Grease Composition for Lubrication of Journal Bearings in Sugar Mills

Grease Composition for Lubrication of Journal Bearings used in Sugar Mills

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In this paper we are reporting the grease composition for lubrication of journal bearings used in sugar mills. Traditionally in journal bearing of the sugar mills the bituminous and non-bituminous lubricating oils having higher viscosities are used. In recent years the grease having lower penetrations are used through different central lubrication systems. These products are performing well as compared to bituminous and non-bituminous lubricating oils.

We have developed a grease composition by using non-soap base grease thickener and desired additives for lubrication of the journal bearings used in sugar mills. The developed grease composition showed promising results during the field trails. The developed grease performed well as compared to the grease currently used for lubrication of journal bearings in sugar mills.

KEY WORDS: Sugar Mill Grease, Journal Bearing Lubrication, Clay-based Non-soap Grease, EP Additives.

INTRODUCTION

Cane crushing mills are designed to shred, crush and press the sugar cane between rollers in a series of mill stands. The journal bearings supports these rollers, commonly referred to as Top Roll Bearings, Receiving Roll Bearings and Discharge Roll Bearings and they work in extremely hostile environment that includes heavy loads and shock loading in addition to mechanical misalignment, contamination with hot water, acidic sugar cane juice, and other debris such as cane fibers, dirt, etc. Under these adverse conditions, the lubricant in use has to maintain a continuous film in between the wear components of these bearings. Generally the lubricant forms a tenacious continuous lubricating film, which reduces the operating temperatures and also lubricant consumption.

Traditionally, for sugar mill lubrication, the high viscosity polymeric type products (it may either bituminous or non-bituminous) fortified with solid or sulfurized compounds are used. They provide both adequate film thickness and proper load carrying capacity.

Grease lubricating the journal bearing of the crushing mills should have the following properties to function properly under hostile conditions:

a) Should be able to take severe loads coming on to the bearings, as the crushing mills are heavy and have to perform under high pressure to crush juice out of the cane

b) Should have excellent water resistance properties, as there is huge pouring and spraying of both cane juice and water over some mills which may cause the grease to wash away from the bearings and thereby may not be able to provide required lubrication to the components

c) Should have appropriate consistency to take the loads on the bearing and should not thin out during the entire operation

d) Should be easily pumpable through the grease lubrication system employed for lubricating the components.

e) The grease consumption should be minimal for providing lubrication to the parts

This paper will discuss the preparation of grease to be used in journal bearings of the crushing mills and its performance evaluation in laboratory tests and actual field evaluations. The performance characteristics of this product will be covered along with the product consumption and its impact on the sugar mill rolling process. In the developed grease composition, we have taken organoclay base grease along with additives to get desired performance.

Organoclay greases are referred to as 'non melt'. Their extremely high dropping point qualifies them for high-temperature applications, such as those found in steel mills, thermal power stations, cement plants and mining applications and they work under very dusty conditions.

Organoclay (non-soap) greases are prepared with organically modified Smectite clays. Smectite clay is a general classification for hydrophilic, expanding lattice structure clays. Both of the two main classifications, bentonite and hectorite are used in grease. Smectite clay is capable of entering into true chemical reaction through ion exchange sites contained on its basal plane surfaces. Unmodified clays are hydrophilic (water loving), and do not get lubricating oils. To make the clay an effective gellant for lubricating oils, mixed chain quaternary amines (called quats) are reacted onto the surface of the clay. The organic modification makes the clay hydrophobic (water hating) and, in turn, creates a product capable of swelling in lubricating oils and producing stable, efficient gels. Selection of the organic modification is quite specific to nature of the fluid to be gelled (1-6).

EXPERIMENTAL

1. **Greases Used for Trials**

   a) **Developed Sugar Mill Grease** - The sugar mill grease was processed in-situ by mixing high viscosity base oil with organoclay, polar activator and desired additives to achieve the properties required for lubrication of journal bearings used in sugar mill's hostile environment. The prepared grease posses higher load bearing ability, good oxidation resistance, excellent water and corrosion resistance and excellent ability to withstand high temperature.

   b) **Reference Sugar Mill Grease** – The grease currently in use for lubrication of journal bearings was taken as a reference grease.

2. **Apparatus**

   a) **Extreme Pressure and Anti-wear Properties** The test values are reported in Table-1.

   i) **Extreme Pressure by Four-ball machine** - The test was conducted as per ASTM D 2596 (7). The duration of the test was 10 seconds. A series of tests were performed with the prepared greases until the welding point was reached.

   ii) **Extreme Pressure by Timken machine** – The Timken OK load test was carried out by following ASTM D 2509 test (7). The test duration was ten minutes at each load unless the scoring occurs. The maximum load that does not produce scoring and the minimum load that produce scoring were reported as Timken OK loads and scores values. Timken machine produces condition similar to those of industrial gears and some slow speed automotive axles.

   iii) **Anti-wear by Four-ball machine** - The anti-wear test was also conducted in a 'Four-ball' machine as per ASTM D 2266 (7).

   b) **Roll Stability test** – This test was carried out using ASTM D 1831 test method (7).

   c) **Corrosion preventing test** - The test values are reported in Table-1.

Table 1
Typical test results – Developed Grease vs Reference Grease

Test	Developed Grease	Reference Grease	Methods
Appearance	Homogenous, smooth & tacky	Homogenous, smooth & tacky	Visual
Colour	Grey black	Grey black	Visual
NLGI Grade	2	2	NLGI
Dropping Point, °C	284	280	ASTM D 2265
Penetration, 60X	282	285	ASTM D 217
Roll stability, change in penetration from 60X	10	10	ASTM D 1831
Deleterious particles, number of scratches	Nil	Nil	ASTM D 1404
Oil separation, 100°C, 30h, % loss	1.80	2.10	ASTM D 6184
Oxidation stability, 99$\pm$1°C, 100 h, pressure drop in psi	2	2	ASTM D 942
Copper corrosion, 100°C, 24h	Pass	Pass	ASTM D 4048
Oil separation storage, % loss	0.50	0.50	ASTM D 1742
Water washout, % loss	1.64	1.89	ASTM D 1264
Emcor rust test	0.0	0.0	ASTM D 6138
Rust test	1	1	ASTM D 1743
Wear test, 1200 rpm, 40 kg, 75°C, wear scar in mm	0.48	0.50	ASTM D 2266
Four ball weld load, kg	250	250	ASTM D 2596
Timesn OK load, lbs	45	45	ASTM D 2509

i) **Emcor rust test** - The Emcor rust test was used to assess the ability of greases to prevent rusting in following bearing operated in presence of distilled water. It was performed as per ASTM D 6138 method in SKF Emcor test rig (7). As per ASTM test method, the prepared greases were tested in ball bearing running at 80+5 rpm under no applied load in the presence of distilled water.

ii) **Rust preventing test** - In this test the lubricated tapered roller bearings were tested at 52+1°C for 48 hrs fewer than 100% relative humidity as per ASTM D 1743 test method (7).

d) **Oxidation stability test** - It was carried out using oxidation bomb method, ASTM D 942 (7). In this method the sample of the prepared greases were oxidized in a bomb heated up to 99+1°C and filled with oxygen at 110 psi. Pressure was observed and recorded at stated intervals. The degree of oxidation after 100 hrs was determined by corresponding decrease in oxygen pressure.

e) **Water washout test** - It was carried out at 79+1.0°C as per ASTM D 1264 test method (7).

3. Methodology for Trials

Crushing mill's journal bearings work under severe conditions of heavy loads, shock loads, high temperatures and heavy cane juice and water interaction. One crushing mill has basically four rollers which are supported on journal bearings. The main roller is called "Top Roller" which is involved in crushing action, "Feed Roller" helps in feeding cane to the top roller, the roller involved for discharging of cane is "Discharge Roller" and another roller has an extra supporting function called as "Under Feed Roller". The role of grease is not only to provide lubrication under these severe conditions but also to provide proper sealing towards inclusion of excessive contaminants in the form of fibers from the cane which gets crushed.

On the basis of above hostile conditions, the grease performance is critical and thereby needs to be observed frequently. From observation point of view monitoring of grease performance is checked only on Top Roller, Feed Roller and Discharge Roller Bearings. The following parameters are generally monitored by the plant engineers:

a) Bearing heating is monitored manually by touching the bearing covers

b) Bearing temperature is also seen by cooling water jacket water outlet manually by touching water

c) Thinning out of grease is monitored visually

d) Proper pumpability of grease through the Lincoln Helios grease system is checked for consumption rate. Consumption is checked by taking out quantity of grease in one purging and weighing it

e) Washing off of grease is also checked visually

Since most of the observations taken by plant engineers were either manual or visual, and hence the observations are not reliable, we decided to quantify these observations in form of data. The following steps were taken during the trials:

a) Bearing housing temperatures were measured through Non Contact Infra Red thermometer on hourly basis

b) Grease samples, purging from points were withdrawn timely and were weighed to get per cycle total grease consumption

c) The temperature of the water coming out from cooling water jacket was checked through thermometer and were monitored on a regular intervals

d) Timer settings for grease purging were varied each day and bearings were allowed to run with varied grease quantity for full day crushing. Various parameters were recorded to observe grease performance at various grease quantity levels.

RESULTS AND DISCUSSION

Table -1 records the various parameters obtained with laboratory performance test rigs as per standard test methods. This table includes the test results obtained on developed grease and reference grease. The parameters obtained on the developed grease are comparable with the reference grease. The main requirement of the journal bearing grease is to have good load carrying capacity, excellent water and corrosion resistant properties. The load carrying properties were measured by using four—ball anti-wear and extreme pressure and Timken test rigs. The developed clay based grease showed excellent water resistant property. The additives used for anti-rust properties, exhibited desired results in static and dynamic Emcor rust tests.

Trial Results:

a) Monitoring of Temperatures

Top Roller, Feed Roller and Discharge Roller bearings for grease performance evaluation were monitored and the temperature profiles for these rollers were recorded under various conditions. We have taken four mills for trials to check the performance of the developed grease vis-à-vis reference grease. On completion of the trials, it was observed that the developed grease showed reduction in temperature on an average 2-3 °C as compared to the reference grease.

b) Monitoring of Grease Consumption

The lubrication of the Journal Bearings of crushing mills were done through automatic Lincoln Helios Grease lubricating system, the system purges the grease to the various lubricating points of the journal bearings through a channel of pipe lines and various grease purging points. The grease was smoothly pumpable through the automatic Lincoln Helios lubrication system without any problem. On taking out total quantity of grease purged in 1 cycle, we can calculate the total grease consumption of the plant on per day and per month basis. On completion of the trials, when we have calculated the total consumption of the developed grease, we observed that the slight reduction in the consumption of the grease when we compared the results with the reference grease.

CONCLUSIONS

The field trials results reveal that:

1) The developed grease showed good performance in the journal bearings of crushing mills as we observed consistent temperature readings along the bearing housing, we interpret that the grease is capable of lubricating the bearings under hostile conditions
2) The grease did not thin out during the operation and hence found suitable for high load and high temperature operations
3) The grease was found to be compatible with the automatic Lincoln Helios grease lubricating system and was easily pumpable through the system and pipelines
4) The water washout resistance of the grease was found to be satisfactory
5) Grease consumption was found to be slightly reduced as compared to the reference grease

Thus on the basis of trial results, we can conclude, when the developed grease used in journal bearings of crushing mills, the temperature was reduced to 2-3 Deg C and consumption of the developed grease was also slightly reduced as compared to reference grease.

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