2017 STLE Annual Meeting & Exhibition
May 21-25, 2017
Hyatt Regency Hotel,
Atlanta, Georgia, USA

Extended Abstract (Control ID 2617231)

Deriving Energy Efficiency from Coal Mill Gear Box Lubricant

TRACK OR CATEGORY: Gears

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Abstract:
The coal mill gear boxes are energy intensive equipments and consume significant amount of electrical energy during coal pulverization in thermal power plants. The industrial gear oil is being used in such equipments to provide lubrication and cooling of moving parts. The combination of additives were tried to reduce coefficient of friction and achieving reduction in energy consumption.

This paper provides the details of new industrial gear oil over reference oil, its physico-chemical, tribological properties and field evaluation. The new oil provided excellent thermal-oxidation stability, reduction in coefficient of friction and energy efficiency in the laboratory. The back to back run carried in coal-mill gearbox over a period of 2500 hours and power savings measured. The new oil provided power savings of around 6 percentages and analysis of two oils exhibited less than fifty percentage changes in kinematic viscosity at 40 ^{0}C and wear debris generation over reference oil.

Introduction:
Lubrication scientist's has shown interest in saving energy in almost all the energy intensive applications using viscosity modification as well additive approach. The researchers earlier have made an attempt to establish test methods for evaluation of energy efficiency characteristics of the gear oils [1-5]. A novel product has been developed and credentials established in the coal mill gearbox of thermal power plant.

Experimental:
This paper describes the details of new energy efficient industrial gear oil developed in the author's laboratory which includes its laboratory, tribological and field evaluations. Two industrial gear oils viz. energy efficient industrial gear oil (EIGO) and conventional industrial gear oil (CIGO) as reference oil were selected for the present study. These oils were subjected to evaluate for various physico-chemical properties as per ASTM & IP standards. It includes the gear oil oxidation test (GOOT) as per ASTM D 2893.

In order to compare the tribological performance of test oils (EIGO & CIGO) weld load (WL) and wear scar dia (WSD) done as per IP 239 and ASTM D 4172. Coefficient of friction of test oils was assessed in SRV test rig @ 200N, 50 ^{0}C, 50Hz, 1 mm for 1 hour. Reduction in coefficient of friction during test run was taken the criteria for energy saving potential. The FZG test machine (DIN 51354) used for gear oil testing was used to measure the amount of electric power consumption using precise microprocessor controlled energy meter at three different load stages (4, 6 & 8) at speeds of 1500 rpm, maintaining the oil test temperature of 80 ^{0}C (using heater coils and cooling water) for running of 1 hour at each load

stages. This enabled to assess the effect of both friction modifier (boundary) and viscosity (hydrodynamic) effect for test oils.

In order to validate the laboratory findings, test oils (EIGO vis. a vis. CIGO) was put for field evaluation over a period of 2500 hours in a coal mill gear box in back to back manner.

Results & Discussions:

EIGO and CIGO meets physico-chemical requirements as per DIN 51517 (CLP) Part 3 specification. EIGO exhibits much superior oxidation resistance to oxidation as compare to CIGO viz. ~10 % lower in gear oil oxidation test (figure 1) which ensures longer drain interval. This property is the result of optimized combinations of chemical additives incorporated in EIGO. EIGO provided ~ 17% lower coefficient of friction as compare to CIGO in SRV screening test (figure 2). EIGO also showed reduction in energy consumption of around ~8.8 % in FZG test (figure 3). This indicates that EIGO has potential of significant amount of power savings. EIGO showed average power savings of around 6% in the field evaluation. The analysis of aged oil samples collected at different intervals during the field validation exhibited more than 50% lower viscosity rise and around 50% lower wear metals build-up with EIGO over CIGO. This confirms the enhancement of oil drain interval and correlated well with the laboratory test results.

It has been concluded that by switching over to EIGO in a coal mill gear box (210 MW), an annual monetary savings of INR 20 lakhs (US $ ~ 30,000) is expected taking an account of 6 % average power saving and cost of electricity as INR 8.00 per KWh. Additionally, EIGO has shown potential of longer drain interval. Thus, this new energy efficient industrial gear oil (EIGO) may provide enhanced oil and gear box life, reduced down time and reduction in carbon footprint.

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Key words: energy efficiency, gear box, thermal-oxidation stability

Figure 1 : % reduction in kinematic viscosity in Gear Oil Oxidation Test (ASTM D 2893)

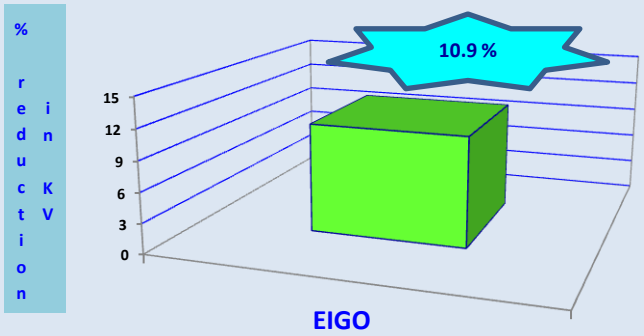

Figure 2: % Reduction in Coefficient of Friction (COF) in SRV test rig

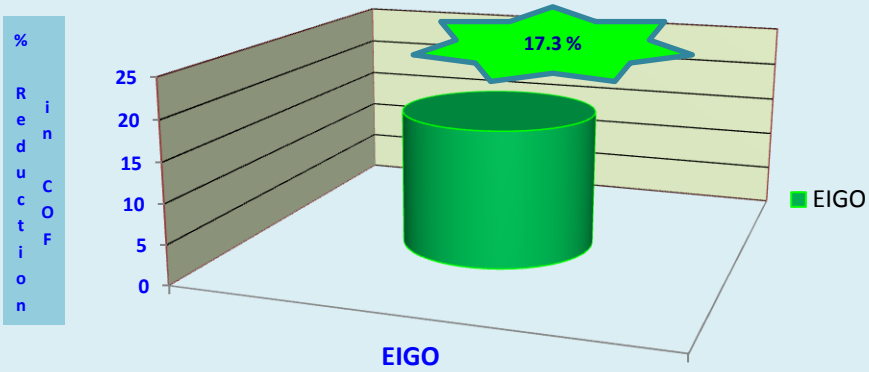

Figure 3 : % reduction in power consumed in FZG test of EIGO vis. a vis. CIGO