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Early detection of Cooling System Water Leaks in Gas Engines

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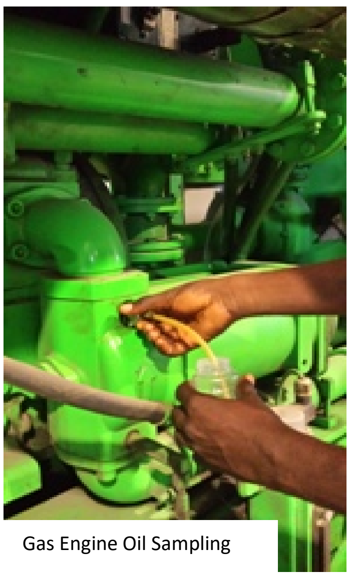
Oil analysis remains a veritable tool for "listening" to the rapidly changing condition of the in-service oil. Without oil analysis, most engine problems will continue undetected, propagating from hidden to evident catastrophic failure. Thus, leading to forced machinery shutdown with consequential losses in production downtime and expensive repairs. This case study shares how early detection of cooling system leaks through routine Oil Analysis, helped two Power Plants in Lagos, Nigeria mitigate potential damages to critical Gas Engines and thereby achieved **K$ 240** cost-avoidance savings.



Gas Engine Oil Sampling

The Problems

For Power Plant A, Oil sampling/analysis of Gas Engine 1 @ 2,006 RH detected sudden emergence of "coolant markers" – Sodium and Potassium. Continued oil sampling/analysis, showed a rapidly worsening trend. Decision was taken to schedule a shut-down of this Gas Engine for Maintenance trouble-shooting and corrective actions. For Power Plant B, owned by a leading Paper Mill having 1.5MW x 3 Gas Engines installed; routine oil analysis results had showed good trend, proof of good Maintenance practices. However, May 27, 2015 Gas Engine G1 @ 12,645 RH oil sampling/analysis detected a spike increase in Sodium. April 28, 2015 Gas Engine G2 @ 12,643 RH oil sampling/analysis detected spike increase in Sodium. July 28, 2016 Gas Engine G3 @ 12,110 RH oil sampling/analysis also detected major spike increase in Sodium.

April – September months of every year are usually seasonal demand peak period and Production was on full throttle to maximize sales in the Company's very competitive market segment. Therefore, all Power Plant B three (3) Gas Engines were primed to run on maximum loads. For each above situation, decision was taken to schedule a shut-down of the affected Gas Engine for Trouble-shooting.

Discussion

Results trend for Power Plant A, Gas Engine G1:

Date	3/19/2014	5/12/2014	6/5/2014	7/14/2014	8/13/2014	10/13/2014	11/17/2014	12/8/2014	3/12/2015
Oil Hrs	1,500	468	695	959	1,201	1,712	203	377	631
Engine RHrs	1,500	2,006	2,233	2,497	2,739	3,192	3,531	3,705	4,554
V40 [cSt]	143.1	135.3	138.6	141.9	149.3	151.3	131.3	132.4	137.1
V100 [cSt]	14.5	13.9	14.2	14.4	14.9	15.0	13.6	13.7	14.1
TAN [mgKOH/g]	3.2	1.2	1.7	2.6	2.7	3.2	0.8	1.6	1.9
TBN [mgKOH/g]	2.7	4.8	4.3	3.8	3.4	2.7	5.7	5.0	4.5
Oxidation [A/cm]	11.7	5.3	7.7	9.0	9.2	10.3	3.5	4.8	4.4
Iron, Fe [ppm]	0	8	10	7	21	14	3	8	0
Sodium, Na [ppm]	2	34	93	184	223	308	39	14	2
Potassium, K [ppm]	3	0	0	41	25	6	0	0	0

Note: Reversal of Sodium trend followed the maintenance repair job carried out after the Oct. 13, 2014 Oil Sampling

An estimated 60 percent of engine downtime in the commercial trucking sector is cooling system related [1].For Power Plant A Gas Engine G1 and Power Plant B Gas Engines G1 & G2, the ***Intercoolers cores*** for respective Gas Engine were pressure tested for leaks. Leaks occurred, thus confirming coolant ingress caused by water/coolant seepages from the intercoolers of those engines. Intercooler gaskets, suspected to be flattened and the associated o-rings were replaced. Cooling Water ingress problem was instantly solved. Subsequent oil analysis Reports, validated those maintenance corrective actions as effective.

Intercooler of Gas Engine

However, for Power Plant B Gas Engine G3, water/coolant ingress was from a different source. The ***Pre-Chamber sleeve o-ring*** at the Cylinder Head was worn and immediately replaced. Cooling Water ingress problem instantly solved. Subsequent oil analysis results confirmed above Maintenance repairs as effective. For all above situations, although no water or glycol was detected, cooling water ingress was evidenced by "coolant markers" - Na & K present at critical Levels; measured by Elemental Analysis (AES method). Gas Engines run very hot and much of the Glycol & Water data at incipient stages of the problem, are often lost in exhaust gas discharge, leaving may be trace quantities in the sampled oil; possibly below the detection concentrations if using some conventional test methods.

Pre-chamber Sleeve

Note that by themselves, Na and K pose no risk to the gas engine even though there may be clearly specified OEM Limits. Na and K are exactly what they are ...."coolant markers" (tell-tale sign that indicates possible cooling water ingress). OEM's concern is on the real danger that water can do to the engine oil. According to one Study [2], Water is the most destructive contaminant to lube oils. Water washes away TBN additives, emulsifies the oil (meaning increase in viscosity), induces base oil oxidation, and interferes with oil film production (strips the oil of its lubricity) as well as create fertile condition for acidity (increase in TAN). As the Cooling Water ingress worsens to the point, the oil can no longer effectively lubricate; rapid wear of engine components set in threatening the business bottom-line.

For this reason, as soon as Na and K are flagged as alerts, oil sampling interval should be shortened for closer monitoring of in-service oil condition, wear metals and associated contaminants trend.

Continued running of the gas engine supported by oil analysis, hopefully getting to the next lubrication service, which affords the opportunity for detailed investigation of the alerts by maintenance engineers. Shutdown for oil change provides an excellent opportunity to also inspect the coolant reservoir for possible oil film on the surface of the cooling water. Considering that oil circulation pressure is always higher, sometimes more than double that of water circulation pressure; imply there also may be a counter ingress of oil into water. Of course, such inspection is additional to pressure testing (at shutdown). Aside from weakened/brittle o-rings sealing etc., leaks may arise from micro holes in the body of the Oil Cooler core resulting from ***leaching***. Micro holes (pits) in the cooler core are sometimes indicated by rising Copper levels occurring alone (meaning unassociated with any other wear metal)

Cost-Saving Benefits

Key cost-avoidance benefits which formed part of the K$240 savings include: K$105 estimated for forced Gas Engine shutdown with consequential losses in production, K$15 assessed as penalties arising from breach of Service Contract Agreement and K$120 calculated to cover extensive Repairs, Spares replacement etc. The K$240 Savings excludes other benefits realizable from increased Gas Engines Uptime as seasonal Production Targets were met and minimal expenditure achieved (no Downtime, Shutdowns for Cooling System repairs were scheduled).

References

1. Machinery Lubrication: "Engine Coolant Basics", by Paul Fritz, Chevron
2. Machinery Lubrication: "Four Lethal Diesel Engine Oil Contaminants", by Jim Fitch, Noria Corporation.

Key Word: Engines- Natural Gas Engines