Actuators	50-250
Servo valves orifice	130-450

Micrometer Scale

Particle sizes are generally measured on the micrometer scale. One micrometer (or "micron") is one-millionth of one meter, or 39 millionths of an inch. ***The limit of human visibility is approximately 40 micrometers***.

Keep in mind that most damage-causing particles in hydraulic or lubrication systems are smaller than 40 micrometers.

Therefore, they are microscopic and cannot be seen by the unaided eye.

The actual thickness of a lubricating film depends on fluid viscosity, applied load, and the relative speed of the two surfaces.

In many components, mechanical loads are to such an extreme that they squeeze the lubricant into a very thin film, less than 1 micrometer thick.

If loads become high enough, the film will be punctured by the surface roughness of the two moving parts. The result contributes to harmful friction.

Relative Sizes of Particles		
Substance	**Microns**	**Inches**
Grain of table salt	100	.0039
Human hair	70	.0027
Lower limit of visibility	40	.0016
Red blood cells	**8**	**.0003**
Bacteria	2	.0001

Side benefits of managing lubrication to prevent wear: (Proactive)

1) Reduction in downtime and lost production: We're always in battle against equipment breakdowns that result in lost production, but contaminated fluid is often the ultimate enemy. The initial investments of resources into a rigorous Lubricant Contamination Control program yield benefits that significantly outweigh the costs of downtime. Factor in the costs of equipment repair or replacement over time and it's easy to see that controlling the risks that contribute to lubricant/fuel contamination is a worthy investment.

2. Extend fluid life: This benefit boils down to a simple fact: Dirty fluid must be disposed of and replaced. There's a clear cost benefit to maintaining cleanliness standards rather than enacting frequent wholesale oil replacement.

3.Reduction in maintenance labor costs: Although it may seem counterintuitive on the surface, a cost analysis can show that maintaining higher standards will reduce costs associated with complete oil changes, element changes and other labor-intensive activities. These activities often create larger or less predictable blocks of downtime, which produce an additional chip at your bottom line

It is financially beneficial to manage the risks that impact equipment longevity and their production!

Lubrication for Reliability

Why is controlling/eliminating contaminates in lubricating oil/grease/fuel important?

As it appeared in Machinery Lubrication Magazine

Article written by

Ed Bohn,

General Motors Corp.

Linden Assembly Plant in New Jersey

The first time I used this article in my presentation was in 2002! (15 years ago)

Think about how much money has been "pissed way" through premature component failures, scheduled and un-scheduled down time over the last 14 years!

Return on Investment for Lubrication Management

Estimates	Simple 5-year Financial Analysis of Program Improvement					
	0	1	2	3	4	5
Savings						
Documented Savings (yrs 1 and	-	$900,000.00	$700,000.00			
Lubricant Expenditure Savings **		$19.00	$17.00	$42.00	$26.00	$26.00
Projected Savings (Yrs 3, 4, 5) **				$500,000.00	$500,000.00	$500,000.00
Subtotal – Program Savings		**$900,019.00**	**$700,017.00**	**$500,042.00**	**$500,026.00**	**$500,026.00**
Capital Purchases						
Lubricant Storage Tanks	$9,000.00					
Lube Trucks		$10,000.00	$20,000.00			
Laboratory Equipment	$55,000.00					
Expenses Purchases						
Lubrication Training	$16,000.00					
Oil Safe Containers	$5,700.00					
Material Handling Changes	$4,550.00					
Tapping System	$560.00					
Increase Lubricant Consumption						
Laboratory Equipment Training	$10,000.00					
Subtotal–Program Expenses * **	**$100,810.00**	**$10,000.00**	**$20,000.00**			
Depreciation Tax Shield ****		$4,440.00	$5,640.00	$5,640.00	$5,640.00	$5,640.00
Total Cash Flows	**($100,810)**	**$894,459.00**	**$685,657.00**	**$505,682.00**	**$505,606.00**	**$505,606.00**
Discount Rate (Factor) *****	15% 1	0.8696	0.7561	0.6575	0.5718	0.4872
Discounted Cash Flow	($100,810)	$777,790.00	$518,455.00	$332,494	$289,116.00	$251,405
Projected 5 year Return	$2,068,451.00					
Payback Term – Months	**2**					
IRR (Based on 20%)	**738%**					
NPV 5 Year Estimate	**$2,068,451**					

*	Actual savings documented in formal cost program
**	Projected savings based on undocumented and anticipated savings
***	Expenses include initial outlays and additional outlays during the first and second years
****	Tax shield based on straight-line depreciation at a 30% corporate tax rate
*****	Discount rate equals the estimated target for returns on capital purchases

How does lubricants/grease and fuel become contaminated?

Where does lubricant contamination come from?:

- All new oil / fuel is guaranteed to be new, not clean! (it is nearly impossible for an oil supplier to provide cleaned / kept clean, product to end users!)
- Shipping containers: pails/drums/totes and bulk delivery systems might not be clean.
- Every time lubricant/fuel is handled, there is a risk for contamination ingress.
- Most existing pump/reel/tank/industrial suppliers are in the fluid delivery business.
- If lubricant / grease / fuel is exposed to the atmosphere, a contamination ingress risk occurs.
- Diesel engines create their own contaminates (soot load).
- Lubricant / Fuels left in containers/tanks exposed to temperature swings can ingest contamination.
- Liquids decanted from a tank ingest air: airborne particles suspended in the atmosphere!

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How does lubricants/grease and fuel become contaminated? 1: STORAGE








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How does lubricants/grease and fuel become contaminated? 2: Dispensing













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How does lubricants/grease and fuel become contaminated? 3: Transfer Containers












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How does lubricants/grease and fuel become contaminated? 4: Insertion










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How does lubricants/grease and fuel become contaminated? 5: In Service Protection





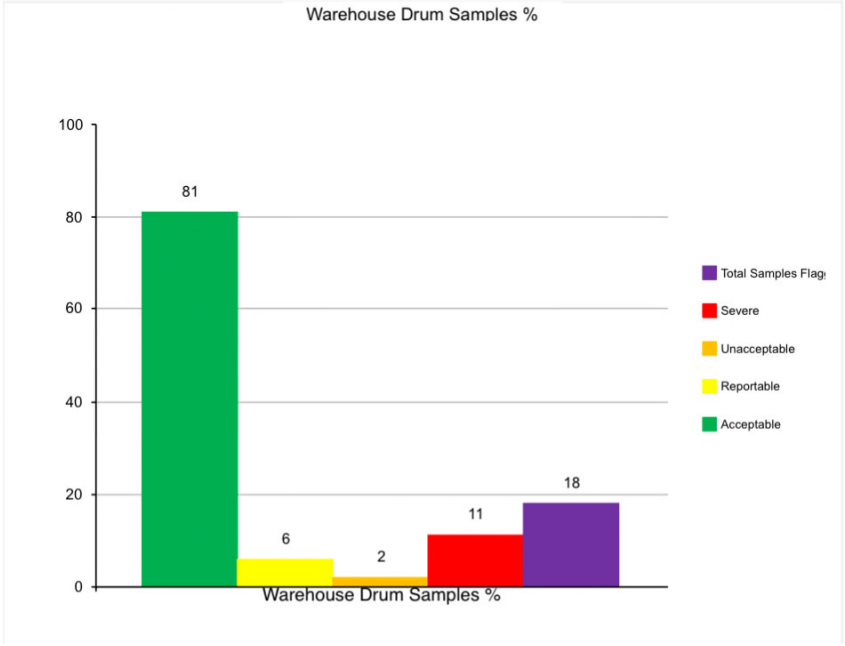


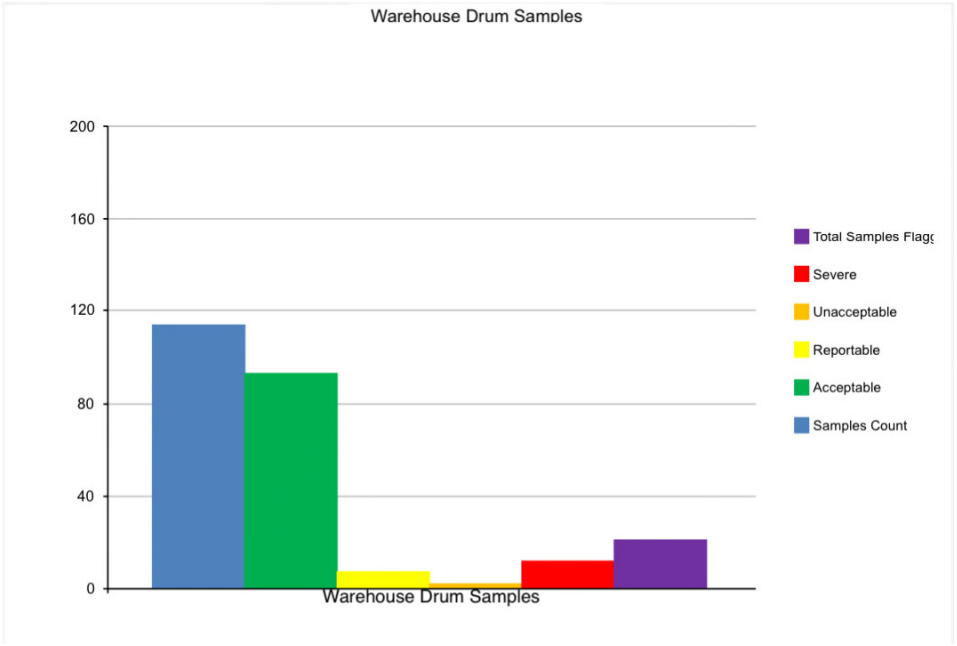




Detecting/measuring oil contamination: Oil Analysis: New oil in drums

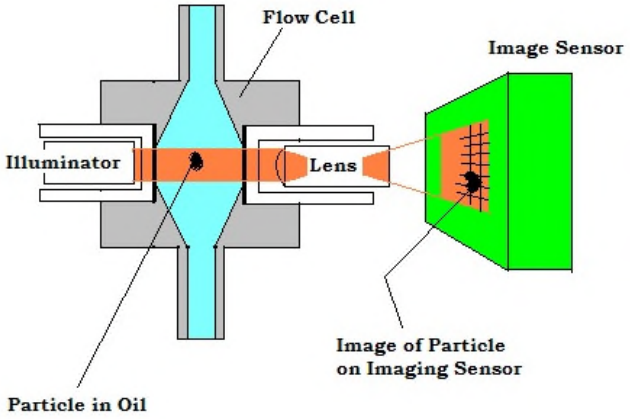
	Samples Count	Acceptable	Reportable	Unacceptable	Severe	Total Samples Flagged
Warehouse Drum Samples	114	93	7	2	12	21
	Acceptable	Reportable	Unacceptable	Severe	Total Samples Flagged	
Warehouse Drum Samples %	81	6	2	11	18	



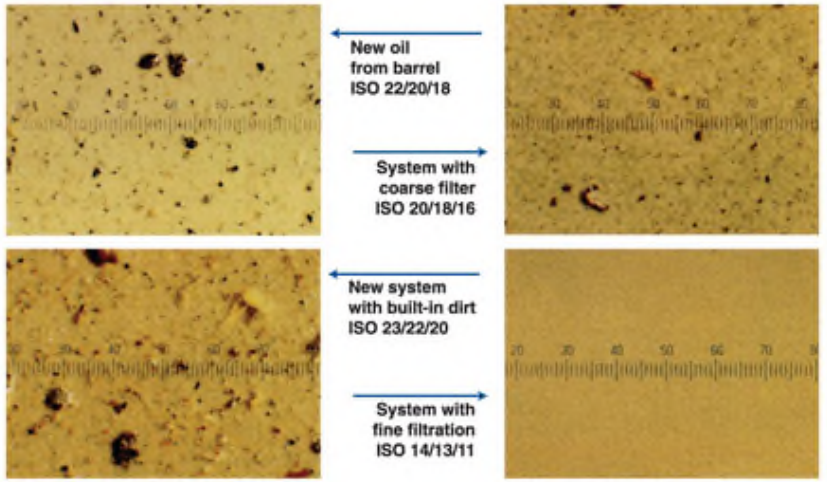


Detecting/measuring oil contamination: Oil Analysis: Particle Counts

Number of particles, by size in a given volume of fluid



Current Cleanliness Level	Existing ISO	"Life Expectancy Improvement Multiple" 2X	3X	4X	5X	6X
	26/23/21	23/20/18	22/19/17	21/18/16	20/17/15	19/16/14
	25/22/20	23/19/17	21/18/16	20/17/15	19/16/14	19/15/13
	24/21/19	21/18/16	20/17/15	19/16/14	19/15/13	18/14/12
	23/20/18	20/17/15	19/16/14	18/15/13	17/14/12	17/13/11
	22/19/17	19/16/14	**18/15/13**	17/14/12	16/13/11	16/12/10
	21/18/16	18/15/13	17/14/12	16/13/11	15/12/10	14/11/9
	20/17/15	17/14/12	16/13/11	15/12/10	14/11/9	13/10/9
	19/16/14	16/13/10	**15/12/10**	14/11/9	13/10/8	12/10/8
	18/15/13	15/12/10	**14/11/9**	13/10/8	12/9/8	11/8/6
	17/14/12	14/11/9	**13/10/8**	12/9/7	11/8/6	
	16/13/11	13/10/8	12/9/7	11/8/6		
	15/12/10	12/9/7	11/8/6			
	14/11/9	11/8/6				
	13/10/8	11/8/6				
	12/9/7	11/8/6				



Detecting/measuring oil contamination: Oil Analysis; Water

FLUID ANALYSIS REPORT

SAMPLE CODE: 1034 **DATE:** 06-01-04

XYZ Corporation
12345 Middleton Rd.
Anywhere USA 41114
Attn:

PARTEST Fluid Analysis Service
Parker Hannifin Corporation
16810 Fulton County Road #2
Metamora, OH 43540
Tele:(419)644-4311
Fax:(419)644-6205

SAMPLE DATA

COMPANY NAME:	XYZ Corporation	SAMPLE DATE:	06-01-04
SYSTEM TYPE:	Hydraulic System	HOURS (on oil/unit):	100 / 100
EQUIPMENT TYPE:	LOADER	SYSTEM VOLUME:	20 L
MACHINE ID:	x1111	FLUID TYPE:	
FILTER ID:		CITGO AW 46	
		ANALYSIS PERFORMED:	AI-RSTV4 (W)

AUTOMATIC PARTICLE COUNT SUMMARY

Size	Counts per ml.	Cleanliness Code
> 2 µm	303242.0	
> 5 µm	34434.0	
> 10 µm	2342.0	26/22/14
> 15 µm	154.0	
> 25 µm	17.0	
> 50 µm	1.0	

FREE WATER PRESENT

☐ YES
☒ NO

ISO CHART

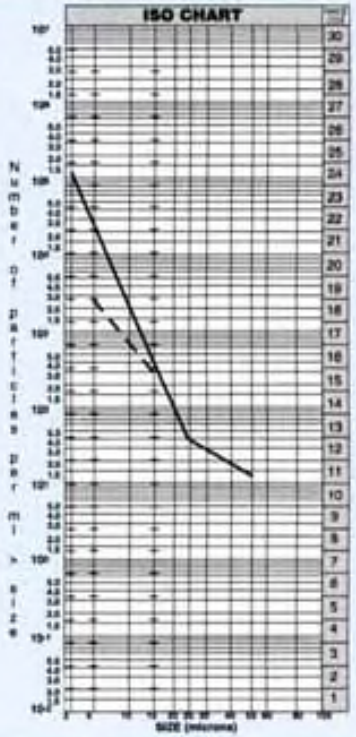
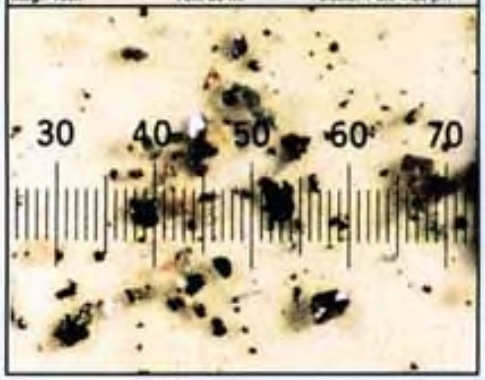


PHOTO ANALYSIS

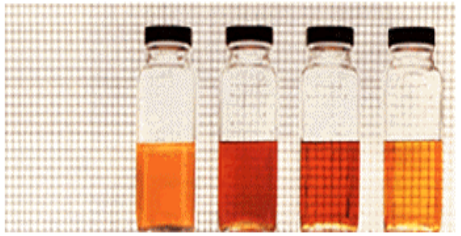
Mag.: 100x Vol.: 20 ml Scale: 1 div = 20 µm



REMARKS

WARNING

1. The recommended CLEANLINESS Code is not met. Clean-up maintenance may be warrant.
2. Dotted graph line indicates recommended ISO Code level.



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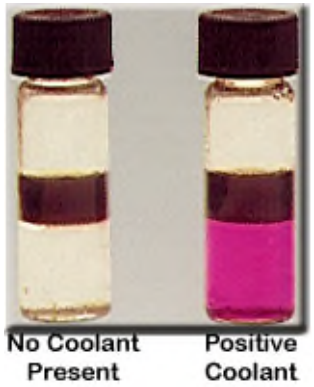
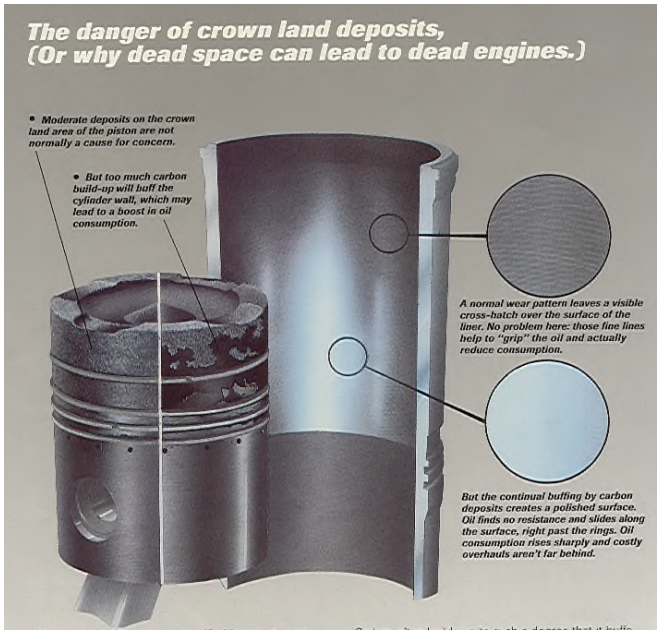
Detecting/measuring oil contamination: Oil Analysis; Engines, Viscosity, Soot, Dirt, Fuel, Coolant, and (Water -not so much)





Lubricant contamination control program: Approach

Controlling lubricant contamination is not a singular event!

Problem: people that don't know advising/suppling "so called" lubrication solutions!

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How can you protect your equipment and production? 1: Storage / Protection

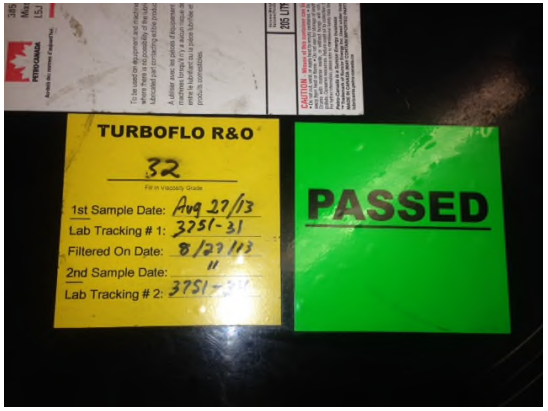







1: Clean dry storage, 2: Only stock levels required, (Consolidation), 3: First in, First out (FIFO) 4: Controlled access

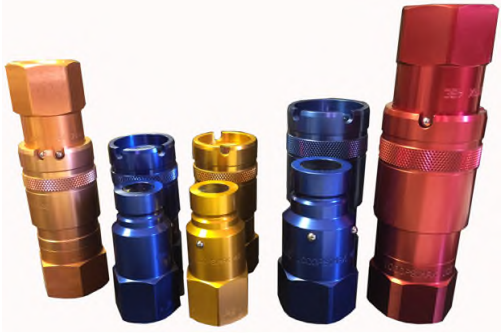
How can you protect your equipment and production? 1: Storage Lubricant ID



Colour	Oils	40°c	100°c
BLUE	Mobil Delvac 15W40	110	14.65
TAN	Mobil DTE FM 32	32	
BLACK	Mobil SHC 824	32	
ORANGE	Mobil DTE 10 Excel 46	46	
Army Green	Mobil DTE Heavy Oil	100	
YELLOW	Mobil SHC Gear 220	220	
PURPLE	Mobil SHC 524	32	
GREEN	Mobil SHC 624	32	
GREY	Mobil SHC 626	46	
RED	Mobil SHC 630	220	
BROWN	Mobil SHC 634	460	
GOLD	Mobil Hydraul 56	53	
	Mobil SHC 629	150	
	Mobil SHC 632	320	
	Mobil SHC 825	42	
YELLOW	Mobil SHC Gear 150		
YELLOW	Mobil SHC Gear 320		
	Quin Syn Plus	46	

150	320

	Grease	NLGI	40°c	Thickner	Colour/Grease	
BLACK	Mobilgrease 28	1 to 2	30	PAO/Clay	Drk RED	Aviation
RED	Mobilith SHC 100	2	100	LI Comp	RED	
BLUE	Mobil Polyrex EM	2	115	Polyurea	BLUE	
PURPLE	Mobilith SHC 220	2	220	LI Comp	RED	
YELLOW	Mobiltemp 2	2	460	Clay	AMBER	Moly/Disl
	Mobilith SHC 007	0	460	Lithium	RED	



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MADE IN CANADA
FABRIQUÉ AU CANADA

How can you protect your equipment and production? 2: Filtered Dispensing; Drums/pails

1. Dispense from Delivered Container
2. Two Stage: Water and Particulates
3. Recirculation Plumbing
4. Drum Wand Seals to Drum
5. Air Breather Filter on Drum
6. “Trigger” Control Valve
7. Quick Coupler Container Fill
8. Colour Coded for Oil Type

We have portable units for mobile service trucks in design and in field testing

How can you protect your equipment and production? 2: Filtered Dispensing; Totes

1. Dispense from Delivered Container
2. Two Stage: Water and Particulates
3. Recirculation Plumbing
4. Drum Wand Seals to Drum
5. Air Breather Filter on Drum
6. “Trigger” Control Valve
7. Quick Coupler Container Fill

We have proper bench tanks in design and in field testing

3: How can you protect your equipment and production? 2: Tank Dispensing Systems

1. Space Saving Requirement
2. Pump/Filter for Each Tank.
3. Two Stage: Water and Particulates
4. Fill and Recirculation Plumbing
5. Drum Wand for Each Tank and it Seals to Drum
6. Air Breather Filter on Drum wand and on Tanks
7. “Trigger” Control Valve
8. Quick Coupler Container Fill
9. Container Fill Tray
10. Tanks/Control Valves, Switches, Drum Wand match COLOUR CODING of Top Up Containers

We have steel units for plant use in design being field tested

3: How can you protect your equipment and production? 2: Filtered Dispensing; Portable

1. Dispense from Delivered Container
2. Two Stage: Water and Particulates
3. Recirculation Plumbing
4. Drum Wand Seals to Drum
5. Air Breather Filter on Drum
6. “Trigger” Control Valve
7. Quick Coupler Closed Fill
8. Colour Coded for Oil Type

We have steel units for mobile service trucks in design being field tested.

3: How can you protect your equipment and production? 2: Filtered Dispensing; Portable

1. **Gear Oil Reclamation**
2. Two Stage: Water and Particulates
3. Recirculation Plumbing
4. Drum Wand Seals to Drum
5. Air Breather Filter on Drum
6. “Trigger” Control Valve
7. Quick Coupler Closed Fill
8. Colour Coded for Oil Type

We have steel units for mobile service trucks in design and being field tested

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3: How can you protect your equipment and production? 3: Top Up Containers: 3 Suppliers

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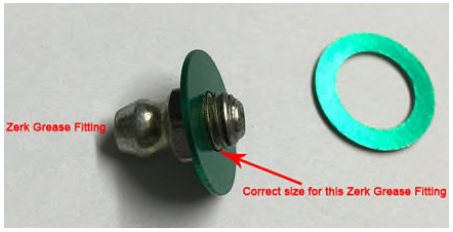
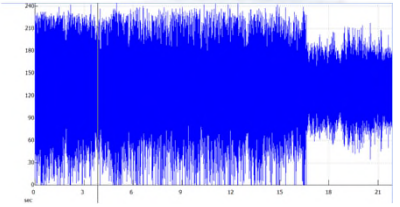
3: How can you protect your equipment and production? 4: Insertion: Grease





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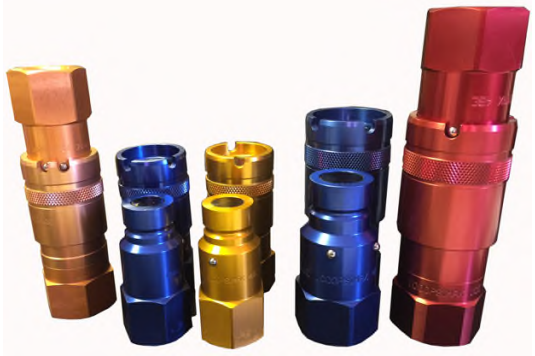
3: How can you protect your equipment and production? 4: Oil Level Determination

3: How can you protect your equipment and production? 4: CLOSED Insertion

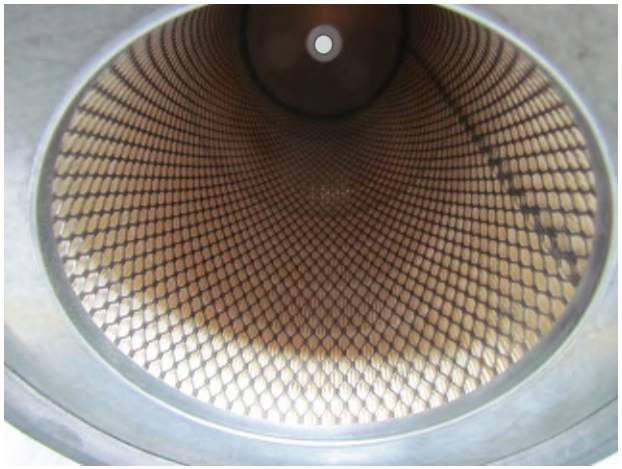
1. Contamination Control Closed oil fill Fittings
2. Place to insert oil, hold air breather and colour coded for oil type and or tagged



3: How can you protect your equipment and production? 5: Oil In Service: Prevention!

Nothing coarser then 3µm
Air breather filters:
Engines, transmissions, differentials , hydraulics, fuel tanks, drums, pails.

Caution: If desiccant air breathers filters are used in the wrong application there is a potential for component failure!



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If you can't prevent contamination, you must remove it! Oil Change or Filtration
If you want to extend oil changes, you need additional filtration and oil analysis!

How can you protect your equipment and production? 5: Oil In Service: L.C. Removal

Filter um Rating (B = 1000)	Typical ISO 4406 Cleanliness Code
1	12/10/07 - 14/12/10
3	14/12/10 - 16/14/12
6	16/14/12 - 17/16/13
12	17/16/13 - 19/17/14
25	19/17/14 - 21/19/17

Beta Ratio (ß)	How Many Particles of a Given Size Will Pass Through the Filter?	Actual Filter Efficiency
2	1 out of every 2 particles	50%
10	1 out of every 10 particles	90%
20	1 out of every 20 particles	95%
75	1 out of every 75 particles	98.67%
100	1 out of every 100 particles	99%
200	1 out of every 200 particles	99.5%
1000	1 out of every 1000 particles	99.9%
2000	1 out of every 2000 particles	99.95%

3: How can you protect your equipment and production? Summation

Only you can protect your lubricants/equipment: PEOPLE

Train to change awareness for everyone involved!

The right PROCESS must be in place: Contamination control is NOT a singular task!

Corporate, Plant, Site, Department or Area Lubrication Policy (move from reactive to proactive)

Oil Analysis: 3 Parts: Contamination, Oil Condition and (Wear Generation - *the "end result")*

The right PRODUCTS must be used!

Just because someone thought, it might be "best practices", does not mean it works in the field!

Understand the scope of the requirement, source systems/products that meet long term objectives.

Seek advice, educate yourself, to make proactive decisions!

3 P's : People - Process - Products

Proactive Lube Manager Inc.

- Formed in March 2000, after being in the oil analysis business for 15 years. (for over 32 years in total)
- Determined that existing lubrication handling equipment, did not control contamination.
- Started to design and manufacture filter carts, including dispensing systems in 2001.
- Started to “up-fit” Oil Safe Containers in 2003, to control contamination.
- Audited, consulted and trained, across multiple industries.
- Provides complete turnkey lube rooms and buildings.
- Provides complete contamination control process for lubricant handling.
- Moved the business to Thorsby AB in 2011, from Niagara Falls.
- Opened larger shop in Aug 2016.
- Continually designing field based lubrication solutions.

3 P’s : People - Process - Products