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(PROVISIONAL VERSION)

Presented By - MMI

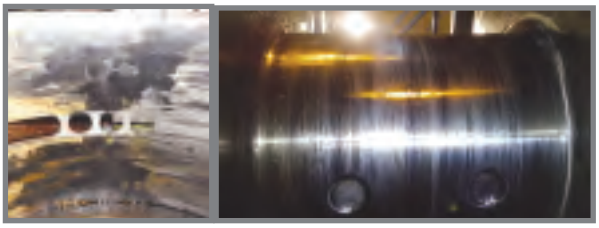
ENGINE OIL PURIFICATION

Efficient Cleaning
| Increased Reliability | Reduced Downtime | Less Spare Consumption | Lower Operating Cost

OIL CLEANLINESS AND ENGINE RELIABILITY

Engine oil plays the most vital role in continuous and smooth engine operation. Ensuring its cleanliness should get the highest priority. Without oil an engine will not turn as built-in protection system will resist it. Naturally, **NO TURN NO HARM** to the engine. But when the oil contains highly abrasive solids like wear debris, soot, airborne grit, dirt, and spent additives, then the oil is harmful for engines instead of caring. The dirty oil can not give the required level of protection and it becomes a silent engine killer, performs its killing jobs staying beyond detection.

The reason is that, we do not have any built-in wear and corrosion detection system in engine that will monitor the cleanliness of lubrication system and warn us about oil dirtiness. Yes, after RCA (Root Cause Analysis) we discover that the oil dirtiness was mainly responsible for this catastrophic disaster but at that time engine has already lost its one or more limbs and incapable of delivering power. Definitely a big cost is involved in parts or sometimes entire engine replacement.



A burnt bearing shell (left) and severely damaged crank-pin (right) because of lubrication failure

Do we really think about the impacts of dirty engine oil as much we do for engine coolant?
The damaging effects of coolant are chronic and get sufficient time to come in attention but the damaging effects of dirty engine oil are instenteneous, catastrophic and most of the time remain undetected until a critical component failure

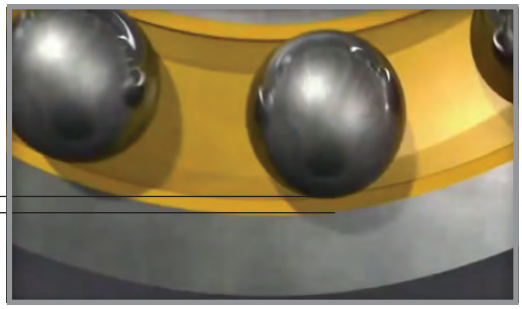
WHY WE NEED AN EFFICIENT OIL CLEANING SYSTEM?

Lubricating oil, a specially formulated blend of **base oil** and oil solube **additives** that acts as the blood stream of an engine. It plays the most critical role on reliable engine operation and ensuring extended service life of engines by protecting its components. As long as the blood is clean, it efficiently protects interacting surfaces but when get contaminated by foreign particles, it looses its performance, causes accelerated wear and corrosion in critical engine components.

A fixed volume of oil in the lube circuit, continuously exposing to contaminants, protecting engine components, loosing their effectiveness over time and getting dirty. To restore the efficiency, the oil demands an efficient cleaning. As we cannot operate an engine without allowing the ingression of some abrasive solids to the system but we can control their accumulation rate by installing correct cleaning tools in lube circuit. If we do not remove contaminants continuously from the oil stream, they will keep accumulating in the oil stream and gradually the oil gets dirty and incompatible with the engine. Runing an engine allowing this codition will certainly fail with a catastrophic disaster.

ENGINE PARTS REQUIRE LUBRICATION

- Piston Motion in Cylinder
- Crankshaft Rotation in Bearings
- Camshaft Rotation in Cam Bearings
- Piston Pin Rotation in Small End Bearings
- Cam Lobes Sliding Over V/V Rods
- Cam Lobes Sliding Over HP Fuel P/P Roller
- Intermediate Gears
- Turbocharger Bearings
- Pedestal Bearings
- Reciprocating Motion of V/V Stems
- Rocker Arm Shaft & Tips
- Individual High Pressure P/P



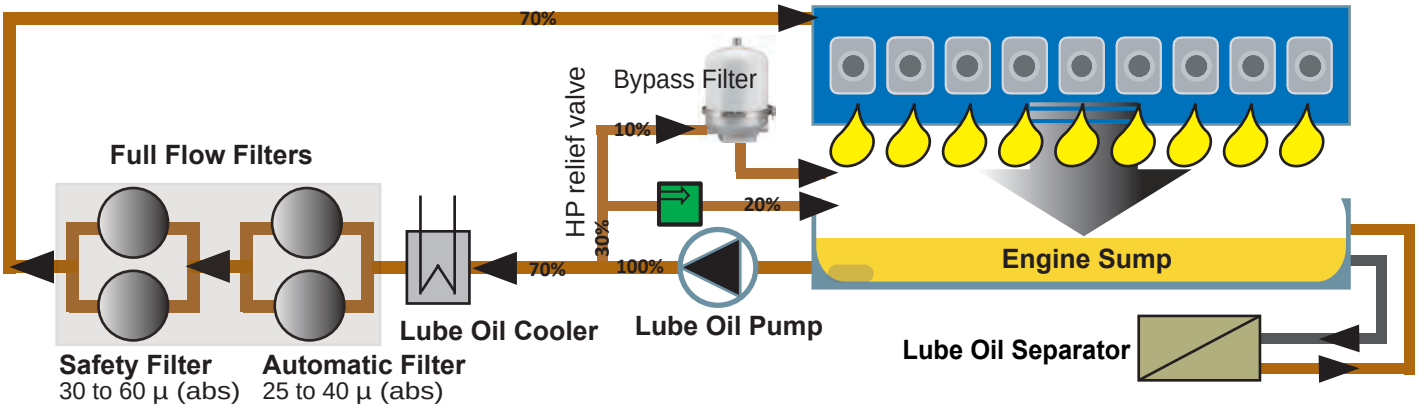
Particles larger than the critical film thickness when enter between two interacting surfaces initiate fatigue wear

CRITICAL OIL FILM THICKNESS

Engine Parts	Thickness (µm)
Piston Rings / Liner	0.3 - 7
Rod / Bearings	0.5 - 20
Crankshaft / Bearings	0.8 - 50
Turbocharger Bearings	0.5 - 20
Piston Pin Bushing	0.5 - 15
Valve Train	0 - 1.0
Gearing	0 - 1.5

TYPICAL LUBE OIL CIRCUIT AND ASSOCIATED EQUIPMENTS IN ENGINE

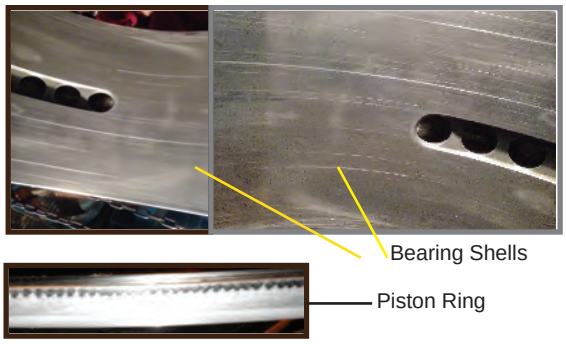
The diagram is only for illustration. based on engine brand and model the circuit may be different



- Built-in lube oil cleaning tools are intended to ensure basic protection to engines while running, not designed for complete protection.
- Approx 70% of total flow capacity of the engine driven lube oil pump is used by the engine. Remaining 30% is bypassed to the sump

SOURCES OF CONTAMINANTS AND THEIR DETRIMENTAL EFFECTS

Solid Contaminants	Primary Sources	Detrimental Effects
Metalic particles	Wear in engine components	Abrasion, fatigue, oil breakdown
Metal oxides	Engine wear and corrosion	Abrasion and fatigue corrosion
Airborn grit, sand & dust	Intake air and combustion blowby	Abrasion and fatigue
Catalytic fines	From fuel contamination	Abrasion and fatigue
Carbon soot	Combustion blowby	Lubricant breakdown & wear
Liquid & Gaseous Types	**Primary Sources**	**Detrimental Effects**
Fuel	Fuel P/P, combustion blowby	Lubricants breakdown
Water	Cylinder head and liner	Oil breakdown and corrosion
Acids	Combustion blowby and oxidation	Corrosion
Exhaust gases	Combustion blowby	Lubricant breakdown



Ditches and scratches on lubricated surfaces indicate the presence solids in circulating oil. Piston rings & liner surface severely affected by solids

TYPICAL CONTAMINANTS CONTROL GUARDS IN ENGINE LUBE OIL SYSTEM

Depending on engine brand, model, capacity and nature of contamination lube purification circuit, arrangements of its elements and their specifications are different but the objectives are same, efficiently and continuously removal of contaminants from oil stream so that they cannot do any further harm to the engine as long as it is running.

cleanable wire mesh & disposable filters used as full flow filters

1.0 FULL FLOW FILTERS

- Filters are directly mounted on main lube circuit
- Disposable types (made of paper/synthetic material) or cleanable wire mesh
- Mesh size to be small enough to trap all harmful tiny particles from oil stream
- Pressure drop across filters to be as minimum as possible to ensure sufficient oil flow to the system
- Smaller the mesh size, better filtration efficiency but larger the pressure drop.
- Considering the both opposing constraints OEM's recommend full flow filters mesh size 20 to 80µ depending on engine brand, model and capacity.

2.0 LUBE OIL SEPARATOR

We have a strong belief on lube oil separator that once oil passing through separator is being completely clean.

Motor Driven Centrifuge

In large engines both Gas and Diesel, Motor Driven Centrifuge (MDC) is a built-in lube purification system continuously takes oil from engine sump and return back to the sump after centrifugation. This unit is mainly separating water and other solids from oil stream which easily pass through full flow filters. These types of centrifuges remove particles down to 15µ efficiently where 83% of particles present in used engine oil are 5µ or smaller in size. Hence, another powerful tool is required to remove these harmful fine particles.

3.0 BY-PASS FILTRATION

- This is the most efficient method for removal of tiny abrasive solids from oil stream but strongly depends on selection of correct tools for bypass filtration system
- Absorptive types filters can remove particles typically 10µm in size but demands frequent replacement
- Oil Cleaning Centrifuge utilizes unused energy from pressurized oil flowing through bypass line to operate itself and traps the finest abrasive solids from oil stream by generating a centrifugal force 2500 times larger than gravity force. Thus keeping lubrication system and associated components clean, ensuring efficient and reliable operation

Centrifuges remove particles by weight instead of size. Thats why it not only trapping large particles but also very fine particles (like soot) even down to 0.1µ in size. Research shows 83% of solid particles present in used engine oil are 5µ or less and 31% are less than 1µ in size. Oil additives are unaffected and remain active. Without an oil cleaning centrifuge almost all these tiny particles easily pass through built-in full flow filter and typical by-pass filter and get back into the engine and increase engine wear.

SELECTION CRITERIA FOR OIL CLEANING CENTRIFUGE

- The centrifuge capacity should be selected based on contaminant loads on the lube oil system. There should have a balance between the rate of generation solids and the rate of their removals
- The TURN RATE (How many times the entire sump oil is being centrifuged within 1 hour, Turns/Hour) should be as max as possible. Because higher the Turn Rate, greater the chance of solids coming under centrifugation and higher the dirt removal efficiency.
- Higher the engine displacement volume, greater the contaminants load, larger centrifugation rate is required
- Larger the sump capacity, larger centrifugation rate is required to remove wear debris, soot and dirt from large amount of oil.

HOW SOLIDS AFFECTING ENGINE PERFORMANCE?

Oil Breakdown:

Presence of solids (metal particles, soot, dirt and other spent additives) in circulating oil under pressure and temperature severely damage lubricants base oil and additives as metalic balls in rotary ball mill crushes clincker to produce cement

Increase Wear Rate:

Metalic particles generated from wear are worked hardned and much harder than base metals. As a result, wear particles, sizes larger than critical oil film thickness when enter between two interacting surfaces, begin their micro-machining operation on metal surfaces as like cutting tools in lathe machines. These types of abrasive wears induce premature component failures in engine / equipments under lubrication.

Responsible for lube oil starvation:

Excessive solids in circulating oil causes deposite and lacquer formation in various components (especially where oil flow and pressure are relatively low), blockage small orifices intended to lubricate critical components. Insufficient supply of oil causes lube oil starvation and catastrophic disasters in short time

Responsible for lubrication failure:

- More abrasives in circulating oil produces more friction betwewn interacting surfaces. Friction generates heat , causes temperature rise at the contact zone.
- As temperature increases, the oil viscosity reduces followed by reduction of critical oil film thickness that keeps two moving surfaces apart from each other
- The thin film between too moving surfaces fails to keep them apart from each other and causes direct metal to metal contact and increase more friction
- Equipment running under this condition results rapid rise in temperature at the contact zone which is high enough to evaporate all oil from that location and its surroundings. The final result is a catastrophic component failures or permanent breakdown in engine.

MINERAL VS SYNTHETIC OIL- HOW STRONG AGAINST ABRASIVE SOLIDS?

-Less molecular uniformity
-Low viscosity index
-Produced from crude oil
-Low resistance to oxidation and biodegradability

Molecular distribution in MINERAL base oil is analogous to naturally formed stones with less uniformity in sizes and shapes. Mineral oils are relatively weak to withstand the impacts of solids

-High molecular uniformity
-High viscosity index
-Synthesized from hydrocarbon
-High resistance to oxidation and biodegradability

Conversely the molecular distribution in SYNTHETIC base oil is analogous to artificially synthesized teflon balls with high uniformity in sizes & shapes. Synthetic oils are relatively strong to withstand the impacts of solids.

Are we really concern about our lube purification?
Do we ever feel to check whether our purifiers are working efficiently or not?
Do we really think about the impacts of dirty engine oil as much we do for engine coolant?

The damaging effects of coolant are chronic and get enough time to come in attention but the detrimental impacts of dirty engine oil are instenteneous, catastrophic and most of the time remain undetected until a critical component failure