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.

For 3 years the power plant gas engine of a Food Processing company in Lagos was operated at 3,000 – 3,500 Hrs ODI without oil analysis backup.

Oil Analysis was installed afterwards and initial results showed that in-service GEO becomes completely degraded under 1,000 Hours; the Company Management was livid.
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.
Case Study 1: Impact of Oil Make-up.

1. 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.

2. Engine Operators insisted that all running conditions particularly Load levels remained same.

3. 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.
4. 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.

5. 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.
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.
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.

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**Case Study 2: Lubrication Service – Impact of Partial Drain**

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**Gas Engine Oil Analysis Report**

- **Client Information**
  - Company Name: [Company Name]
  - Company Address: [Address]
  - Client Contacts:
    - Department: [Department]
    - Mobile Phone No.: [Number]
    - Email Address: [Email]

- **Equipment Information**
  - Equipment Type: Gas engine
  - Equipment ID:
    - Make: [Make]
  - Equipment Year of Manufacture: [Year]
  - Equipment Location: [Location]

- **Used Oil Samples**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td></td>
</tr>
<tr>
<td>Critical</td>
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**Lube Oil Properties**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Value</th>
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<tr>
<td>Viscosity @ 40°C</td>
<td>cSt</td>
<td>110.3</td>
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<tr>
<td>Viscosity @ 100°C</td>
<td>cSt</td>
<td>11.3</td>
</tr>
<tr>
<td>TBN</td>
<td>mg/Kg</td>
<td>6.4</td>
</tr>
<tr>
<td>Oxidation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ash %</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**Elemental Analysis**

- **Sulfur**
  - ppm: 0.0
- **Nitrogen**
  - ppm: 0.0
- **Iron**
  - ppm: 15.0
- **Copper**
  - ppm: 50.0
- **Magnesium**
  - ppm: 5.0
- **Aluminum**
  - ppm: 5.0

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**Diagnoses**

- High Oil Viscosity
- Sulfur in Oil
- High Copper
- High Magnesium

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**Service Engineer’s Comment**

- Cooling Water Ingress is evidenced by "coolant marker".
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 effective 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.
Initially total process load powered by the Gas Engines were 50 – 60% of their combined installed capacities and in-service oil life averaged 10,000 Hours for each engine.

Afterwards, the Company added a new Production Line to existing Power Plant installed capacity. Additional 1050kW load from the new Line was therefore shared across all 3 running Gas Engines.
Effect of that decision:
1. Raised engine load level from earlier 50-60% to current 85-90% of installed capacity.
2. Occasional spikes of “sacrificial metals” – Tin, Chrome, Molly in the oil analysis reports occurring particularly during peak and/or shock loads.
3. Shortened the life of in-service GEOs in those engines from prior 10,000 Hrs ODI to barely 4,000 Hrs today.

One Study observed that gas engine when loaded beyond 80% of its design capacity; results in rapid oil degradation as seen in higher levels of Oxidation and Nitration with associated increases in oil viscosity, TAN level and TBN depletion all of which combine to shorten the oil life.
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 (1.8 kW 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
Case Study 4: **Constant Production Load**  
– Impact of Higher Engine Capacity

- Oil Drain Interval for the J620G averages >7,000 Hrs
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
Case Study 5: Low Production Load

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
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 (3.0 kW; 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
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
Case Study 7: Impact of Contaminants
- e.g. Cooling Water Ingress

That contaminants can compromise the lubrication function of in-service oil and thereby shorten oil life is well known.

The Gas Engine has established 2,000 Hrs ODI trend. However, severe Cooling Water ingress detected after 468 Oil Hrs evidenced by high “coolant markers” – Sodium & Potassium; forced Lubrication Service after just 1,712 Oil Hrs following Mte repairs.
Case Study 7: Impact of Contaminants - e.g. Cooling Water Ingress

- ODI for same J620G reverted to 3,000 Hrs post Mtce Repairs
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.
### Case Study 8: Impact of Fake GEO Brands

#### Fresh Oil Analysis Report

**Client Information**
- **Company Name:** PetroSave Integrated Services Limited
- **Client Contact:**
  - **Company Address:** 7A, Ilasemaja Scheme, Nite Junction Oleiso Expressway Iloso, Lagos
  - **Department:** Mobile Phone No.: 00279309088
  - **Email Address:** naneh.nkana25@gmail.com

**Date:** 14-Jun-16

#### Test Results

<table>
<thead>
<tr>
<th>Test</th>
<th>Units</th>
<th>Fresh Mobil Pegasus 805</th>
<th>Mobil Pegasus 805 Website PDS Info</th>
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<tbody>
<tr>
<td>Color</td>
<td>Visual</td>
<td>Clear, Brown</td>
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<td>SAE Grade</td>
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<td>Viscosity @ 40C</td>
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<td>99</td>
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<td>Total Acid Number [TAN]</td>
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<td>Water</td>
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<tr>
<td>Potassium, K</td>
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</table>

*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.*

##### Notes:
- ASTM D92 Open Cup Method
- Field Oil sample taken from the Make-up Oil Tank of GEJ Gas Engine No. 1 is NOT Mobil Pegasus 805.

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<td>Clear, Brown</td>
<td>NA</td>
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<tr>
<td>SAE Grade</td>
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<td>Viscosity @ 40C</td>
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<td>Viscosity @ 100C</td>
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<td>mg/g</td>
<td>6.7</td>
<td>6.2</td>
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<tr>
<td>Total Acid Number [TAN]</td>
<td>mg/g</td>
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<td>0.3*</td>
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<tr>
<td>Flash Point [ASTM D92 Closed C]</td>
<td>°C</td>
<td>215</td>
<td>282 #</td>
</tr>
<tr>
<td>Water</td>
<td>% vol</td>
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<td>Nil</td>
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<tr>
<td>Elemental Analysis - Select Inh. Fe</td>
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<td>Copper, Cu</td>
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<tr>
<td>Potassium, K</td>
<td>ppm</td>
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</table>

*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.*

##### Notes:
- ASTM D92 Open Cup Method
- Field Oil sample taken from Drum [Batch # C200329] is NOT Mobil Pegasus 805.
Case Study 8: Impact of Fake GEO Brands

Fresh Oil Analysis Report

Client Information
- Client Name: Petro Save
- Company Address: 7A, House of Win, Old Junction
- Contact Person: Suresh Lokka
- Mobile No.: 09602716306
- Email Address: nareeshlokka23@gmail.com

Test Results

<table>
<thead>
<tr>
<th>Test</th>
<th>Units</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
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Gas Engine Oil Analysis Report

Client Information
- Client Name: Petro Save
- Company Address: 7A, House of Win, Old Junction
- Contact Person: Suresh Lokka
- Mobile No.: 09602716306
- Email Address: nareeshlokka23@gmail.com

Equipment Information
- Equipment Type: Gas Engine Generator [1.4 MWe]
- Equipment Make: GE JENNY HITEC
- Equipment Usage: Lubricating Oil 
- Equipment Location: Oil Plant, IIA

Used Oil Samples: Trend of Actual Laboratory Tests

<table>
<thead>
<tr>
<th>Engine Operating Hours</th>
<th>Used Oil Samples</th>
<th>Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh Oil</td>
<td>Condensing Limit</td>
<td></td>
</tr>
</tbody>
</table>

Diagnoses:
- No and Good

Service Engineer’s Comments:
All engine wear metals within limits. In-service GEO is ok for continued use. Subsequent 600 hrs of 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 multigrade 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 vandalism.
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