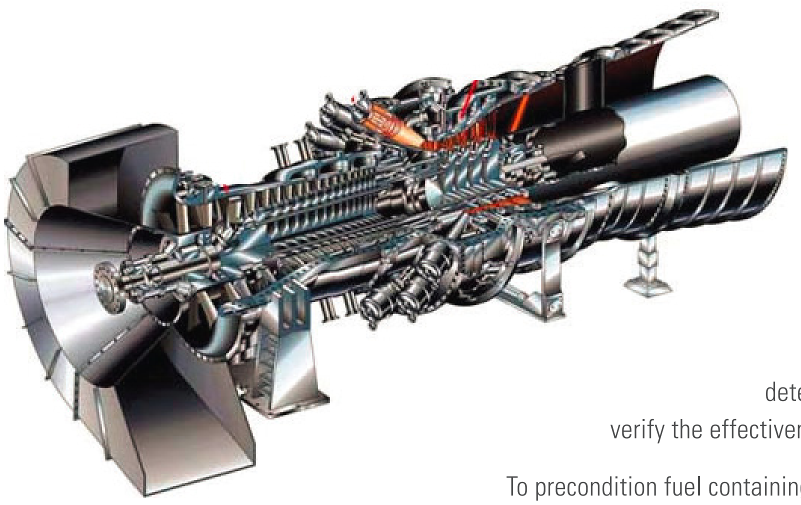
Spectro Scientific
Confidence in knowing

Monitoring Fuel Treatment with On-site Fuel Analysis

The Middle East has a plentiful supply of liquid fuel, and a high demand for power generation in growing economies. For these reasons, gas turbine power plants are especially popular, and the ability to run liquid fuel gives power plant operators flexibility.



Contaminants in liquid fuel, such as vanadium and other alkali metals, can cause corrosion problems in liquid fuel-fired turbines. Fortunately, there is a way to pre-condition the fuel to suppress alkali and vanadium effects before the fuel reaches the gas turbine. This process has become a prerequisite for installations using heavy petroleum fuel and also for many sites that use light distillate fuels. Implementation of this process requires on-site fuel analysis as an integral part of a fuel quality management program. Fuel analysis is first used to determine the extent of the required treatment, and later, to verify the effectiveness of the treatment.

To precondition fuel containing trace amounts of vanadium and lead, additives containing magnesium [Mg] are used primarily to control vanadic oxidation by modifying ash composition and increasing ash melting point. The proper Mg/V treatment ratio, causes magnesium orthovanadate [$3MgO.V_2O_5$] to form instead of vanadium oxide which is a corrosive liquid at typical operating temperatures. Magnesium orthovanadate has a much higher melting point of 1243°C (2269°F). Corrosion is controlled by ensuring that the combustion ash remains in a solid state on gas turbine blades and vanes. The magnesium additive also reacts with sulfur in the fuel, generating magnesium sulfate [$MgSO_4$] as an additional ash component. This compound is water-soluble and can be removed with periodic washing of the hot gas path with water, thereby recovering lost power.

Figure 1: A typical dosing injection system that can be installed to treat the fuel lines. (Ref: omggrouppumps.com)

Pretreatment starts with the delivery of the fuel, continues through fuel handling and ends only as the fuel is injected into the turbine combustor. An example of how this process should work features a SpectrOil Series MF Spectrometer (predecessor to the new SpectrOil 120 MF) used in a Middle East gas turbine power plant which detected a problem in the preconditioning system. This preconditioning system is shown in Figure 1. In this case, oil samples were tested in the fuel flow lines before and after the treatment unit.

Samples	Mg (ppm)	V +Pb (ppm)
Upstream	0.5	1.2
Downstream	0.7	1.1

Samples after setting change	Mg (ppm)	V +Pb (ppm)
Upstream	0.5	1.2
Downstream	3.8	1.1

The dosing unit controls the addition of the magnesium inhibitor to the fuel at a ratio of [(V+Pb) x 3)]. The pump flow rate of the dosing unit determines the quantity of inhibitor added and is set based on vanadium and lead concentrations in the incoming fuel as determined by the on-site SpectrOil MF. The SpectrOil is an ideal tool for this job as it can measure numerous elements simultaneously. A routine check of the before and after dosing unit measurements for magnesium showed no difference. The magnesium content of the fuel after pretreatment should be significantly higher than before pretreatment, so these results raised a red flag.

The first response of the operator was to repeat the sample test. Since the SpectrOil was on-site, results were available almost instantly as opposed to using an off-site lab, which could take several days for results. The results were the same as the previous test. The Operations team questioned the calibration of the spectrometer for magnesium. The spectrometer was then verified with standards containing certified magnesium concentrations. Fuel samples were also prepared with different magnesium inhibitor values, and all results were within expected limits – thus increasing confidence that something was amiss with the dosing system. The plant manager recommended that the operation of the inhibitor dosing pumps be checked and validated.

Results

Based on the plant manager's recommendation, maintenance personnel performed an urgent work order. They discovered a problem with the dosing unit. An unbalanced pressure at the mixing point between the fuel flow lines and the inhibitor dosing line prevented the required magnesium additive from combining with the fuel. In order to balance the pressure, Engineering recommended increasing the flow rate of the dosing pumps to return magnesium dosing to the required range. Analysis of the fuel with the SpectrOil MF after the fix confirmed that the dosing results were within specifications.

SpectrOil MF

Conclusion

Severe damage would have occurred to the gas turbine if the dosing problem had not been discovered and corrected in a timely manner. Sending oil samples to an outside laboratory would have added days or weeks to the troubleshooting process. Repair costs to the turbines would have been massive, and unexpected downtime would have been unacceptable. The value of on-site fuel analysis was demonstrated by diagnosing and fixing this problem quickly, thus preventing costly and unacceptable downtime for the power generator.

Spectro Scientific | One Executive Drive, Suite 101, Chelmsford, MA 01824-2563
978-431-1120 | www.spectrosci.com | sales@spectrosci.com | An ISO 9001:2008 company

CS_SpectrOil MF_Monitoring Fuel Treatment_2017-03-21