

DEVELOPMENT OF FULLY SYNTHETIC, LONG DRAIN AXLE OIL FOR DELHI METRO RAIL TRANSPORT

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ABSTRACT:

Urban metro rail net work is on an ever expanding spree, with all the major metropolitan cities not only in India but also in Asia-Pacific region, embracing this mass, rapid, light transport mode as an effective infra-structural solution for meeting the intra-city commuting needs of general public. These operations are signified by their continuous, uninterrupted and high load nature such that any disruption in the services due to mechanical failures results in huge furor and public discontent. Hence, the lubricants that one employs for these services should be highly reliable with continuous performance potential and more importantly with longer drain potential to avoid frequent shut downs for oil changes.

Gear boxes of these operations are a combination of cylindrical and bevel gears without offset and require high degree of oxidation stability, load carrying capacity, pitting and scuffing resistance besides good anti-wear protection from lubricants to be used in them. To offer longer drain capacities, fully synthetic platforms are preferred. Currently, only one lubricant from a MNC oil company is approved Worldwide for such operations by leading gear manufacturer

Authors' company, as the leading national oil company, thought it incumbent on it to develop a viable alternative which would be indigenous with sustained supply potential and more so cost effective. This paper outlines the performance attributes of such fully synthetic, long drain gear oil developed by us. OEM monitored, field validation results of this oil in their gear boxes of Delhi Metro Rail Corporation racks are presented. Based on the trial data accrued till 100,000 Kms, oil had performed exceedingly well in terms of oxidative viscosity control and wear build up thus corroborating the vast lab data generated prior to the field test.

INTRODUCTION:-

The urban metro rail network in India is developing at a very fast rate. The operation condition of these railroad net works are very significant because of their continuous and uninterrupted service. The lubricant used for these operations should have reliable and long drain potential to downtimes failure of operation due to lubricant change which results in public discomfort.

Gear boxes which are used in DMRC rail racks are a combination of cylindrical and bavel gears without offset and require high degree oh oxidation stability, load carrying capacity, pitting and scuffing resistance and good anti wear protection from the gear lubricants used in these gears. Currently only one MNC oil company worldwide is approved by such gear manufacturer OEM for this application.

As the major lubricant supplier to rail road industry in India for many years, Indian oil (IOC) tried to develop an indigenous, cost effective axle oil with long drain capabilities.

EXPERIMENTAL:-

For the development of subject oil, a well proven cost effective additive system and good shear stable VM were selected and oil was optimised in fully synthetic base oil in SAE 75W-90 Viscometrics meeting API GL-5 performance level. Complete lab data was generated as per OEM format .Based on the data submitted, OEM cleared the product for field trial in their gear boxes of Delhi Metro Rail Corporation (DMRC) as per their stipulated trial protocol

FIELD TRIAL :-

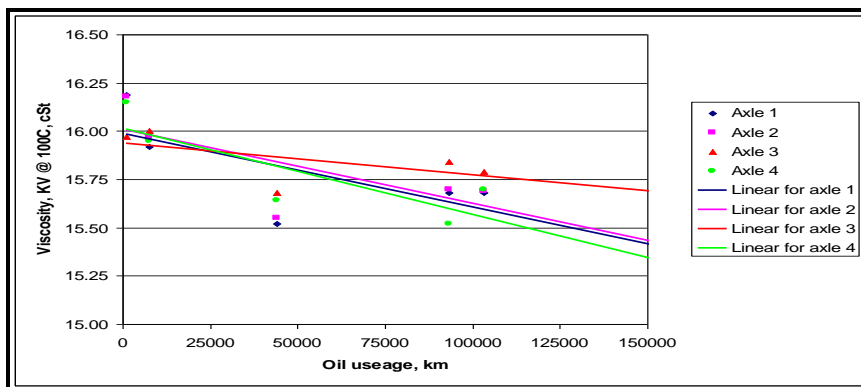
Trial was started as per the following guidelines of Gear manufacturer OEM

- As per the protocol, existing oil was drained out and test oil was charged into four axles which were allocated to IOC by DMRC. All of them were logged approx. 515000 Kms. At the time of trial initiation. No pre-trial visual inspection was carried out. Drained sample in one of the allotted axles (Axle -3) was black in colour as compared to other axle oils
- After 990 Kms. of running-in ,oil was flushed out from these axles and fresh oil was charged in all the four axles.
- After one month of trial which logged approx. 7554 Kms., samples were collected from these four axles for testing . Oil from axle-3 was black in colour
- Second sampling was done after three months of trial which logged approx. 43000 Kms. at that time.
- Similarly third and fourth samplings were done after seventh and ninth month of trial which logged 93300 and 103300 kms respectively.

RESULTS AND DISCUSSIONS;-

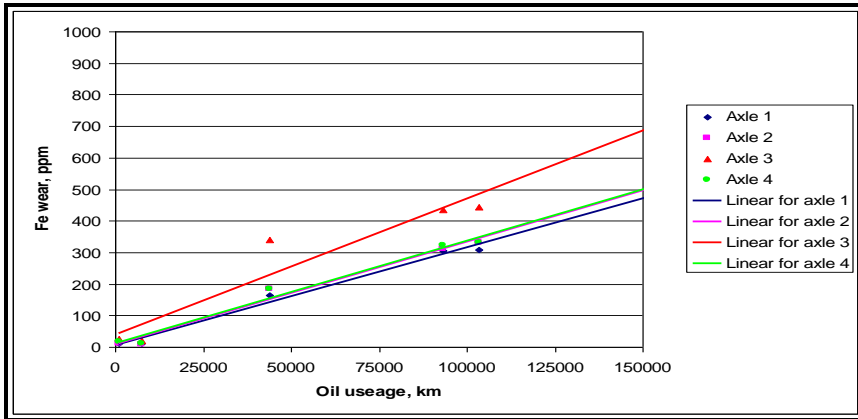
Results, discussion and trend analysis of these four axles are given below

TREND -1: Viscosity data

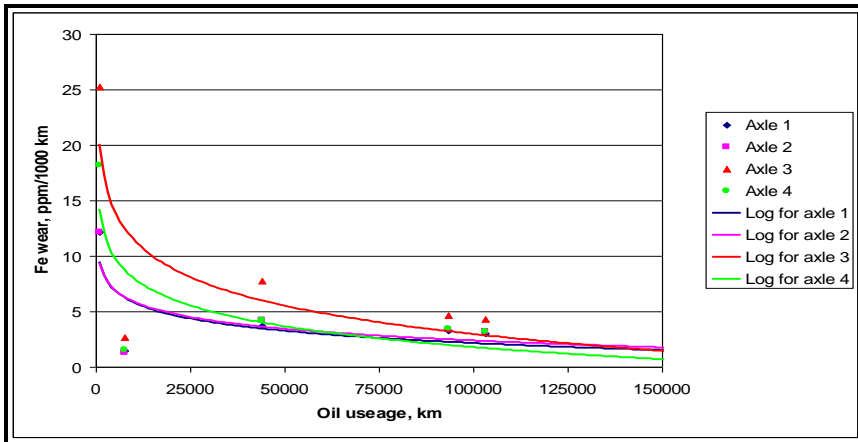


Axles 1,2 & 4 exhibit good oxidative controls as reflected by steady viscosity trend at 100 degree Centigrade. This also indicate that oxidative coupled wear is not occurring. However Axle-3 shows slight increase in viscosity because of oxidation.

TREND-2:- Iron Wear Build Up



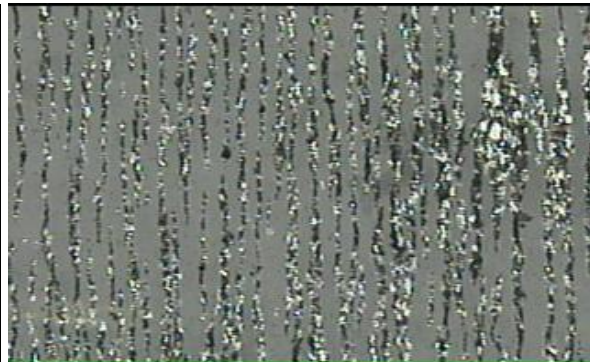
TREND-3:- Iron Build Up 1000 Kms :-



FERROGRAPHY:-

AXLE- 1, sample after 103300 Kms

AXLE -2 , sample after 103300 Kms



AXLE -3, sample after 103300 Kms

AXLE 4, sample after 103300 Kms



This sample shows excessive normal wear and particles



This sample shows wear is normal wear and reflects that fluid and axles are working in good harmony

Trend 2 & 3 indicate normal wear in axles 1,2 & 4 as reflected by the steady Fe content varying from 110- 350 ppm. Fe/1000 Kms. also reveals a very controlled normal rubbing wear in these three axles and well within the general industry limit of 5-7 ppm /1000Kms

Ferrogram of axles 1,2 &4 also correlates the normal rubbing wear pattern of these axles. However axle-3 indicates that there is higher wear since beginning. Ferrogram of Axle-3 also indicates some corrosive wear. DMRC and OEM agreed that this is not oil related wear but due to some mechanical problem. They treated this axle as an outlier

From the analysis data conducted at various intervals , it was found that

- Viscosity is stable with the VI maintained showing no loss in viscosity performance
- Fe wear is normal except in axle -3
- No Copper wear was seen
- TAN increase is under control
- Appearance of oil samples in all the axles is clear except axle-3

Axle-3 from the start of the trial is found to be culprit as drained out sample from this axle was black in colour as compared to oils from other three axles. The Fe wear was also high in this axle

APPEARANCE OF SAMPLES AFTER 103300 Kms OF TRIAL



Visual appearance of oils in axle 1 ,2 & 4 are quite clear and brighter ,much the same way as fresh oil, even at 103000 Kms. This also further proves the colour and oxidative stability of the oil

CONCLUSION :-

IOC successfully developed a fully synthetic , high performance long drain axle oil for major gear manufacturer OEM. The field trial data generated up till 103000 Kms. at DMRC Delhi highlights superior oxidative control, viscosity stability & Cu & Fe wear protection of the oil. Based on this superior performance data up till 1030000 Kms, OEM had granted Interim approval for this oil. Trial will conclude at 180000 Kms