GAS TURBINE CASE STUDY

Castrol Power

Case Study 1
Gas Turbine Control Valve Varnishing
7 Years of Trouble-free Operation

Plant Description: GE Frame 6FA Gas Turbine
120MW CCGT Power Station (1 x GT / 1 x ST Configuration)

1. Problem

A GE MS6001FA (Frame 6FA) gas turbine installed in a 120MW Combined Cycle Gas Turbine Power Station was suffering poor reliability and availability due to failure or malfunction of the Moog servo control valves. Sticking servo-valves were causing frequent trips resulting in unplanned downtime and consequential trading penalties and loss of production.

2. Background

Failure and malfunction of servo-valves due to varnish deposits on the oil-wetted components is a common problem in gas turbine control systems. This can be a particular problem in combined lubrication and hydraulic control systems where the lubricant is subjected to more severe service and often extreme conditions of temperature and pressure.

Varnish formation is the result of a complex inter-reaction of a number of parameters associated with both oil condition and system operation. As a result of extensive testing, it has been shown to be closely linked with the level of total insolubles in the oil which results from base oil and additive degradation and gives rise to the formation of varnishes and sludges.

Total insolubles level is quantified by the Gravimetric “Patch Test” filtering the oil through a 0.8micron filter membrane. Oil in good general condition coupled with a low level of total insolubles normally results in reliable servo-valve operation. On the other hand, a high level of total insolubles almost invariably results in poor reliability of operation.

3. Operational Experience

Initial fill of the gas turbine lubrication system took place in 1998 using a conventional grade of anti-wear, gas turbine lubricant which was correctly specified in accordance with GE specification, GEK 101941, for service in the GE MS6001FA unit incorporating a load gearbox. Servo-valve malfunction and failure was a problem from quite early on in the service of the unit becoming an increasingly frequent occurrence during the latter part of 2000.

Oil analysis confirmed evidence of increasing degradation of the lubricant. Although the Rotating Pressure Vessel Oxidation test (RPVOT) indicated a value of 440 minutes, just above 50% of the new oil value for the grade in use, suggesting the oil was still in serviceable condition, other test results indicated an advancing state of degradation. Increasing levels of total insolubles, increasing total acid number and declining antioxidant content together indicated that the oil condition was such that varnish forming propensity had reached a level where it was likely to be problematic in service.

By mid-2001, servo-valve failure was a common occurrence causing an unacceptable incidence of unplanned outages and resulting in a serious negative impact on reliability and availability of the plant.

4. Solution - Castrol Perfecto XPG 32

During a planned outage in November 2001, BP's "Castrol Plus" site service operation was engaged to carry out a full oil change including tank clean out and complete system flush. Castrol Perfecto XPG 32 which, at the time, was a newly launched grade was selected to refill the system.

Castrol Perfecto XPG 32 high performance gas turbine lubricant is based on leading edge base oil and additive technology, taking excellence in lubrication and plant protection to a new level. Formulated using special highly refined base oil coupled with the latest in antioxidant technology, Castrol XPG 32 offers a high degree of oxidation resistance even under arduous service conditions of high operating temperatures and intermittent running or "peaking" duty, providing superior reliability in operation and long service life.

Now well proven in a wide range of applications with over 500,000 hours of field operational experience, Castrol Perfecto XPG 32 has demonstrated superior performance and extreme resistance to the formation of insoluble degradation products which result in sludge build-up in tanks and pipe work and varnish on bearings and hydraulic control valve components. By minimising the formation of such deposits Castrol Perfecto XPG 32 offers a valuable contribution to improvement in reliability and availability and to optimisation of the plant.

5. Post Oil Change Operational Experience

- **Impact on Servo-valve Malfunction and Failures:**
  The immediate effect of the change to Castrol Perfecto XPG 32 was the elimination of servo-valve malfunction and failures due to deposits and varnish from lubricating oil. This represents a dramatic step change in performance from earlier experience which has now been sustained for over 7 years of subsequent operation without an oil change.

- **Dramatic Reduction in Total Insolubles:**
  At the same time, a dramatic reduction was observed in the levels of total insolubles in the oil as a result of the extremely low sludge forming propensity of Castrol Perfecto XPG 32. Furthermore, this low level of total insolubles has been sustained to the present time. The value is currently running at 0.9mg of deposit per 100g of oil which is considered to be a very low level, even after more than 7 years in the system.

- **No Need for Other Control Measures:**
  Servo-valves are still exchanged on a routine programme every three years as a precaution but, on examination, are found to be consistently free of any evidence of varnishing. No other measures are in place or have been found necessary on this system to combat the problem of varnishing. No supplementary cleaning systems are in use in the form of ultra-fine filtration or electrostatic precipitation and no intervention has been made in respect of the lubricant in any way by partial oil change, additive treatment or any other action.

6. Conclusion

Castrol Perfecto XPG 32 is an effective and long lasting solution to the problem of varnishing and associated servo-valve malfunction in gas turbines.

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