

CASE STUDY: Power Generation Plant Mechanical Issue on a Sulzer ZA40S

Summary

Operations and maintenance personnel identified a mechanical “ticking” sound coming from Cylinder L1. The plant’s peak pressure monitoring also identified cylinder L1 has having the highest peak pressure at 11% higher than the engine average. The increase in pressure was noted after a maintenance activity where the head was removed and reinstalled.

Comprehensive engine analysis was performed which determined that the mechanical ticking was occurring just prior (1 deg.) to Top Dead Center (TDC) on the scavenging stroke. With the piston at or very near TDC on the scavenging stroke, both the exhaust valves and intake valves are open. As a result of the analysis, a maintenance activity was performed which indicated the valves were touching the piston at TDC. It was also determined that a 1mm shim or spacer was installed, not the required 2mm spacer.

Background

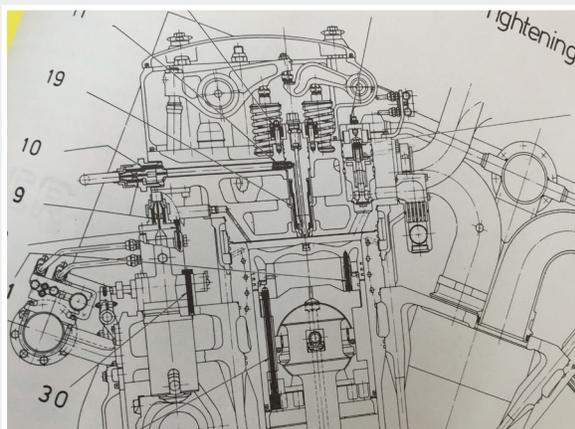
The diesel generator is one of many at this station that provide power to a Caribbean Island. The engine is a 16 cylinder Sulzer 16ZV40/48 rated at 11,125 BHP. Each cylinder has a 400mm (15.748”) bore and a 480mm (18.989”) stroke and operates at 514 rpm. This engine also employs a rotating piston crown design.

Technology

The client utilized a Windrock 6320/DA portable analyzer to assess the condition and performance of the diesel engine. The 6320/DA analyzer measures dynamic data relative to crank position and then applies the principles of thermodynamics and science to precisely assess machinery condition and performance. The portable analyzer utilizes multiple sensor technologies to collect data degree-by-degree with respect to crank-angle. Measurement points include in-cylinder pressure, vibration and ultrasonic data on the cylinders. The system also measures vibration in the spectrum realm on the turbocharges and frame as well as angular velocity of the crankshaft. Using this information and built-in diagnostics, Windrock analyzers and software are able to assess the mechanical condition, performance and economic return of diesel engines.

Findings

Utilizing a comprehensive engine analyzer allows for the quick and reliable identification of a fault before the fault creates a catastrophic failure. As these valves were constantly being impacted by the piston, the risk of a valve failure (dropped valve) was very high. In addition, the higher and earlier peak pressure places more strain on the bearings, more stress on the cooling and lube oil systems as well. It is also very clear from this event that exhaust temperatures are not a reliable indicator of cylinder health and performance.



Machine
Protection



Condition
Monitoring



Performance
Analysis



Economic
Evaluation

Analysis Details

As shown in the engine report below (Figure 1), it should be noted that even though the peak pressure and compression pressure were the highest, the peak pressure angle was earliest, the exhaust temperature was below the engine average. This is caused by the higher compression pressure (17%) due to the smaller clearance volume which in turn results in earlier combustion and a higher peak pressure. When the cylinder 1L head was removed on Engine E8 (Figure 2), it could be seen that the piston crown had a polished ring with no carbon on it indicating that the valves were hitting the piston each scavenge stroke and as the piston crown rotated it kept a ring free of carbon. The valves also exhibited damage. Due to the damage to the valves from being impacted, all were replaced and same head re-installed with the correct 2 mm shim. After this maintenance, the engine noise was eliminated and peak pressure monitoring indicated the peak pressure was back to normal.



Diesel Engine Report
Diesel Engine Examples and Case Studies
Sulzer 16ZV40/48 Piston Hitting Valves

Unit ID: Sulzer Model: 16ZV40/48 Date: 12-19-16 09:49:30
 Unit Mfr: Sulzer Serial No: Run No: 1 Page: 1/6

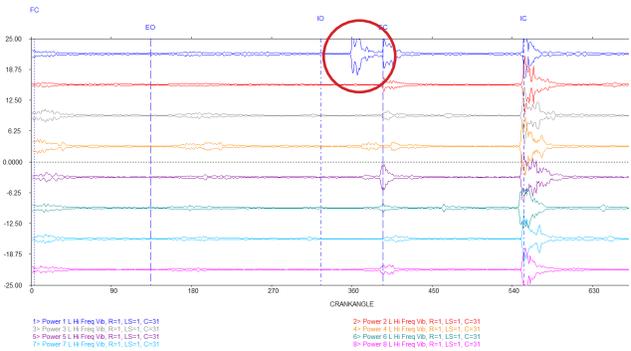
Stroke: 4 Offset(+ after TDC): 0.00 Engine runs: CW and Left/Right

Fuel Flow Rate, SCFH: *** Fuel Cost, \$ / day: *** Fuel Cost, (\$/BHP-day): ***
 Fuel Conv. (BTU/BHP-hr): *** Engine COV(%): 12.5 Gas BTU (Lower HV): 560.0
 Thermal Efficiency, %: ***

Engine Speed, RPM: 515 Engine Load (MW): 5.9 Engine Left Bank Air Man Temp: 25.0
 Engine Right Bank Air Man Temp: 25.0 Left Air Manifold Press: 1.3 Right Air Manifold Press: 1.3

Cyl	# of Cycles	Rack Position	MEP (psi)	BHP (hp)	Comb Start BTDC	Max Rise Rate (psi/deg)	Peak Firing Pressure (psi)					PFP Angle ATDC	Comp Ref 20 BTDC (psi)	Exp Ref 1% ATDC (psi)	Exp Temp 150 ATDC (°F)	Exhaust Temp (°F)
							AVG	STDEV	MAX	MIN	DELTA					
L1	31	0	235	562	1	65	1838	17	1869	1806	187 H	7.5	724 H	263	93	394
L2	31	0	218	522	3	58	1630	18	1683	1595	-21	9.3	693	257	89	417
L3	31	0	235	539	3	56	1612	13	1542	1591	-39	9.6	669	267	93	422
L4	31	0	227	542	1	61	1701	16	1741	1665	50	8.3	698	269	93	426
L5	31	0	210	503	3	57	1579	15	1612	1541	-73 L	10.5	669	253 L	88 L	411
L6	31	0	228	545	1	59	1709	15	1742	1681	58	8.0	705	267	94	440
L7	31	0	225	536	3	56	1642	14	1699	1616	-10	9.5	682	266	95	422
L8	31	0	236	570	2	62	1581	18	1621	1542	-71	10.6	686	263 H	106 H	441
R1	31	0	221	529	4	68	1677	17	1706	1648	25	9.8	687	260	92	401
R2	31	0	214	512	4	70	1607	15	1633	1574	-44	10.0	660	255	89	426
R3	31	0	216	516	4	65	1668	16	1692	1637	16	9.9	694	255	89	397 L
R4	31	0	226	542	3	55	1644	17	1687	1605	-7	10.0	705	266	95	390

(Figure 1) Peak Pressure Angle is early, exhaust temperature is below engine average



(Figure 2) Piston crown has a polished ring indicating the valves are hitting the piston each stroke.

About Windrock

Windrock offers industry-leading expertise in condition-based and performance-based monitoring solutions for compressors and engines across multiple applications. We design and manufacture portable analyzers and online systems at our headquarters in Knoxville, TN. In addition to our products, Windrock Technical Services analysts travel the world to help companies with their reliability and maintenance programs. We are proud to be a part of Dover Energy Automation (a Dover Corporation company).

