



Operating Conditions that shorten Gas Engine Oil Life

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Benefits Statement

Going by Petrosave Laboratory oil analysis database information accumulated over the years, from analyzing oil samples from well over 500 Gas Engines comprising different brands, operating at remarkably different locations and subjected to varying loads, loading procedures and all sorts of operational/maintenance practices; Gas Engine Oil life could span from **under 500 to > 8,000 Hours** depending on Oil quality, Oil Sump Capacity, Operating Loads and even consistence in keeping to OEM specified Oil Make-ups.


Situation

As one strategy to minimize running cost, it is the drive of every operator to safely extract the most hours during the life of the in-service oil. One Gas Engine OEM, in its service communications to users, recommended 2,000 Hours Oil Drain, however, strongly recommended the use of *Oil Analysis* to more appropriately determine oil change.

This presentation show cases different scenarios for which oil analysis reports produced widely different ODIs even for same Make/Model Gas Engines but operating in different Plants.





Case Study 1: Impact of Oil Make-up.

Earlier fresh oil analysis produced good results showing that quality Gas Engine Oil (GEO) was in use.

		Fresh Oil Analysis Report		
Client Information Company Name: OK Foods Ltd. Client Contact: Mangesh Vaidya Company Address: Near Guardian Newspaper Department: Maintenance (Power Plant) Off Apapa - Oshodi Expwy Mobile Phone No.: 08063365430 Isolo, Lagos Email Address: mangesh.vaidya@olamnet.com Date: 27-Jan-15				
Test	Units		OKF1: Fresh Oil Sample Drum Batch No. C4A0038 Sample Taken: <i>Jan. 26, 2015</i>	Mobil Pegasus 805 Website PDS Info
Color	Visual		Clear, Brown	NA
SAE Grade	-		40	40
Viscosity @ 40C	cSt		124.7	130.0
Viscosity @ 100C	cSt		13.2	13.5
Viscosity Index, VI	-		100	99
Specific Gravity [SG] @ 15C	kg/m ³		887	890
Total Base Number [TBN]	mgKOH/g		6.3	6.2
Total Acid Number [TAN]	mgKOH/g		0.3	0.3 *
Flash Point [ASTM D93 Closed Cup]	°C		220	262 #
Water	% vol		Nil	Nil
* Note the TAN level of fresh oil is not available as a Product Data Sheet (PDS) information. However, TAN = 0.3 is typical value, which has been measured at Petrosave Lab for several GEO samples, of authentic sources and correctly meeting other Mobil Pegasus 805 published oil parameters. # ASTM D92 Open Cup Method				
Comment(s) 1. In spite of some variations seen in the parameters reported above, it is safe to conclude that the fresh oil sample MEETS the product formulation properties of Mobil Pegasus 805.				


Case Study 1: Impact of Oil Make-up.

- Oil sampling intervals was shortened beginning with 50 Hrs to more closely track the degradation changes in that oil. Results trend confirmed recent observation that parameters such as - oil oxidation, TBN and TAN levels rapidly crossed threshold Limits while the remaining parameters such as Viscosity approached Warning.
- Engine Operators insisted that all running conditions particularly Load levels remained same.
- Investigation shifted to Oil Consumption with specific focus on oil make-up rate. Operators provided total Make-up oil since the last lubrication service and that figure was much smaller than the theoretically calculated Oil Make-up, using the OEM guide of **0.3g of oil per kWh**.


PetroSave Integrated Services Limited		Gas Engine Oil Analysis Report					
Client Information		Company Name: OK Foods Ltd. Company Address: Near Guardian Newspaper, Off Apapa - Oshodi Expwy, Isolo, Lagos		Client Contact: Mangesh Vaidya Department: Maintenance (Power Plant) Mobile Phone No.: 08063365430 Email Address: mangesh.vaidya@olamnet.com Equipment Operator/Driver: -			
Equipment Information		Equipment Type: Gas Engine Generator [1.4 MW] Equipment ID Ref: Gas Gen #1 [Engine S/N: 1044867] Equipment Make: JENBACHER Equipment Year of Manufacture: 2012 Equipment Location: OK Foods 1, Guardian		Component: Engine Make/Type: JENBACHER / J420GS Lube Oil in use: Mobil Pegasus 805 Oil Brand: Mobil Oil Weight: SAE 40			
	Fresh Oil Sample	Condemning Limit	Used Oil Samples - Trend of Actual Laboratory Tests				Condition  OK  Caution  Critical
			08 March 2015 4502CKF1/00G#1/05	27 March 2015 4718CKF1/00G#1/06	20 April 2015 4813CKF1/00G#1/07	04 May 2015 4916CKF1/00G#1/08	
Engine Operating Hours							
	Oil Sample [Hrs]	0	1,059	50	430	743	792
	Cumm. Engine [Hrs]	-	16,903	17,320	17,700	18,013	18,062
Lube Oil Properties							
	Color [Clear, Turbid or Dark]	Clear	Dark	Dark	Dark	Dark	Dark
	Viscosity @ 40C [cSt]	125.8	148.3	130.6	139.1	142.4	143.4
	Viscosity @ 100C [cSt]	13.2	14.8	13.6	14.3	14.4	14.5
	TBN [mgKOH/g]	6.2	2.8	5.7	4.1	3.4	3.3
	TAN [mgKOH/g]	0.3	2.9	0.8	2.2	3.1	3.3
	Soot [%]	0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Nitration [A/cm]	0	9.8	2.5	3.6	6.5	6.6
	Oxidation [N/cm]	0	6.3	0	3	4.4	4.8
	Water in Oil [%]	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Glycol [%]	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Elemental Analysis							
Wear Metals							
	Aluminum, Al [ppm]	0	0	0	0	0	2
	Copper, Cu [ppm]	0	0	0	0	0	0
	Chromium, Cr [ppm]	0	0	0	0	0	0
	Lead, Pb [ppm]	0	0	0	0	0	0
	Iron, Fe [ppm]	0	0	0	0	0	0
	Tin, Sn [ppm]	0	0	0	0	0	0
Contaminant Metals							
	Silicon, Si [ppm]	0	0	0	0	0	0
	Sodium, Na [ppm]	0	6	0	0	0	0
	Potassium, K [ppm]	0	0	0	0	0	0
Additive Metal							
	Molybdenum [ppm]	0	0	0	0	0	0
Diagnostics:							
Low TBN - causes include Over-extended oil drain intervals, Excessive blowby, Insufficient additive package, Overheating							
High TAN - causes include increased acid level in natural gas engine oil							
Service Engineer's Comment:							
Lubrication Service is advised. Subsequent oil sampling/analysis to monitor trend.							

Case Study 1: Impact of Oil Make-up.

- Root cause investigation to resolve the difference revealed that the **automatic oil make-up mechanism became faulty and was shut-off while Operators decided on manual oil top-up**, which was inefficient.
- While that incident lasted, self-help initiatives by shift supervisors to push oil life >1,000 Hours produced alerts of abnormal wear rates and rapid oil degradation requiring Lubrication Service.



Gas Engine Oil Analysis Report



Client Information

Company Name: **OK Foods Ltd.**
 Company Address: **Near Guardian Newspaper
 Off Apapa - Oshodi Expwy
 Isolo, Lagos**

Equipment Information

Equipment Type: **Gas Engine Generator [1.4 MW]**
 Equipment ID Ref: **Gas Gen #1 [Engine S/N: 1044887]**
 Equipment Make: **JENBACHER**
 Equipment Year of Manufacture: **2012**
 Equipment Location: **OK Foods 1, Guardian**

Client Contact: **Mangesh Vaidya**
 Department: **Maintenance (Power Plant)**
 Mobile Phone No.: **08063365430**
 Email Address: **mangesh.vaidya@olamnet.com**
 Equipment Operator/Driver: **-**

Component: **Engine**
 Make/Type: **JENBACHER / J420GS**
 Lube Oil in use: **Mobil Pegasus 805**
 Oil Brand: **Mobil**
 Oil Weight: **SAE 40**

	Fresh Oil Sample	Condensing Limit	Used Oil Samples - Trend of Actual Laboratory Tests					Condition
			06 May 2015 4922/OKF1/GG#1/09	15 May 2015 4984/OKF1/GG#1/10	08 June 2015 5085/OKF1/GG#1/11	25 June 2015 5189/OKF1/GG#1/12	10 July 2015 5297/OKF1/GG#1/13	
Engine Operating Hours								
Oil Sample [Hrs]	0	-	792	58	625	996	1,330	
Cumm. Engine [Hrs]	-	-	18,062	18,200	18,767	19,138	19,472	
Lube Oil Properties								
Color [Clear, Turbid or Dark]	Clear		Dark	Dark	Dark	Dark	Dark	
Viscosity @ 40C [cSt]	125.8	± 25%	143.4	129.9	137.1	142.3	137.5	●
Viscosity @ 100C [cSt]	13.2	± 4%	14.5	13.5	14.1	14.4	14.1	●
TBN [mgKOH/g]	6.2	3.1	3.3	6.0	4.4	3.7	3.2	●
TAN [mgKOH/g]	0.3	+ 2.5	3.3	0.5	2.1	2.5	3.2	●
Soot [%]	0%	2%	0.0%	0.0%	0.0%	0.0%	0.0%	●
Nitration [A/cm]	0	20	6.6	0	2.4	4.7	9.8	●
Oxidation [A/cm]	0	20	4.8	0	2.6	4	5.3	●
Water in Oil [%]	0.00%	0.20%	0.00%	0.00%	0.00%	0.00%	0.00%	●
Glycol [%]	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	●
Elemental Analysis								
Wear Metals								
Aluminum, Al [ppm]	0	15	2	2	3	4	4	●
Copper, Cu [ppm]	0	15	0	0	4	0	0	●
Chromium, Cr [ppm]	0	5	0	0	0	0	0	●
Lead, Pb [ppm]	0	20	0	0	0	0	0	●
Iron, Fe [ppm]	0	20	0	0	0	0	0	●
Tin, Sn [ppm]	0	5	0	0	0	0	0	●
Contaminant Metals								
Silicon, Si [ppm]	0	20	0	0	0	0	0	●
Sodium, Na [ppm]	0	20	0	0	0	0	0	●
Potassium, K [ppm]	0	5	0	0	0	0	0	●
Additive Metal								
Molybdenum [ppm]	0	10	0	0	0	0	0	●



Diagnostics:
 High TAN - causes include increased acid level in natural gas engine oil
 Low TBN - causes include Over-extended oil drain intervals, Excessive blowby, Insufficient additive package, Overheating

Service Engineer's Comment:
In-service oil has served out its useful life; Lubrication Service advised. Next 250 Hrs oil sampling/analysis to monitor trend.

Case Study 1: Impact of Oil Make-up.

Manually topping up a gas engine running 24/7 across shifts by different operators has its setbacks.

Fortunately the Company Management reviewed the situation and the **faulty Automatic Oil Make-up was replaced. Oil Drain Interval gradually reverted to > 2,000 Hours service life.**

		Gas Engine Oil Analysis Report 						
Client Information Company Name: OK Foods Ltd. Company Address: Near Guardian Newspaper, Off Apapa - Oshodi Expwy, Isoto, Lagos		Client Contact: Mangesh Vaidya Department: Maintenance (Power Plant) Mobile Phone No.: 08063365430 Email Address: mangesh.vaidya@olamnet.com Equipment Operator/Driver: -		Component: Engine Make/Type: JENBACHER / J420GS Lube Oil in use: Mobil Pegasus 805 Oil Brand: Mobil Oil Weight: SAE 40				
Equipment Information Equipment Type: Gas Engine Generator [1.4 MW] Equipment ID Ref: Gas Gen #1 [Engine S/N: 1044887] Equipment Make: JENBACHER Equipment Year of Manufacture: 2012 Equipment Location: OK Foods 1, Guardian								
		Used Oil Samples - Trend of Actual Laboratory Tests					Condition	
	Fresh Oil Sample	Condensing Limit	08 December 2015 5995/OKF1/03#1/20	11 January 2016 6109/OKF1/03#1/21	29 January 2016 6217/OKF1/03#1/22	02 March 2016 6377/OKF1/03#1/23	08 March 2016 6400/OKF1/03#1/24	● OK ● Caution ● Critical
Engine Operating Hours								
Oil Sample [Hrs]	0	-	1,020	1,554	1,949	472	606	
Cumm. Engine [Hrs]	-	-	22,561	23,095	23,490	24,163	24,297	
Lube Oil Properties								
Color [Clear, Turbid or Dark]	Clear		Dark	Dark	Dark	Dark	Dark	
Viscosity @ 40C [cSt]	125.8	+ 25%	137	138.8	143.7	135.2	135.7	●
Viscosity @ 100C [cSt]	13.2	± +3	14.1	14.2	14.5	13.9	14.0	●
TBN [mgKOH/g]	6.2	3.1	4.6	4.0	3.9	5.3	5.1	●
TAN [mgKOH/g]	0.3	+ 2.5	2.1	2.1	2.3	1.6	1.7	●
Soot [%]	0%	2%	0.0%	0.0%	0.0%	0.0%	0.0%	●
Nitration [A/cm]	0	20	0	2.4	3.3	1.4	1.7	●
Oxidation [A/cm]	0	20	2.9	4.3	4.6	0	2.4	●
Water in Oil [%]	0.00%	0.20%	0.00%	0.00%	0.00%	0.00%	0.00%	●
Glycol [%]	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	●
Elemental Analysis								
Wear Metals								
Aluminum, Al [ppm]	0	15	0	0	0	0	0	●
Copper, Cu [ppm]	0	15	0	0	0	0	0	●
Chromium, Cr [ppm]	0	5	0	0	0	4	3	●
Lead, Pb [ppm]	0	20	0	0	0	0	0	●
Iron, Fe [ppm]	0	20	0	0	0	0	0	●
Tin, Sn [ppm]	0	5	3	0	0	2	0	●
Contaminant Metals								
Silicon, Si [ppm]	0	20	0	0	0	0	0	●
Sodium, Na [ppm]	0	20	0	0	2	0	0	●
Potassium, K [ppm]	0	5	0	0	0	0	0	●
Additive Metal								
Molybdenum [ppm]	0	10	0	0	0	0	0	●
Diagnosics: No alert seen.								
Service Engineer's Comment: All engine wear rates within normal limits. Oil is ok for continued use. Next 500 Hrs oil sampling/analysis to monitor trend.								

Case Study 2: Lubrication Service
 – Impact of Partial Drain

First 500 Hrs oil sample taken after Lubrication Service revealed that remaining oil life was less than 40%. Initial thoughts were that operators were only carry out “oil sweetening”, a common practice of combining partial drain-out and oil make-up in order to manage limited oil stock; to keep engine safe and running pending when adequate oil replenishment stock is received to enable full lubrication service.

When the operators informed otherwise, root cause investigations driven by oil analysis commenced, and fortunately was quick to connect oil analysis observation to the amount of oil used during Lubrication Service.



Gas Engine Oil Analysis Report



Client Information

Company Name: Contour Global Solutions Nigeria
 Company Address: 1st Floor, East Wing, City Hall, 23 - 25, Catholic Mission Street, Lagos Island, Lagos, Nigeria

Client Contacts: Anthony Ornuwgbuzie
 Department: Service - Power Generation
 Mobile Phone No.: 08079391308
 Email Address: <anthony.ornuwgbuzie@contourglobal.com>

Equipment Operator/Driver: -

Equipment Information

Equipment Type: Gas Engine Generator [1180 KW]
 Equipment ID Ref: Gen #3 [S/N 33180429]
 Equipment Make: Cummins
 Equipment Year of Manufacture: 2010
 Equipment Location: NBC Plant, Benin

Component: Engine
 Make/Model: Cummins / GQSK80-G4
 Lube Oil in use: Valvoline Premium Blue GEO LA40
 Oil Brand: Ashland
 Oil Weight: SAE 40

	Fresh Oil Sample	Conditioning Limit	Used Oil Samples - Trend of Actual Laboratory Tests					Condition
			20 September 2013 1825/ContourG/Gen#3/12	14 December 2013 2128/ContourG/Gen#3/13	20 April 2014 2694/ContourG/Gen#3/14	09 June 2014 2854/ContourG/Gen#3/15	22 July 2015 5354/ContourG/Gen#3/16	
Turbine Operating Hours								
Oil Sample [Hrs]	0	-	1,000	500	500	1,500	1,000	OK
Cumm. Gas Engine [Hrs]	0	-	12,947	14,949	xxxxx	xxxxx	27,097	OK
Lube Oil Properties								
Appearance [Clear, Turbid, Dark]	Clear		Dark	Dark	Dark	Dark	Dark	OK
Viscosity @ 40C [cSt]	119.7	+/-25%	169.1	170.8	139.5	162.4	150.3	Caution
Viscosity @ 100C [cSt]	12.8	+/-20%	16.2	16.4	14.2	15.8	15	Caution
TAN [mgKOH/g]	0.3	4	4.1	4.9	1.8	4.4	3.3	OK
TBN [mgKOH/g]	5.5	2.8	1.6	1.4	4.5	2.1	3.4	OK
Insolubles [%]	0%	1%	0.0%	0.0%	0.0%	0.0%	0.0%	OK
Nitration [A/cm]	0	25	23.5	15.2	0.0	17.2	11.6	OK
Oxidation [A/cm]	0	25	18.0	17.5	0.0	14.6	6.4	OK
Water in Oil [%]	0.0%	0.2%	0.0%	0.0%	0.1%	0.1%	0.2%	OK
Glycol [%]	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	OK
Elemental Analysis								
Wear Metals								
Iron, Fe [ppm]	0	20	0	4	0	0	3	OK
Chromium, Cr [ppm]	0	5	3	0	2	0	0	OK
Lead, Pb [ppm]	0	30	0	0	0	0	0	OK
Copper, Cu [ppm]	0	15	7	6	3	2	96	Caution
Tin, Sn [ppm]	0	10	2	0	0	0	0	OK
Aluminum, Al [ppm]	0	15	1	0	0	0	3	OK
Molybdenum, Mo [ppm]	0	10	0	0	0	0	0	OK
Additive Contaminant Metals								
Silicon, Si [ppm]	0	25	0	0	0	0	0	OK
Sodium, Na [ppm]	0	8	4	3	0	3	0	OK
Potassium, K [ppm]	0	10	0	0	0	0	9	Caution


Diagnostics:
 High Oil Viscosity - causes include Wrong top-up with thicker oil, High Oxidation, High Nitration, increased Contamination levels, High Insolubles, Volatilization of light-ends, Emulsified water (sludge)
 High Water Ingress - causes include leaks from Oil Cooler (leaking seals), improper storage, condensation from humid air in the oil reservoir, bearing pedestals
 High Level of Copper - causes include Bearings, Wrist Pin Bushings, Cam Bushings, Valve Train Bushings, Thrust Washers, Oil Coolers, Oil Pipings, Governors & Oil Pump, Oil Additives

Service Engineer's Comment:
 Cooling Water ingress is evidenced by "coolant marker" - Potassium at Caution Level. High Copper, occurring alone, may arise from Oil Cooler leaching. High Oil Viscosity is a product of water emulsifying oil. Urgent Maintenance action advised. Subsequent oil sampling/analysis to monitor trend.

Case Study 2: Lubrication Service
 – Impact of Partial Drain

1. Power Plant operators had a procedure to mechanical drain off oil using a transfer pump. It was important that oil change is done shortly after engine shutdown to ensure that particulate contaminants suspended in the oil are effectively removed before they have a chance to settle at obscure corners of the oil galleries & oil sump.
2. Safety consideration required that since the oil is still very much hot, pumping device should be used to accomplish this.
3. Dip level of the pipe coupled to the suction-side of the pump was wrongly positioned within the oil sump and that resulted to incomplete draining of the used oil.
4. Furthermore, without checking to ensure that the drained out oil roughly approximated to the oil sump capacity, operators proceeded to add fresh oil after replacing oil filters.


Such oil changes amount to partial drain which are flagged by oil analysis for rapid oil degradation.

PetroSave Integrated Services Limited		Gas Engine Oil Analysis Report						
Client Information		Company Name: Conour Global Solutions Nigeria 1st Floor, East Wing, City Hall 25 - 25, Catholic Mission Street Lagos Island Lagos, Nigeria		Client Contacts: Anthony Onwagbuzie Department: Service - Power Generation Mobile Phone No.: 0807 8391368 Email Address: <anthony.onwagbuzie@conourglobal.com>		Equipment Operator/Driver: -		
Equipment Information		Equipment Type: Gas Engine Generator (1160 KW) Equipment ID Ref: Gen #1 (S/N 32180303) Equipment Make: Cummins Equipment Year of Manufacture: 2010 Equipment Location: NBC Plaza, Benin		Component: Engine Make/Model: Cummins / COSK89-G4 Lube Oil in use: Valvoline Premium Blue GEO LA-40 Oil Brand: Ashland Oil Weight: SAE 40				
		Used Oil Samples - Trend of Actual Laboratory Tests					Condition	
	Fresh Oil Sample	Condemning Limit	08 August 2010 1675/ConourG/Gen#1/10	30 May 2014 2659/ConourG/Gen#1/03	27 March 2015 4774/ConourG/Gen#1/021	15 May 2015 5048/ConourG/Gen#1/022	21 July 2015 5332/ConourG/Gen#1/025	<div style="display: flex; justify-content: space-between;"> OK Caution Critical </div>
Turbine Operating Hours								
Oil Sample [Hrs]	0	-	500	1,500	XXXX.X	500	1,000	
Cumm. Gas Engine [Hrs]	0	-	11,024	XXXXX	XXXXX	XXXXX	27,270	
Lube Oil Properties								
Appearance (Clear, Turbid, Dark)	Clear		Dark	Dark	Dark	Dark	Dark	
Viscosity @ 40C [cSt]	119.7	4-25%	155.4	162.6	152	145.1	145.2	●
Viscosity @ 100C [cSt]	12.8	4-20%	15.3	15.8	15.1	14.7	14.6	●
TAN [mgKOH/g]	0.3	4	3.4	4.7	3.5	1.8	3	●
TBN [mgKOH/g]	5.5	2.8	3.2	2.2	2.3	2.6	3.6	●
Insolubles [%]	0%	1%	0.0%	0.0%	0.0%	0.0%	0.0%	●
Nitration [A/cm]	0	25	0.0	20.3	23.6	20.2	11.7	●
Oxidation [A/cm]	0	25	7.4	15.8	11.3	7.1	0.0	●
Water in Oil [%]	0.0%	0.2%	0.0%	0.0%	0.1%	0.1%	0.2%	●
Glycol [%]	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	●
Elemental Analysis								
Wear Metals								
Iron, Fe [ppm]	0	20	0	3	4	3	0	●
Chromium, Cr [ppm]	0	5	0	0	0	4	0	●
Lead, Pb [ppm]	0	30	0	0	0	0	0	●
Copper, Cu [ppm]	0	15	10	16	40	26	13	●
Tin, Sn [ppm]	0	10	0	0	0	0	3	●
Aluminum, Al [ppm]	0	15	0	0	0	3	2	●
Molybdenum, Mo [ppm]	0	10	0	0	0	5	0	●
Additive/Contaminant Metals								
Silicon, Si [ppm]	0	25	0	0	0	0	0	●
Sodium, Na [ppm]	0	8	9	7	0	18	4	●
Potassium, K [ppm]	0	10	2	0	0	18	3	●
Diagnosics:		Low TBN - causes include Over-extended oil drain intervals, Excessive blowby, Insufficient additive package, Overheating High Level of Copper - causes include Bearings, Wrist Pin Bushings, Cam Bushings, Valve Train Bushings, Thrust Washers, Oil Coolers, Oil Pipings, Governors & Oil Pump, Oil Additives High Level of Sodium - causes include Oil additive constituent, Coolant additive High Level of Potassium - cause include Coolant additive, Trace element in fuel						
Service Engineer's Comment:		Observe this gas engine for Cooling Water ingress; evidenced by "coolant markers" - Potassium and Sodium. High Copper may arise from Oil Cooler leaching Urgent Maintenance action advised. Subsequent oil sampling/analysis to monitor trend.						

Case Study 4: Constant Production Load
 – Impact of Higher Engine Capacity

Background

1. Pasta Plant factory with operational load averaging 1,500 kW
 2. Powered by either of two(2) GEJ Gas Engines
 - J612G (1.8kW capacity) &
 - J620G (3.0 kW capacity).
 3. One Gas Engine runs at a time. The gas engines are run in alternating order.
 4. Oil change is determined by oil analysis.
- **Oil Drain Interval for the J612G averages 1,000 to <2,000 Hrs**

PetroSave Integrated Services Limited		Gas Engine Oil Analysis Report						
Client Information								
Company Name:	Flour Mills Nig PLC	Client Contact:	Mr. Dimas Panagiotis					
Company Address:	Old Dock Road Apapa, Lagos	Department:	Power Plant					
		Mobile Phone No.:	08068289141					
		Email Address:	nydimas@yahoo.com					
		Equipment Operator/Driver:	-					
Equipment Information								
Equipment Type:	Gas Engine Generator	Component:	Engine					
Equipment ID Ref.:	Gen #1 (1.8 MW)	Make/Model:	J612G					
Equipment Make:	JENBACHER	Lube Oil in use:	Pegasus 808					
Equipment Year of Manufacture:	-	Oil Brand:	Mobil					
Equipment Location:	Golden Pasta Plant, Agbara	Oil Weight:	SAE 40					
Used Oil Samples - Trend of Actual Laboratory Tests								
	Fresh Oil Sample	Conditioning Limit	18 February 2016 6334/Agbara/GG#1/28	23 March 2016 6486/Agbara/GG#1/27	06 June 2016 6784/Agbara/GG#1/26	22 September 2016 7223/Agbara/GG#1/25	01 November 2016 7411/Agbara/GG#1/20	Condition
Engine Operating Hours								
Oil Sample [Hrs]	0	-	1,663	544	1,022	448	719	
Cumm. Engine [Hrs]	-	-	12,944	13,500	13,978	14,451	14,722	
Lube Oil Properties								
Appearance [Clear, Turbid, Dark]	Clear		Dark	Dark	Dark	Dark	Dark	
Viscosity @ 40C [cSt]	122.6	+ 25%	153.3	145.1	154	146.4	150.1	●
Viscosity @ 100C [cSt]	13	± +3	15.2	14.6	15.2	14.7	15.0	●
TAN [mgKOH/g]	0.3	+ 2.5	3.1	2.3	4.2	1.8	2.3	●
TBN [mgKOH/g]	6.2	3.1	2.4	3.8	2.6	4.3	3.4	●
Soot [%]	0%	2%	0.0%	0.0%	0.0%	0.0%	0.0%	●
Nitration [A/cm]	0	20	15.5	5.5	9.1	3.1	5.7	●
Oxidation [A/cm]	0	20	10.7	5.6	8.4	5.4	7.7	●
Water in Oil [%]	0.00%	0.20%	0.00%	0.00%	0.00%	0.00%	0.00%	●
Glycol [%]	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	●
Elemental Analysis								
Wear Metals								
Aluminum, Al [ppm]	0	15	0	0	3	0	0	●
Copper, Cu [ppm]	0	15	0	0	0	0	0	●
Chromium, Cr [ppm]	0	5	0	0	0	0	3	●
Lead, Pb [ppm]	0	20	0	0	0	0	0	●
Iron, Fe [ppm]	0	20	8	0	4	0	0	●
Tin, Sn [ppm]	0	5	4	0	0	0	0	●
Contaminant Metals								
Silicon, Si [ppm]	0	20	0	0	0	0	0	●
Sodium, Na [ppm]	0	20	0	0	0	0	3	●
Potassium, K [ppm]	0	5	0	0	0	0	0	●
Additive Metal								
Molybdenum [ppm]	0	10	0	0	0	0	0	●
Diagnostics: No critical alerts seen.								
Service Engineer's Comment: All engine wear rates normal. In-service GEO is approaching end of its useful service life; oil is ok for continued use. Next 260 Hrs oil sampling/analysis advised to determine if Lubrication Service is due.								

Case Study 4: Constant Production Load
 – Impact of Higher Engine Capacity


- Oil Drain Interval for the J620G averages >7,000 Hrs

		Used Oil Samples - Trend of Actual Laboratory Tests					Condition
		18 December 2015	19 January 2016	18 February 2016	23 March 2016	01 November 2016	OK Caution Critical
Client Information							
Company Name:	Flour Mills Nig PLC	Client Contact:					Mr. Dimas Panagiotis
Company Address:	Old Dock Road Apapa, Lagos	Department:					Power Plant
		Mobile Phone No.:					08058299141
		Email Address:					pydimas@yahoo.com
		Equipment Operator/Driver:					-
Equipment Information							
Equipment Type:	Gas Engine Generator	Component:					Engine
Equipment ID Ref:	Gen #2 (3.2 MW)	Make/Model:					J620GS
Equipment Make:	JENBACHER	Lube Oil in use:					Pegasus 805
Equipment Year of Manufacture:	-	Oil Brand:					Mobil
Equipment Location:	Golden Pasta Plant, Agbara	Oil Weight:					SAE 40
Engine Operating Hours							
Oil Sample [Hrs]	0	6,309	6,857	7,284	7,632	380	
Cumm. Engine [Hrs]	-	12,666	13,266	13,641	13,999	14,752	
Lube Oil Properties							
Appearance (Clear, Turbid, Dark)	Clear	Dark	Dark	Dark	Dark	Dark	
Viscosity @ 40C [cSt]	122.6	+ 25%	132.9	133.2	133.3	135.6	OK
Viscosity @ 100C [cSt]	13	± +3	13.8	13.8	13.8	14.0	OK
TAN [mgKOH/g]	0.3	+ 2.5	1.9	1.2	1.3	1.7	OK
TBN [mgKOH/g]	6.2	3.1	5.4	5.3	5.2	5.2	OK
Soot [%]	0%	2%	0.0%	0.0%	0.0%	0.0%	OK
Nitration [A/cm]	0	20	0.0	0.0	0.0	0.0	OK
Oxidation [A/cm]	0	20	3.0	2.9	3.1	3.2	OK
Water in Oil [%]	0.00%	0.20%	0.00%	0.00%	0.00%	0.00%	OK
Glycol [%]	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	OK
Elemental Analysis							
Wear Metals							
Aluminum, Al [ppm]	0	15	0	0	0	0	OK
Copper, Cu [ppm]	0	15	2	0	0	0	OK
Chromium, Cr [ppm]	0	5	0	0	0	0	OK
Lead, Pb [ppm]	0	20	0	0	0	0	OK
Iron, Fe [ppm]	0	20	0	0	8	0	OK
Tin, Sn [ppm]	0	5	0	0	3	0	OK
Contaminant Metals							
Silicon, Si [ppm]	0	20	0	0	0	0	OK
Sodium, Na [ppm]	0	20	0	0	0	0	OK
Potassium, K [ppm]	0	5	0	0	0	0	OK
Additive Metal							
Molybdenum [ppm]	0	10	0	0	0	0	OK
Diagnostics: No alert seen.							
Service Engineer's Comment: All engine wear rates normal. Sample free of external contamination. Analysis indicates proper performance of lubricant and engine of gas generator set. Continue with current oil in the gas engine and sample by the next 500 oil service hours.							

Case Study 5: Low Production Load

1. Plastics making factory with process load averaging 950 kW
2. Powered by a single GEJ Gas Engine J612G (1.8kW capacity); running at < 60% load capacity.
3. Oil change is determined by oil analysis.


- Oil Drain Interval for the J612G averages > 4,500 Hrs

PetroSave Integrated Services Limited		Gas Engine Oil Analysis Report							
Client Information									
Company Name:	Qesa Plastic Products Nig. Ltd	Client Contacts:	Mr. Tony Sahnari / Mr. Assisi						
Company Address:	Plot 9, Block E Mazon Industrial Estate Badejo Kalesanwo Str. Mushin, Lagos	Department:	Plant Utilities - Power Plant						
		Mobile Phone Nos.:	08130204255/ 07068327054						
		Email Address:	<managorant@gostaplastic.com>						
		Equipment Operator/Driver:	-						
Equipment Information									
Equipment Type:	Gas Engine Generator (1.8 MW)	Component:	Engine						
Equipment ID Ref.:	Gen#1 (S/N: 1092025)	Make/Model:	JENBACHER / J612 GS-NL						
Equipment Make:	JENBACHER	Lubricant in use:	Senron LD 5000						
Equipment Date:	2013	Oil Brand:	PetroCanada						
Equipment Location:	Mazon Ind. Estate, Mushin	Oil Weight:	SAE 40						
Used Oil Samples - Trend of Actual Laboratory Tests									
	Fresh Oil Sample	Condensing Limit	7-Mar-10 6699/Geshe/GG#1.03	29-Mar-10 9489/Geshe/GG#1.03	15-Apr-10 6279/Geshe/GG#1.03	12-Aug-10 7014/Geshe/GG#1.03	1-Sep-10 7119/Geshe/GG#1.03	13-Oct-10 7322/Geshe/GG#1.03	Condition
Engine Operating Hours									
Oil Sample [Hrs]	0	-	3,286	3,582	3,838	4,384	4,641	507	● OK
Currm. Engine [Hrs]	-	-	11,330	11,626	11,882	12,428	12,685	13,237	● Caution
Lube Oil Properties									
Appearance (Clear, Turbid or Dark)	Clear	Dark	Dark	Dark	Dark	Dark	Dark	Dark	● OK
Viscosity @ 40C [cSt]	111.8	+25%	124.1	123.4	124.5	115.5	113.5	117.4	● OK
Viscosity @ 100C [cSt]	12.2	± +3	13.1	13.1	13.2	12.5	12.4	12.6	● OK
TAN [mgKOH/g]	1.1	+ 2.5	2.4	2.5	2.9	1.1	1.4	1.2	● OK
TBN [mgKOH/g]	4.9	2.5	3.6	3.4	3.1	4.9	4.8	4.9	● OK
Insolubles [%]	0%	2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	● OK
Nitration [A/cm]	0	20	7.5	8.1	8.0	5.3	5.5	5.5	● OK
Oxidation [A/cm]	0	20	3.6	4.0	4.3	0.0	0.0	0.0	● OK
Water in Oil [%]	0.00%	0.20%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	● OK
Glycol [%]	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	● OK
Elemental Analysis									
Wear Metals									
Aluminum, Al [ppm]	0	15	2	0	0	0	0	2	● OK
Copper, Cu [ppm]	0	15	0	0	0	0	0	0	● OK
Chromium, Cr [ppm]	0	5	3	0	4	3	5	0	● OK
Lead, Pb [ppm]	0	20	0	0	3	0	0	0	● OK
Iron, Fe [ppm]	0	20	2	0	5	0	0	0	● OK
Tin, Sn [ppm]	0	5	3	0	4	0	0	0	● OK
Contaminant Metals									
Silicon, Si [ppm]	0	20	0	0	0	0	0	0	● OK
Sodium, Na [ppm]	0	20	4	2	4	0	3	0	● OK
Potassium, K [ppm]	0	5	0	0	0	0	0	0	● OK
Additive Metal									
Molybdenum [ppm]	0	10	0	0	0	0	0	0	● OK
Diagnostics:									
No alert seen.									
Service Engineer's Comment:									
All engine wear rates within Limits; analysis indicates proper performance of lubricant and gas engine. In-service GEO is ok for continued use. Next 500 Hrs of sampling/analysis to monitor trend.									

Case Study 5: Low Production Load

1. Government-owned Water Plant with Pumps load averaging 2,040 kW per Gas Engine.
2. 4 x GEJ Gas Engines J620G (3.2kW capacity each) installed; 3 Gas Engines in operation & 1 on stand-by.
3. Oil change is determined by oil analysis.

- ODI for each J620G Gas Engine averaged > 10,000 Hrs

PetroSave Integrated Services Limited		Gas Engine Oil Analysis Report							
Client Information									
Company Name:	Independent Power Plant	Client Contacts:	Mr. George Laird / Mr. Patrick Nzekwe						
Company Address:	Akule Ogun State	Department:	Clark Energy						
		Mobile Phone Nos.:	08066802622 / 08022341646						
		Email Address:	george.laird@clark-energy.com patrick.nzekwe@clark-energy.com						
		Equipment Operator/Driver:	-						
Equipment Information									
Equipment Type:	Gas Engine Generator	Component:	Engine						
Equipment ID Ref.:	Gen #4 (3.0 MW)	Make/Model:	JENBACHER / J620GSE						
Equipment Make:	JENBACHER	Lube Oil In use:	Pegasus 800						
Equipment Date:	2008	Oil Brand:	Mobil						
Equipment Location:	Power Plant, Akule	Oil Weight:	SAE 40						
Used Oil Samples - Trend of Actual Laboratory Tests									
	Fresh Oil Sample	Condemning Limit	7-Dec-12 305AkuleGG#423	11-Jan-13 396AkuleGG#424	15-Feb-13 550AkuleGG#425	8-Mar-13 605AkuleGG#426	25-May-13 914AkuleGG#427	15-Aug-13 1000AkuleGG#428	Condition ● OK ● Caution ● Critical
Engine Operating Hours									
Oil Sample [Hrs]	0	-	9,231	9,919	10,468	10,784	11,297	388	
Cumm. Engine [Hrs]	-	-	17,304	17,992	18,541	18,857	19,370	20,281	
Lube Oil Properties									
Appearance [Clear, Turbid or Dark]	Clear	Dark	Dark	Dark	Dark	Dark	Dark	Dark	●
Viscosity @ 40C [cSt]	122.6	+/-25%	139.5	141.9	140.4	139.6	142.4	132.1	●
Viscosity @ 100C [cSt]	13.0	+/-20%	14.2	14.4	14.3	14.2	14.4	13.7	●
TAN [mgKOH/g]	0.3	4	1.5	1.2	1.2	1.1	1.2	0.5	●
TBN [mgKOH/g]	6.2	3.1	5.0	5.1	5.1	5.0	5.1	6.0	●
Insolubles [%]	0%	1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	●
Nitration [A/cm]	0	25	0.0	0.0	0.0	0.0	0.0	0.0	●
Oxidation [A/cm]	0	25	3.7	3.4	3.6	4.6	4.1	0.0	●
Water in Oil [%]	0.00%	0.20%	0.00%	0.00%	0.00%	0.10%	0.00%	0.00%	●
Glycol [%]	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	●
Elemental Analysis									
Wear Metals									
Aluminum, Al [ppm]	0	15	3	3	2	0	0	3	●
Copper, Cu [ppm]	0	15	7	13	21	24	23	7	●
Chromium, Cr [ppm]	0	5	2	0	0	0	0	0	●
Lead, Pb [ppm]	0	30	0	0	0	0	0	0	●
Iron, Fe [ppm]	0	20	0	9	3	5	5	0	●
Tin, Sn [ppm]	0	10	7	3	0	0	4	0	●
Contaminant Metals									
Silicon, Si [ppm]	0	25	0	0	0	0	0	0	●
Sodium, Na [ppm]	0	8	4	0	0	0	0	0	●
Potassium, K [ppm]	0	10	0	0	0	0	0	0	●
Additive Metal									
Molybdenum [ppm]	0	10	0	0	0	0	0	0	●
Diagnostics:									
No alerts seen.									
Service Engineer's Comment:									
All other engine wear rates within normal limits. Lube is ok for continued use. Next oil sampling due at 20,781 Engine Hours to monitor trend.									

Case Study 6: Impact of Oil Sump Size

Background

1. Bottling Plant with operational load averaging 2,400 kW per running Gas Engine
2. Powered by either of three(3) GEJ Gas Engines
 - J620G x 2 (3.0kW; Type 6, Class E with **extended oil sump**)
 - J620G x 1 (3.3 kW; Type 6, Class F; oil fill capacity 176 Gals).
3. 2 or 3 gas engines run per at a time; depending on production demands.
4. Oil change is determined by oil analysis.
 - **ODI for Older Model J620 (E Class) averaged 3,500 Hrs**

		Used Oil Samples - Trend of Actual Laboratory Tests							Condition	
		Fresh Oil Sample	Condensing Limit	31-Aug-16 7121/Benin/GG#2/20	26-Sep-16 7230/Benin/GG#2/21	24-Oct-16 7352/Benin/GG#2/22	9-Nov-16 7440/Benin/GG#2/23	28-Nov-16 7553/Benin/GG#2/24		21-Dec-16 7661/Benin/GG#2/25
Engine Operating Hours										
Oil Sample [Hrs]	0	-	1,867	2,447	3,038	3,373	3,838	541		
Cumm. Engine [Hrs]	-	-	54,367	54,947	55,538	55,873	56,338	56,879		
Lube Oil Properties										
Appearance [Clear, Turbid or Dark]	Clear		Dark	Dark	Dark	Dark	Dark	Dark		
Viscosity @ 40C [cSt]	129.7	+ 25%	144.7	145.9	149.0	147.5	150.0	130.2		●
Viscosity @ 100C [cSt]	13.2	± +3	14.6	14.7	14.9	14.8	15.0	13.6		●
TAN [mgKOH/g]	0.4	+ 2.5	2.2	2.3	2.3	2.1	2.2	0.8		●
TBN [mgKOH/g]	6.2	3.1	4.7	4.5	4.3	4.2	4.1	6.0		●
Soot [%]	0%	2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%		●
Nitration [A/cm]	0	20	3.7	3.7	4.0	4.1	4.1	0.0		●
Oxidation [A/cm]	0	20	4.4	4.4	5.9	6.2	7.0	0.0		●
Water in Oil [%]	0.00%	0.20%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%		●
Glycol [%]	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%		●
Elemental Analysis										
Wear Metals										
Aluminum, Al [ppm]	0	15	0	0	3	0	2	0		●
Copper, Cu [ppm]	0	15	0	0	0	0	0	0		●
Chromium, Cr [ppm]	0	5	3	0	0	4	5	3		●
Lead, Pb [ppm]	0	20	0	0	0	0	0	0		●
Iron, Fe [ppm]	0	20	0	0	0	0	0	0		●
Tin, Sn [ppm]	0	5	0	0	4	3	0	0		●
Contaminant Metals										
Silicon, Si [ppm]	0	20	0	0	0	0	0	0		●
Sodium, Na [ppm]	0	20	0	0	0	0	3	2		●
Potassium, K [ppm]	0	5	0	0	0	0	0	0		●
Additive Metal										
Molybdenum [ppm]	0	10	0	0	0	0	0	0		●
Diagnostics: No alert seen.										
Service Engineer's Comment: All engine wear rates within normal limits. Oil is ok for continued use. Subsequent oil sampling/analysis to monitor trend.										



Gas Engine Oil Analysis Report



Client Information

Company Name:	Guinness Nig. Plc	Client Contacts:	Mr. Joel Oglemwoyi
Company Address:	Ogba, Benin Edo State	Department:	Power Plant
		Mobile Phone Nos.:	08037707955
		Email Address:	Joel.Oglemwoyi@dlageo.com
		Equipment Operator/Driver:	-

Equipment Information

Equipment Type:	Gas Engine Generator (3.0 MW)	Component:	Engine
Equipment ID Ref:	Gen #2 [S/N: 5179251]	Make/Model:	JENBACHER / J620 GS [E120]
Equipment Make:	JENBACHER	Lube Oil in use:	Pegasus 805
Equipment Date:	2008	Oil Brand:	Mobil
Equipment Location:	Guinness Plant, Benin	Oil Weight:	SAE 40

Case Study 6: Impact of Oil Sump Size


- **ODI for newer J620 (F Class) averaged 1,300 Hrs**

The J620 - Type 6, Class F has all the design attributes of modern Engines

- compact size (implying smaller oil sump)
- fuel efficient (burns hotter) and
- primed to deliver more power (support more load)


Above requirements take their toll on the in-service GEO causing

- rapid oil degradation &
- shortened oil service life

PetroSave Integrated Services Limited		Gas Engine Oil Analysis Report							
Client Information									
Company Name:	Guinness Nig. Plc	Client Contacts:	Mr. Joel Oglismwonyi						
Company Address:	Ogba, Benin Edo State	Department:	Power Plant						
		Mobile Phone Nos.:	0803707955						
		Email Address:	Joel.Oglismwonyi@diageo.com						
		Equipment Operator/Driver:	-						
Equipment Information									
Equipment Type:	Gas Engine Generator (3.3 MW)	Component:	Engine						
Equipment ID Ref:	Gen #3 [S/N: 1067361]	Make/Model:	JENBACHER / J620 GS [F 0610]						
Equipment Make:	JENBACHER	Lube Oil in use:	Pegasus 805						
Equipment Date:	2014	Oil Brand:	Mobil						
Equipment Location:	Guinness Plant, Benin	Oil Weight:	SAE 40						
Used Oil Samples - Trend of Actual Laboratory Tests									
	Fresh Oil Sample	Condemning Limit	29-Sep-16 7256/Benin/GG#3/33	4-Oct-16 7287/Benin/GG#3/34	17-Oct-16 7368/Benin/GG#3/35	31-Oct-16 7416/Benin/GG#3/36	15-Nov-16 7488/Benin/GG#3/37	28-Nov-16 7554/Benin/GG#3/38	Condition OK Caution Critical
Engine Operating Hours									
Oil Sample [Hrs]	0	-	1,315	3	307	600	905	1,220	
Cumm. Engine [Hrs]	-	-	13,129	13,250	13,557	13,850	14,155	14,470	
Lube Oil Properties									
Appearance [Clear, Turbid or Dark]	Clear		Dark	Dark	Dark	Dark	Dark	Dark	
Viscosity @ 40C [cSt]	129.7	+ 25%	156.8	126.3	134.8	142.5	147.3	151.1	Yellow
Viscosity @ 100C [cSt]	13.2	± +3	15.4	13.3	13.9	14.4	14.8	15.0	Yellow
TAN [mgKOH/g]	0.4	+2.5	3.1	0.4	1.2	1.5	2.1	2.4	Yellow
TBN [mgKOH/g]	6.2	3.1	3.0	6.1	5.4	4.2	3.3	2.9	Red
Soot [%]	0%	2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	Green
Nitration [A/cm]	0	20	8.3	0.0	3.5	4.7	6.7	9.9	Green
Oxidation [A/cm]	0	20	7.1	0.0	2.8	4.7	7.1	8.8	Green
Water in Oil [%]	0.00%	0.20%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	Green
Glycol [%]	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	Green
Elemental Analysis									
Wear Metals									
Aluminum, Al [ppm]	0	15	0	0	2	0	0	0	Green
Copper, Cu [ppm]	0	15	0	0	0	0	0	0	Green
Chromium, Cr [ppm]	0	5	0	0	0	0	3	0	Green
Lead, Pb [ppm]	0	20	0	0	0	0	0	0	Green
Iron, Fe [ppm]	0	20	0	0	0	0	0	0	Green
Tin, Sn [ppm]	0	5	0	0	0	0	3	0	Green
Contaminant Metals									
Silicon, Si [ppm]	0	20	0	0	0	0	0	0	Green
Sodium, Na [ppm]	0	20	0	0	0	0	0	0	Green
Potassium, K [ppm]	0	5	0	0	0	0	0	0	Green
Additive Metal									
Molybdenum [ppm]	0	10	0	0	0	0	0	0	Green
Diagnostics: Low TBN - causes include Over-extended oil drain intervals, Depleted additives, Excessive blowby, Wrong/insufficient additive package, Overheating									
Service Engineer's Comment: In-service GEO has served out its useful life; Lubrication Service advised. All engine wear rates within Limits. Subsequent oil sampling/analysis to monitor trend.									

Case Study 7: Impact of Contaminants
 - e.g. Cooling Water Ingress


- **ODI for same J620G reverted to 3,000 Hrs post Mtce Repairs**

PetroSave Integrated Services Limited		Gas Engine Oil Analysis Report							
Client Information									
Company Name:	Independent Power Plant	Client Contacts:	Mr. Muhammad Asim / Mr. Patrick Nzekwe						
Company Address:	Alausa, Ikeja Lagos State	Department:	Clark Energy						
		Mobile Phone Nos.:	08076961902 / 08022241545						
		Email Address:	muhammad.asim@clarke-energy.com patrick.nzekwe@clarke-energy.com						
		Equipment Operator/Driver:	-						
Equipment Information									
Equipment Type:	Gas Engine Generator (3.0 MW)	Component:	Engine						
Equipment ID Ref:	Gen #2 [S/N: 1072710]	Make/Model:	JENBACHER / JG620 F						
Equipment Make:	JENBACHER	Lube Oil in use:	Pegasus 805						
Equipment Date:	2012	Oil Brand:	Mobil						
Equipment Location:	Power Plant, Alausa	Oil Weight:	SAE 40						
Used Oil Samples - Trend of Actual Laboratory Tests									
	Fresh Oil Sample	Condensing Limit	12-May-14 2652/Alausa/GG42/4	5-Jun-14 2805/Alausa/GG42/5	14-Jul-14 3056/Alausa/GG42/6	13-Aug-14 3225/Alausa/GG42/7	13-Oct-14 3597/Alausa/GG42/8	17-Nov-14 3856/Alausa/GG42/9	Condition ● OK ● Caution ● Critical
Engine Operating Hours									
Oil Sample [Hrs]	0	-	457	710	1,017	1,261	1,725	194	
Cumm. Engine [Hrs]	-	-	1,937	2,190	2,497	2,741	3,205	3,531	
Lube Oil Properties									
Appearance [Clear, Turbid or Dark]	Clear		Dark	Dark	Dark	Dark	Dark	Dark	●
Viscosity @ 40C [cSt]	129.7	+ 25%	135.8	139.1	144.2	150.5	152.8	132.2	●
Viscosity @ 100C [cSt]	13.2	± ±3	14.0	14.2	14.6	15.0	15.1	13.7	●
TAN [mgKOH/g]	0.4	+ 2.5	1.5	1.3	3.1	3.2	3.4	5.9	●
TBN [mgKOH/g]	6.2	3.1	5.0	4.3	3.8	3.4	2.4	5.6	●
Soot [%]	0%	2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	●
Nitration [A/cm]	0	20	0.0	2.0	3.3	5.2	8.0	0.0	●
Oxidation [A/cm]	0	20	4.7	6.5	7.6	8.2	9.6	3.4	●
Water in Oil [%]	0.00%	0.20%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	●
Glycol [%]	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	●
Elemental Analysis									
Wear Metals									
Aluminum, Al [ppm]	0	15	0	0	0	0	2	0	●
Copper, Cu [ppm]	0	15	0	0	0	3	0	0	●
Chromium, Cr [ppm]	0	5	0	0	0	0	0	0	●
Lead, Pb [ppm]	0	20	0	0	0	2	0	0	●
Iron, Fe [ppm]	0	20	0	0	0	0	0	0	●
Tin, Sn [ppm]	0	5	0	0	0	0	5	0	●
Contaminant Metals									
Silicon, Si [ppm]	0	20	0	0	0	0	0	0	●
Sodium, Na [ppm]	0	20	6	4	11	20	5	0	●
Potassium, K [ppm]	0	5	8	0	17	40	0	0	●
Additive Metal									
Molybdenum [ppm]	0	10	0	0	0	0	0	0	●
Diagnostics: No alerts seen.									
Service Engineer's Comment: All engine wear rates within normal limits. Oil is ok for continued use. Subsequent oil sampling/analysis to monitor trend.									

Case Study 8: Impact of Fake GEO Brands

Background

1. Some Gas Engine operators, erroneously believe in buying from unauthorized Oil Vendors at cheaper prices
 2. Often oil drum offered at cheaper price is mere perfect copy of a successful Brand's drum design "external" but fails remarkably to match its content quality "internal".
 3. Such purchases most time put the gas engine to risk, because the quality content of the oil is compromised
 4. If oil analysis is in place, such poor oil quality may be quickly detected from measuring rapid degradation of key lubricant parameters
- Oil Analysis detected the in-service GEO was both over-Based and over-Acidified, shortening its service life. Fresh oil analysis confirmed, the GEO was fake.

PetroSave Integrated Services Limited		Gas Engine Oil Analysis Report						
Client Information								
Company Name:	OK Plast Ltd.	Client Contact:	Naresh Lenka					
Company Address:	7A, Illesamaja Scheme, Idiro Junction Off Isolo Expressway Isolo, Lagos	Department:	Maintenance (Power Plant)					
		Mobile Phone No.:	08027936088					
		Email Address:	nareshlenka23@gmail.com					
		Equipment Operator/Driver:	-					
Equipment Information								
Equipment Type:	Gas Engine Generator [1.4 MW]	Component:	Engine					
Equipment ID Ref:	Gas Gen #1 [S/N: 1087650]	Make/Type:	JENBACHER / JGC420 GS-NL					
Equipment Make:	GE JENBACHER	Lube Oil in use:	Mobil Pegasus 80S					
Equipment Year of Manufacture:	2013	Oil Brand:	Mobil					
Equipment Location:	OK Plast, Idiro	Oil Weight:	SAE 40					
Used Oil Samples - Trend of Actual Laboratory Tests								
	Fresh Oil 29-Aug-14	Condensing Limit	12 May 2015 4953/OK/PVG0#1/09	09 June 2015 5089/OK/PVG0#1/10	12 June 2015 5124/OK/PVG0#1/11	13 July 2015 5245/OK/PVG0#1/12	23 July 2015 5295/OK/PVG0#1/13	Condition OK Caution Critical
Engine Operating Hours								
Oil Sample [Hrs]	0	-	609	985	1,060	459	578	
Cumm. Engine [Hrs]	-	-	4,909	5,285	5,360	5,857	5,976	
Lube Oil Properties								
Color [Clear, Turbid or Dark]	Clear		Dark	Dark	Dark	Dark	Dark	
Viscosity @ 40C [cSt]	122.8	+ 25%	125.5	131.8	132.1	130.4	130.3	OK
Viscosity @ 100C [cSt]	13.0	± +3	13.2	13.7	13.7	13.6	13.6	OK
TAN [mgKOH/g]	0.4	+ 2.5	1.5	2.0	2.6	1.8	2.1	OK
TBN [mgKOH/g]	6.2	3.1	5	4.6	4.5	5.3	5.1	OK
Soot [%]	0%	2%	0.0%	0.0%	0.0%	0.0%	0.0%	OK
Nitration [A/cm]	0	20	0	2.4	2.4	4.2	4.5	OK
Oxidation [A/cm]	0	20	4.6	5.4	5.5	3	3.8	OK
Water in Oil [%]	0.00%	0.20%	0.00%	0.00%	0.00%	0.00%	0.00%	OK
Glycol [%]	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	OK
Elemental Analysis								
Wear Metals								
Aluminum, Al [ppm]	0	15	1	1	4	0	2	OK
Copper, Cu [ppm]	0	15	6	12	5	0	0	OK
Chromium, Cr [ppm]	0	5	0	0	0	0	0	OK
Lead, Pb [ppm]	0	20	0	0	0	0	0	OK
Iron, Fe [ppm]	0	20	5	7	0	0	0	OK
Tin, Sn [ppm]	0	5	0	4	0	0	0	OK
Contaminant Metals								
Silicon, Si [ppm]	0	20	0	0	0	0	0	OK
Sodium, Na [ppm]	0	20	83	55	74	15	26	Critical
Potassium, K [ppm]	0	5	0	0	0	0	0	OK
Additive Metal								
Molybdenum [ppm]	0	10	0	0	0	0	0	OK
Diagnostics: High Level of Sodium - causes include Oil additive constituent, Coolant additive, Road Salt/Dirt, Grease								
Service Engineer's Comment: Cooling Water ingress is indicated by presence of Sodium at Critical Level; maintenance action advised. All engine wear metals within Limits. In-service GEO is ok for continued use. Every 150 Hrs oil sampling/analysis advised to monitor trend.								

Case Study 8: Impact of Fake GEO Brands

PetroSave Integrated Services Limited		Fresh Oil Analysis Report		
Client Information				
Company Name:	OK Plast Ltd.	Client Contact:	Naresh Lenka	
Company Address:	7A, Illasamaja Scheme, Itire Junction Off Isolo Expressway Isolo, Lagos	Department:	Maintenance (Power Plant)	
		Mobile Phone No.:	08027936088	
		Email Address:	nareshlenka23@gmail.com	
Date:	14-Jun-16			
Test	Units		Fresh Mobil Pegasus 805 Make-up Oil Tank - Gas Engine #1 Sampled: June 12, 2015	Mobil Pegasus 805 Website PDS Info
Color	Visual		Clear, Brown	NA
SAE Grade	-		40	40
Viscosity @ 40C	cSt		120.7	130.0
Viscosity @ 100C	cSt		12.9	13.5
Viscosity Index, VI	-		100	99
Specific Gravity [SG] @ 15C	kg/m ³		892	890
Total Base Number [TBN]	mgKOH/g		6.4	6.2
Total Acid Number [TAN]	mgKOH/g		1.6	0.3 *
Flash Point [ASTM D93 Closed C	°C		215	262 #
Water	% vol		Nil	Nil
Elemental Analysis - Select	ppm			
Iron, Fe			2	
Copper, Cu			3	
Sodium, Na			42	
Potassium, K			0	
<p>* Note the TAN level of fresh oil is not available as a Product Data Sheet (PDS) information. However, TAN = 0.3 is typical value, which has been measured at Petrosave Lab for several GEO samples, of authentic sources and correctly meeting other Mobil Pegasus 805 published oil parameters.</p> <p># ASTM D92 Open Cup Method</p> <p>Comment(s) Fresh oil sample taken from the Make-up Oil Tank of GEJ Gas Engine No. 1 is NOT Mobil Pegasus 805.</p>				

PetroSave Integrated Services Limited		Fresh Oil Analysis Report		
Client Information				
Company Name:	OK Plast Ltd.	Client Contact:	Naresh Lenka	
Company Address:	7A, Illasamaja Scheme, Itire Junction Off Isolo Expressway Isolo, Lagos	Department:	Maintenance (Power Plant)	
		Mobile Phone No.:	08027936088	
		Email Address:	nareshlenka23@gmail.com	
Date:	14-Jun-16			
Test	Units		Fresh Mobil Pegasus 805 Sampled: June 11, 2015 Drum Batch No. C220028	Mobil Pegasus 805 Website PDS Info
Color	Visual		Clear, Brown	NA
SAE Grade	-		40	40
Viscosity @ 40C	cSt		143.8	130.0
Viscosity @ 100C	cSt		14.5	13.5
Viscosity Index, VI	-		100	99
Specific Gravity [SG] @ 15C	kg/m ³		898	890
Total Base Number [TBN]	mgKOH/g		6.7	6.2
Total Acid Number [TAN]	mgKOH/g		1.8	0.3 *
Flash Point [ASTM D93 Closed C	°C		215	262 #
Water	% vol		Nil	Nil
Elemental Analysis - Select	ppm			
Iron, Fe			9	
Copper, Cu			8	
Sodium, Na			32	
Potassium, K			0	
<p>* Note the TAN level of fresh oil is not available as a Product Data Sheet (PDS) information. However, TAN = 0.3 is typical value, which has been measured at Petrosave Lab for several GEO samples, of authentic sources and correctly meeting other Mobil Pegasus 805 published oil parameters.</p> <p># ASTM D92 Open Cup Method</p> <p>Comment(s) Fresh oil sample taken from Drum [Batch # C220028] is NOT Mobil Pegasus 805.</p>				

Case Study 8: Impact of Fake GEO Brands

PetroSave Integrated Services Limited		Fresh Oil Analysis Report		
Client Information				
Company Name:	OK Plast Ltd.	Client Contact:	Naresh Lenka	
Company Address:	7A, Ilasamaja Scheme, Itire Junction Off Isolo Expressway Isolo, Lagos	Department:	Maintenance (Power Plant)	
		Mobile Phone No.:	08027936088	
		Email Address:	nareshlenka23@gmail.com	
Date:	24-Jul-15			
Test	Units	OKPlast: Fresh Oil Sample Drum Batch No. C530044 Sample Taken: July 24, 2015	Mobil Pegasus 805 Website PDS Info	
Color	Visual		Clear, Brown	NA
SAE Grade	-		40	40
Viscosity @ 40C	cSt		127.8	130.0
Viscosity @ 100C	cSt		13.2	13.5
Viscosity Index, VI	-		97	99
Specific Gravity [SG] @ 15C	kg/m ³		887	890
Total Base Number [TBN]	mgKOH/g		6.2	6.2
Total Acid Number [TAN]	mgKOH/g		0.4	0.3*
Oxidation	A/cm		0	NA
Flash Point [ASTM D93 Closed Cup]	°C		214	262 #
Water	% vol		Nil	Nil
Elemental Analysis				
Wear Metals				
Iron, Fe	ppm		0	NA
Chromium, Cr	-		0	NA
Lead, Pb	-		0	NA
Copper, Cu	-		0	NA
Tin, Sn	-		0	NA
Aluminum, Al	-		0	NA
Contaminant Metals				
Silicon, Si	ppm		0	NA
Sodium, Na	-		0	NA
Potassium, K	-		0	NA
Additive Metals				
Calcium, Ca	ppm		1249	NA
Phosphorus, P	-		265	NA
Zinc, Zn	-		454	NA
<p>* Note the TAN level of fresh oil is not available as a Product Data Sheet (PDS) information. However, TAN = 0.3 is typical value, which has been measured at PetroSave Lab for several GEO samples, of authentic sources and correctly meeting other Mobil Pegasus 805 published oil parameters.</p> <p># ASTM D82 Open Cup Method</p> <p>NA - Not Available as standard Mobil PDS information</p>				
Comment(s)				
1. In spite of some variations seen in the parameters reported above, it is safe to conclude that the fresh oil sample MEETS the product formulation properties of Mobil Pegasus 805.				
2. Note that Sodium is measured Nil for the Fresh Pegasus 805 sample.				

PetroSave Integrated Services Limited		Gas Engine Oil Analysis Report						
Client Information								
Company Name:	OK Plast Ltd.	Client Contact:	Mr. Imad		Maintenance (Power Plant)			
Company Address:	7A, Ilasamaja Scheme, Itire Junction Off Isolo Expressway Isolo, Lagos	Department:	07030030070		dani80_ng@hotmail.com			
		Mobile Phone No.:	-		-			
		Email Address:	-		-			
		Equipment Operator/Driver:	-		-			
Equipment Information								
Equipment Type:	Gas Engine Generator [1.4 MW]	Component:	Engine		JENBACHER / JGC420 GS-NL			
Equipment ID Ref.:	Gas Gen #1 [SN: 1087850]	Make/Type:	Mobil Pegasus 805		-			
Equipment Make:	GE JENBACHER	Lube Oil in use:	-		-			
Equipment Year of Manufacture:	2013	Oil Brand:	-		-			
Equipment Location:	OK Plast, Itire	Oil Weight:	-		-			
Used Oil Samples - Trend of Actual Laboratory Tests								
	Fresh Oil 29-Aug-14	Conditioning Limit	07 September 2015 5562/OKP/IGGF/1/14	12 October 2015 5699/OKP/IGGF/1/15	12 November 2015 5849/OKP/IGGF/1/16	07 December 2015 5993/OKP/IGGF/1/17	06 January 2016 6036/OKP/IGGF/1/18	Condition ● OK ● Caution ● Critical
Engine Operating Hours								
Oil Sample [Hrs]	0	-	1,156	1,885	2,250	247	634	
Cumm. Engine [Hrs]	-	-	6,554	7,083	7,648	8,059	8,446	
Lube Oil Properties								
Color [Clear, Turbid or Dark]	Clear	-	Dark	Dark	Dark	Dark	Dark	●
Viscosity @ 40C [cSt]	122.8	+25%	128.6	133.3	138.9	127.9	133.9	●
Viscosity @ 100C [cSt]	13.0	±+3	13.5	13.8	14.2	14.2	13.9	●
TAN [mgKOH/g]	0.4	+2.5	1.8	2.5	2.9	0.5	1.5	●
TBN [mgKOH/g]	6.2	3.1	5.6	4.7	3.8	6.1	5.4	●
Soot [%]	0%	2%	0.0%	0.0%	0.0%	0.0%	0.0%	●
Nitration [A/cm]	0	20	3.9	4.3	6.1	0	0	●
Oxidation [A/cm]	0	20	2.1	3	3.8	0	0	●
Water in Oil [%]	0.00%	0.20%	0.00%	0.00%	0.00%	0.00%	0.00%	●
Glycol [%]	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	●
Elemental Analysis								
Wear Metals								
Aluminum, Al [ppm]	0	15	0	0	0	0	0	●
Copper, Cu [ppm]	0	15	0	0	0	0	0	●
Chromium, Cr [ppm]	0	5	0	0	0	0	0	●
Lead, Pb [ppm]	0	20	0	0	0	0	0	●
Iron, Fe [ppm]	0	20	0	0	0	0	0	●
Tin, Sn [ppm]	0	5	0	3	0	0	0	●
Contaminant Metals								
Silicon, Si [ppm]	0	20	0	0	0	0	0	●
Sodium, Na [ppm]	0	20	0	3	6	0	0	●
Potassium, K [ppm]	0	5	0	0	2	0	0	●
Additive Metal								
Molybdenum [ppm]	0	10	0	0	0	0	0	●
Diagnostics:								
No alert seen.								
Service Engineer's Comment:								
All engine wear metals within Limits. In-service GEO is ok for continued use. Subsequent 500 Hrs oil sampling/analysis to monitor trend.								

Other Impacting Factors

Oil Make-up with DEO

It is common practice in almost all the Power Plants to run Gas Engines as the prime source of power while retaining the Diesel Engines as backup in case of gas supply outage. In a few cases, operators' initiatives to replace properly blended GEO with multi-grade DEO had also resulted in shortened oil life.

In some case studies already covered, thinning down of oil viscosity, partly from comparatively lower viscosity & shearing of VI improver additives of multigrade DEO blends, rapid increase in Nitration and associated TAN increase, higher TBN with resultant increase in ash deposits are some of the observations, compelling oil analysis to flag for early oil change.

Gas Fuel Quality

Petrosave Laboratory hopes to commence running GC analysis on gas samples to investigate Industry-wide reduction of Oil life across different Power Plants. Early indications point in direction of quality of Natural Gas supplied to the Nigeria Energy Industry which may not be farfetched, as Gas Vendors struggle to meet market demands against the backdrop of severe gas outages resulting from rampant cases of pipeline vandalization.

Wrap-up

In conclusion, above case-studies attempted to showcase operating conditions within which gas engine may efficiently and effectively be operated to yield optimum value and good return on its investment.

1. Use **OEM approved GEO Brand**, genuinely sourced from authorized Distributor(s)
2. Always ensure **complete oil drain** during every Lubrication Service
 - Include some form of physical inspection; replace oil filters as well
3. Ensure **adequate & consistent oil make-up** mechanism
 - Automatic top-up system is recommended
4. **Extended oil sump size offer *oil life extension*** benefits over standard/compact sumps
 - Ensure contamination monitoring/control in place to avoid ruining large volume of oil in a single incident
5. Monitor for **early detection of contaminants**
 - Make Oil Analysis the preferred tool
6. Choose installed **Engine Capacity sized for optimal Process Load** requirement
 - Operating load, 70 – 80% of engine capacity advised
 - 70-80% size also capable of accommodating Peak Load & Shock Loads as may arise

Thank You