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Glimpses of 16th Lubricating Grease Conference held at Chandigarh during February 2-4, 2014

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FIRE RESISTANT GREASE

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Development of Self Extinguishing Grease (FIREXTINT) for High Hazardous Fire Prone Industrial Application-modeled at COKE PLANT, Tata Steel

Fire safety is a major issue in many Industries typically at Steel Plants applications operating at high temperatures. Presently, conventional grease is being used in such applications. Imported Fire Resistant (FR) Grease is very expensive and not economically viable. Therefore a need was felt to develop self-extinguishing grease indigenously. Grease has been developed based on requirement which controls combustible gas generation is an effective way to put out flame when grease catches fire, without compromising the lubricating properties. Self-extinguishing FR Grease can provide safe operating environment for industrial machines where fire hazard is a matter of concern.

Abstract

Integrated Steel Plant is one of the most hazardous areas where harshest work environments are encountered. Many of the equipment operate in areas which are exposed to very high heat radiations. The temperatures at places go as high as 900^0C. The Equipment still needs to be lubricated in spite of the fact that the lubricant might create a fire hazard in the event of any spill over or leakage. One of such Steel Major; Tata Steel has expressed their need for Fire Resistant Grease for such applications. Their requirement was a product (Grease) which can provide lubrication at such elevated temperatures and still doesn't catch fire even if exposed to fire i.e. self-extinguishing grease. This grease which

would henceforth be called FIREXTINT Grease would be tried out in the "Charger plate" lubrication of one of the SCP machines of Coke Plant. The grease developed is high performance semi-synthetic grease having self-extinguishing properties. Candidate Grease was developed and tried out in the said application and found to be working satisfactory. No instance of fire or outage is reported ever since this was introduced. Performance of the grease is encouraging and therefore, TATASTEEL has decided to horizontally deploy this grease in several such applications including the other SCP machines of Coke plant.

Theoretical Consideration:

FR grease is recommended for Industrial applications where fire resistance property of the grease is required. It is recommended for use in lubrication of bearings, conveyers of steel plants where direct contact with molten metal or flame is expected. It is not ignited even in direct contact with the molten metal at 900˚C.

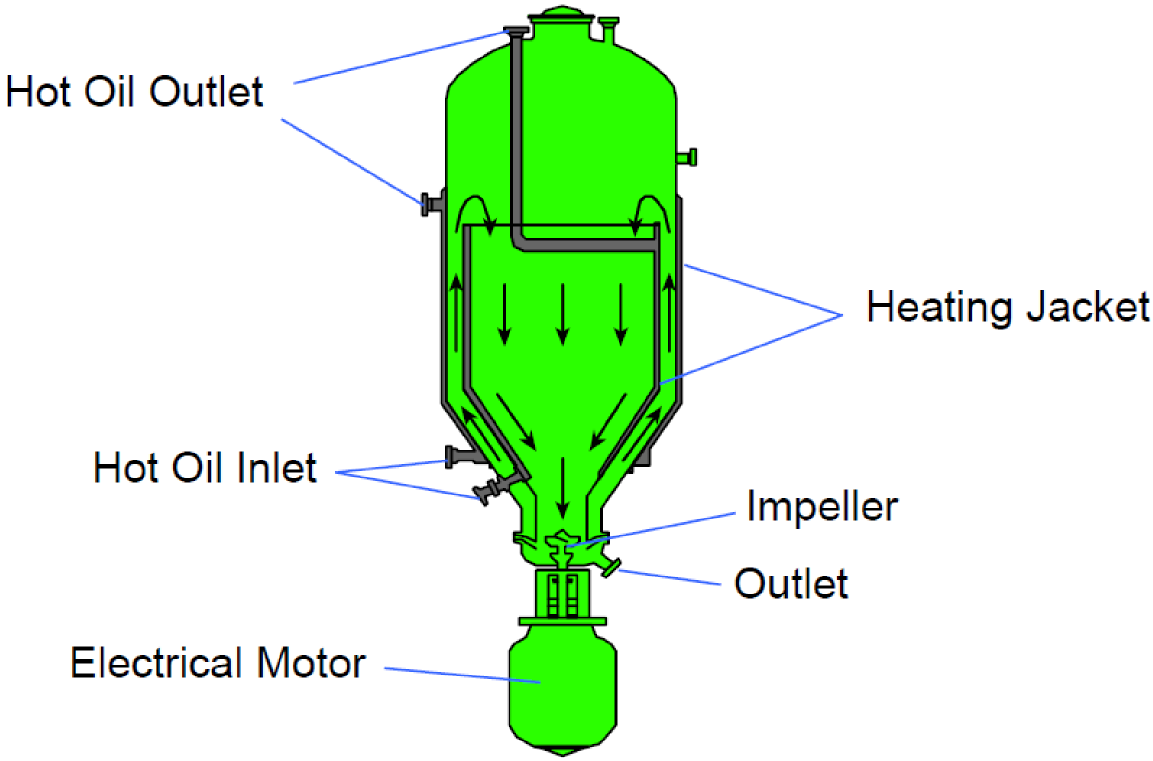
Fire resistant grease is being specifically used in Coke Plant pusher Plate. The pusher plate charges the coal into the oven by sliding on a plate. FR Grease is used to avoid this sliding friction between the two plates. The pusher plate enters into the oven during charging and so does the grease. Inside the oven the avg. temperature is about 900-1200 degree Celsius. So the FR grease is also exposed to this high temperature. Conventional grease on Pusher plate solidifies at very high temperature which can catch fire. That's why fire resistant grease is used in this type of application.

Processing:

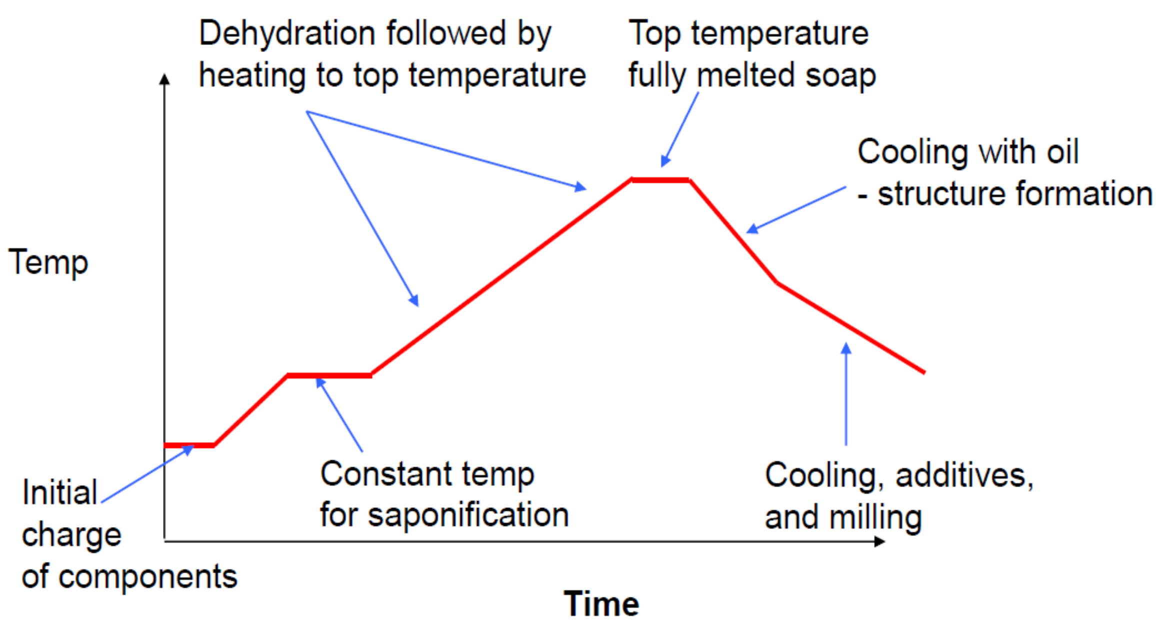
For formulating FIREXTINT Grease, base fluid and performance additives are selected according to specific criteria with an emphasis on the property to prevent generation of combustible gas at elevated operating temperature. Specific care is taken during manufacturing of the grease to impart fire resistant characteristics.

The grease is manufactured by Contractor Processing by combining oil solutions of dissolved fats/fatty acids in Group II/III Mineral and

Synthetic Oil, metal hydroxide. The oil is heated above ambient temperature (around 50^0C) and dry materials are added through top access with one-half total oil metered in and the vessel is sealed. Soap is cooked by circulating hot oil through reactor jacket. Cooking temperature rises about 205^0C to 215^0C at a pressure of around 55-75 PSIG. Half an hour (approx.) of residence time is given at 215°C. Then pressure is released through vent to dehydrate the mass. Soap is transferred to finishing kettle followed by a flush of Synthetic base Total time in the contactor is Three hours. Homogenization starts at around 150^0C. Ester based high performance additives are added to the grease prior to milling. Now, sample is taken out through homogenizer for evaluation.



Generalized Soap Grease Process



Process Parameters Influence Grease Properties:

Process Parameters	Property
Maximum heating temperature	Complete reaction
Cooling rate	Fiber formation
Alkalinity	Stability
Stirring time and rate	Texture/appearance
Milling/Homogenization	Homogeneity
Temperature of additive addition	Appearance/odor

The output of grease production depends upon the following process:

- Control of raw materials
- Temperature (& pressure)
- Rate of heating and cooling
- Mixing /Milling
- Homogenization

Now the finished grease is subjected to physico-chemical evaluation.

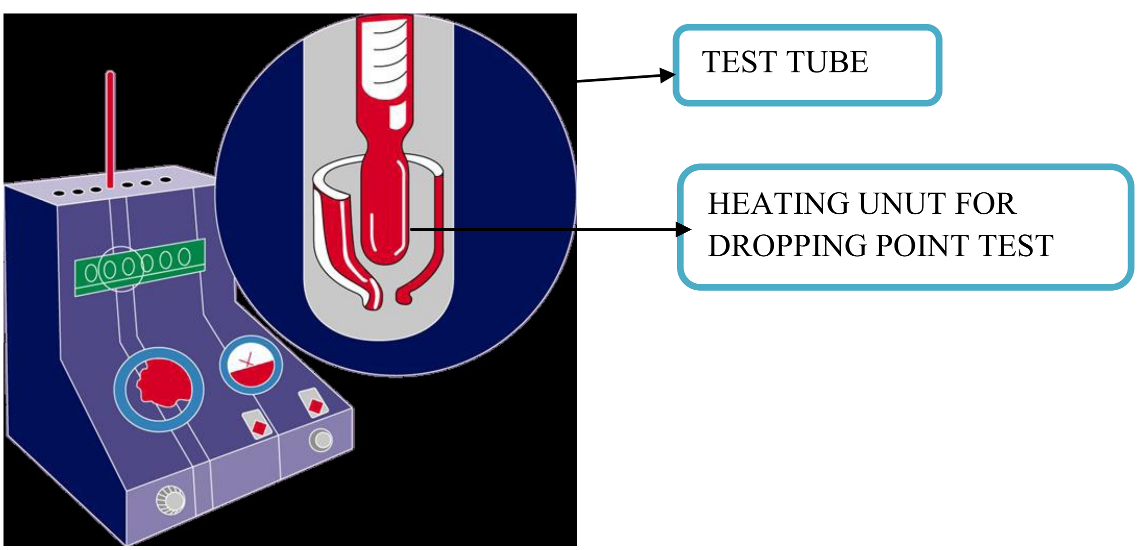
Results:

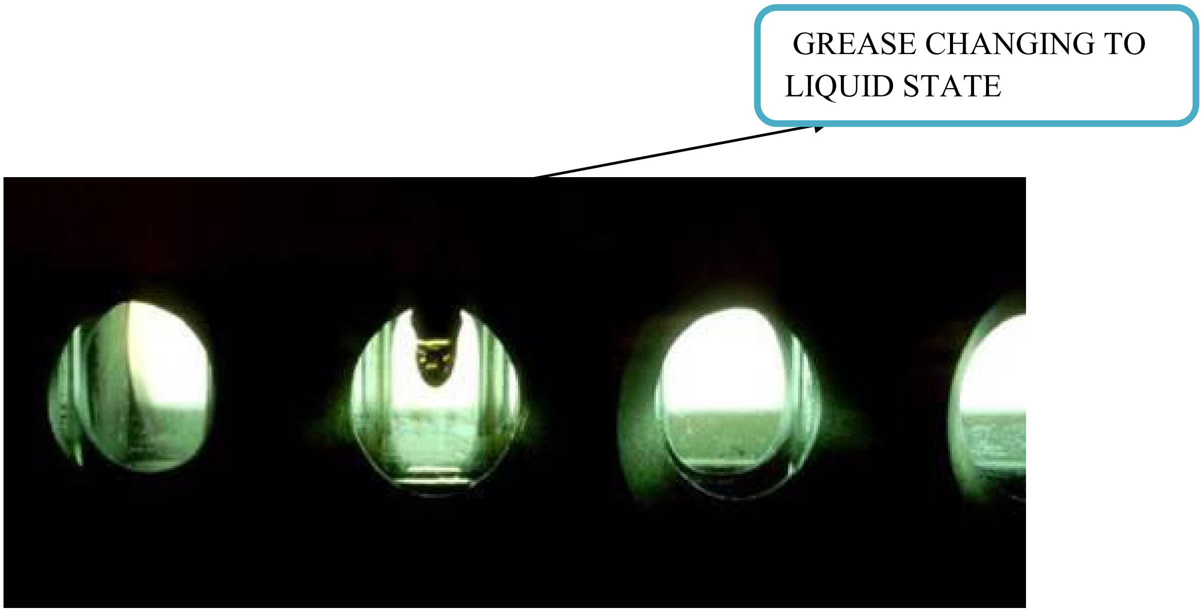
Cone Penetration Test (ASTM D217)

As per ASTM D217 FIREXTINT Grease was evaluated. The worked penetration at @25 Deg C and after 60 Strokes it is of NLGI -1

Grease Dropping Point Test(ASTM D566)

The Dropping point of the FIREXTINT Grease is found to be more than 200 Deg C.





Four-ball Test (EP)

For extreme pressure /anti-wear/friction ASTM D 2596 test was carries out and the weld load was found out. The value of the tested weld load is above 250 kg.

Water Wash-out Test

ASTM D 1264 was carried out for washing out tendency of the candidate grease and it was found about 10% which is very encouraging.

Performance Standards:

Meets Fire resistance property as per vertical gauge test Method A and Fire resistance test @ 900˚C, Method B as per specification.

Two types of samples with slight variation in formulation were subjected vertical gauge test Method A and Steel Ball Fire resistance test @ 900˚C. One sample (HIGHTEMP A) failed in fire resistant test at 900^{0}C. The other sample (FIREXTINT) passed both the test. Data presented in this paper is of FIREXTINT Grease.

Test Summary:

GRADE PROPERTIES	FIREXTINT GREASE
Colour	Brown
Drop Point deg. C	200
Worked Penetration@25 deg.C(Strokes)	NLGI- 1
Weld Load, Kg min.	>250
Base oil viscosity in cst@40 deg,C	ISO VG 100
Copper corrosion test	Negative
Water Washout,% Wt.	<15
Vertical gauge test(Fire resistant)	Difficult to burn and extinguish in a short time
Fire resistant test-Steel Ball@900 deg C	No ignition

Offline test conducted at user end:

Sample of developed FR Grease (FIREXTINT) were subjected for offline trial. First of all, both the sample , FIREXTINT & Imported FR Grease were further subjected to compatibility evaluation as per ASTM procedure and different blends, as recommended in ASTM standard were tested for recommended parameters which are tabulated as below.

Compatibility Test		
Test Result of Original Samples		
Parameters	FIREXTINT Grease	Imported Grease
Penetration 60X	318	323
Dropping Point, ^0C	256	193

<table>
<tr><td colspan="5">Test Result of grease blend in different proportion as per ASTM D 6185 - 97</td></tr>
<tr><td>Parameters</td><td>50 : 50 Blend</td><td>10 : 90 Blend</td><td>90 : 10 Blend</td><td>Remarks</td></tr>
<tr><td>Converted from 1/2 scale</td><td>321</td><td>319</td><td>318</td><td rowspan="2">Converted from 1/2 scale</td></tr>
<tr><td>Dropping Point, deg C</td><td>227</td><td>212</td><td>233</td></tr>
</table>

The result shows that both the samples are compatible in various blends as per ASTM D 6185 – 97 test method.

Self extinguishing property has been determined especially by two test methods:

i) Cup Test

ii) Strip Test

i)Cup Test

a. Grease samples were evenly spread in a metal cup having approx. 70 mm diameter & grease spread thickness of approx. 10 mm.

b. Ensured no air trapped inside the grease spread

c. A steel ball of 1/4th inch in diameter were heated to 800 deg C for approx. 5 min and the red hot steel ball was quickly dropped into those samples.

d. With the help of stop watch, time to self-extinguishing of the flame was recorded in all cases as under.

Results according to Cup Test

Sample	Time taken for flame to self-extinguish
Imported FR Grease	30 Sec
FIREXTINT Grease	31 Sec
Normal Li-Com Grease	76 Sec

Observation: Flame got extinguished in about 30 sec and no oil bleed / oxidation were noticed in & Candidate Grease.

ii) Strip Test:

e. Grease samples were evenly spread in a metal strip approx. 16 inch X 3 inch & grease spread thickness of approx. 6 mm.

f. Ensured no air trapped inside the grease strip

g. A steel ball of 1/4th inch in diameter were heated to 800 deg C for approx. 5 min and the red hot steel ball was quickly dropped into the strip.

h. With the help of stop watch, time to self-extinguishing of the flame was recorded as well as spread of the flame was noted.

<u>Results according to Strip Test</u>

Sample	Time taken for flame to self-extinguish
Imported FR Grease	35 Sec
FIREXTINT Grease	36 Sec
Normal Li-Com Grease	83 Sec

Observations:

1. FIREXTINT grease formed min cavity around compared to all other samples.

2. No oxidation or blackening of oil observed in case of FIREXTINT.

3. Oil bleed was minimum in case of Grease sample.

FIREXTINT GREASE

Photographs of fire extinguishing Grease offline test

Industrial Application:

The candidate grease is recommended for Industrial applications where fire resistance property of the grease is required. It is recommended for use in lubrication of bearings, conveyers of steel plants where direct contact with molten metal or flame is expected. It is not ignited even in direct contact with the molten metal at 900˚C.

Performance Benefits:

· Excellent fire resistant property

· Excellent protection against oxidation and water washout.

· Outstanding structural stability

· High load bearing capacity.

· Extended & improved bearing life.

Field Trial Conducted at User’s End:

1. Fire resistant grease is being used in Coke Plant pusher Plate.
2. The Greasing system is CGS type (centralized greasing system) .This CGS system has not got any filtration in the line.

3. There is no bearing where this grease is used. Actually the pusher plate charges the coal into the oven by sliding on a plate. Fire Resistant Grease is used to avoid this sliding friction between the two plates. on a pusher plate there 12 greasing points on a pusher plate.(6 on each side of the plate)

4. Pump which is used for greasing is a multi-line one and the pump make is of FAW.

5. Pumping rate is 5cc/strokes. In average there are 28 strokes per shift (8 hrs.) which is about single

stroke in every 20 minutes.

6. The maximum distance the grease would need to travel is about 15 meters.

8. The pusher plate enters into the oven during charging and so does the grease. Inside the oven the avg. temperature is about 900-1200^0 C. So the Fr grease is also exposed to this high temperature. The grease on Pusher plate solidifies at very high temperature which can catch fire. That's why fire resistant grease is used in this application.

Benefits from FIREXTINT Grease in Steel plants over Conventional Grease

	Before (Conventional Grease)	After (Firextint)
No. of fire instances	1/month	1/month
no. of stoppages due to fire	1/month	Nil
Greasing Cycle	12 minutes	20 minutes
Greasing Quantity	5 cc/Stroke	5 cc/Stroke
Consumption/unit coke plant/quarter	1533 Kg.	1037 Kg.
Cost on account of breakdown	55 Lacs /Quarter	Nil

High Temperature properties:

Two major tests -Vertical Gauge Test (subjected to

30 Deg C) & Fire Resistant Test-Steel Ball @900 Deg C for 15 minutes was carried out to find out high temperature and ignition resistance properties. These properties in the candidate grease are generated due to addition of proper ester based additives these additives have very low volatility and high flash point & a viscosity index of around 180 which give them an excellent resistance to ignition in high temperature application.`

Pumpability:

The candidate grease shows good flow properties which is essential for grease to be used in steel plant application. Often the grease is dispersed throughout the centralised dispensing system. The developed grease possesses good pumpability characteristics particularly at low shear rate.

Bio-Degradability:

The Ester based additives used in the fire resistant grease are environmental friendly unlike other additive dosage. This FR grease is 94% bio-degradable. These are not only readily bio-degradable but also non-hazardous in water.

Conclusion:

The data presented in the study indicate that the developed fire resistant grease possesses excellent properties suitable for used in high temperature zone like coke plant in steel industry. The application of the developed grease is expected to prolong the segment life of pusher plate and also lead to much higher no of "heats" between relubrication.

Considering the technological demand such fire resistant grease formulated with special flame-retardant additives will be very useful for the industry to meet FR requirement.

Enhancing High Temperature Life Performance of Lithium-Complex Greases

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Abstract

Present research work focuses on the study of enhancement of the high temperature life performance of Lithium complex greases. Effect of complexing agents, base oil type and viscosity, conventional and solid additives, etc. has been studied in detail. Greases were evaluated through tribological rig FE-9 and high temperature life rig as per ASTM D 3336. A novel approach was followed by applying rheology to study apparent viscosity at subzero temperatures and comparing rheological data with tribological data obtained as per ASTM D 1092. An effort was also made to correlate rig test data with Pressure Differential Scanning Calorimetry (PDSC) study findings.

Keywords – Complex grease, Tribology, Rheology, PDSC

Introduction

Lubricating grease guide [1] describes that the easiest way to understand a Lithium complex grease is to compare it with Lithium 12-hydroxystearate base grease. Lithium complex grease has significantly higher dropping point (~50° -100° C) than Lithium grease and therefore has wide-temperature operability. This feature is very important as 'usually for every 10° C increase in working temperature, 50% reduction in grease working life is reported [2]. Fundamentally the high temperature life of a lubricating grease depends on the oxidation stability of base oil at that temperature, type of thickener, presence of additives at application point and operating conditions like load, rpm etc.[3]. Out of these factors 'oxidation of base oil' is an inherent property of base oil. Therefore selection of an appropriate type of base oil can significantly improve the high temperature life of a lubricating grease. Similarly selection of appropriate types of thickeners and additives can increase high temperature life of a lubricating grease to 30 – 40% when compared with non-additized grease [4].

A grease researcher faces three-fold challenges during the development of a lubricating grease namely development of grease to meet specifications, simulation of actual working conditions and application suitability. To deal with these aspects a fundamental understanding of grease manufacturing and lubrication mechanism is required. Author's laboratory earlier published an exhaustive research article on the 'Elevated Temperature Performance' of variety of lubricating greases in rolling element bearings [5]. In this study it was observed that high temperature life [FE9-L_{10} at 140° C] of a Lithium complex grease was a meager 27 hours compared to a whooping 225 hours recorded by Polyurea grease. This observation motivated author to develop a Lithium complex grease to record at least 200 hours high temperature life [FE9-L_{10} at 140° C]. The research work presented in this paper is the study of the development of a multi-purpose Lithium complex grease having wide- temperature operability.

Experimental

Grease Manufacturing

Lithium complex greases were prepared by batch process. Four different types of complexing agents were used in preparing Greases A, B, C and D. Greases were also doped with nearly same percentage of the anti-wear, EP and anti-oxidant additives. Standard test methods such as BIS/ASTM / IP were followed in determination of physico-chemical properties of the greases.

Rheological Analysis

Rheometry analysis of lubricating greases was done using 'MCR 301 Rheometer' (M/s Anton Paar). Sample was taken in a disposable aluminum cylinder. Sample was cooled / heated to desired test temperature and was maintained at this temperature for half an hour before running the experiment. To determine apparent viscosity shear rate was varied from 0.1 to 25 sec^{-1}. Apparent viscosity was also determined by using a rig as per ASTM D 1092 test method. The temperature profile runs were carried range in the range 120° – 180° C out at 1000 sec^{-1} shear rate. Oscillating Rheometry was applied to determine the structure stability of greases.

Pressure Differential Scanning Calorimetry (PDSC) analysis

Oxidation induction time (OIT) of the lubricating grease at desired test temperature was determined as per ASTM D 5483 test method using Q20P Pressure Differential Scanning Calorimeter from M/s TA Instruments.

Scanning electron microscope (SEM) study

To investigate the grease soap fiber structure, size and morphology, SEM studies were performed on the grease samples using HITACHI S-3400N scanning electron microscope at room temperature. Film of a speck of grease sample was made on a micro-slide by means of a spatula and this film was rinsed two times with 70:30 v/v, Hexane/Toluene mixture to remove the oil from the soap fiber matrix. The slide was then dried with air blower and kept at ambient temperature for 24 hours in a dust free chamber. Film was then mounted on a carbon tape and was sputter coated with gold film and SEMs were recorded.

High Temperature Life Analysis

High temperature life of the greases was determined by following ASTM D 3336 test rig and FAG FE9 test rig. Detailed description of FAG FE9 test rig and method of determination of grease life is given in reference no [5].

Results & Discussion

Basic Studies

Both organic (Benzoic acid, Adipic acid etc.) and inorganic (Chlorides, Carbonates etc.) compounds are widely used as complexing agents for Lithium greases. Studies on correlation between the type of complexing agent used and the properties of resulting greases have been well documented [6, 7 & 8]. It is the structure of the resulting co-crystallised salt that determines the oil retention, additive transportation and rheological properties of the resulting grease. Detailed discussion of these factors with respect to a variety of the complexing agent has been reported [9]. Properties of greases prepared with different complexing agents are given in Table 1. SEM micrographs depicting the micro-structures of the complex salts for Grease A, B, C and D are given as Figures 1, 2, 3 & 4 respectively.

Table 1- Physico-chemical properties of lubricating greases

S. No.	Property	Grease A	Grease B	Grease C	Grease D
1.	NLGI grade	2	2	2	2
2.	Penetration (P_{60})	270	279	290	278
3.	Dropping point, (°C)	>270	260	>260	258
4.	Oil separation, %	1.5	1.4	1.8	2.2
5.	L_{10} life, hours	34.28	21.18	27.63	30.76
6.	OIT, 180° C, min	17.1 at 210° C	97.6	106.7	112.5

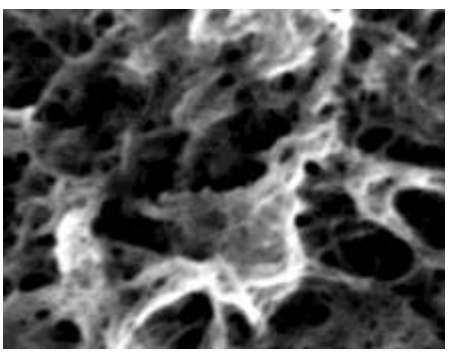


Figure1- Grease A

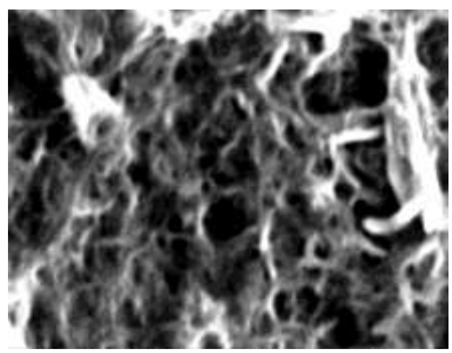


Figure 2- Grease B

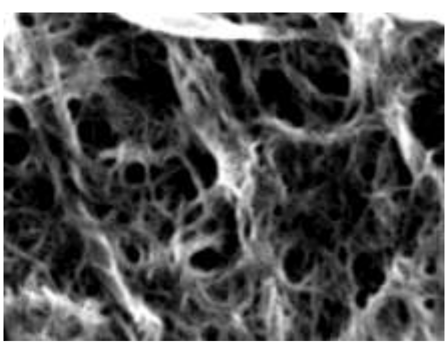


Figure 3 -Grease C

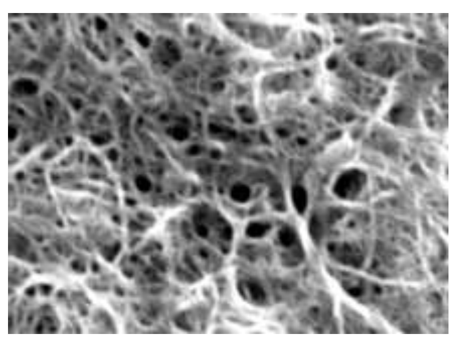


Figure 4 - Grease D

It can be noted from Table -1 that Grease A had overall best properties. SEM micrograph of Grease A showed a sheet-like cross-linked structure indicating more oil retention capacity. Micro-structure of Grease D was thin and fibrous in nature indicating thickener network. Micro-structures for Grease B and C were in between these two extremes. Highest dropping point, OIT and L_{10} life of Grease A was related to its strong cross-linked micro structure. Grease A was selected for further research work.

Rheometry Analysis

Grease A was modified with variety of lubricity additives for improvement in the high temperature life. Three more greases namely Grease A1 (Ester 1), A2 (Ester 2) and A3 (Diester) were prepared. To begin with a temperature profile of greases A1, A2 and A3 was done at 1000 Sec^{-1} shear rate. Shear rate was kept high to simulate the actual application conditions and eliminate the effects of sample history. Results of temperature profile run are given in Figure 5. High Temperature life at 177° C (ASTM D 3336) for Grease samples A1, A2 & A3 were found to be 131, 85 and 80 hours respectively. Keeping in view the ASTM D 3336 data and temperature sweep it can be argued that Ester1 had better compatibility with the thickener structure of Grease A. A structural change was also seen during the temperature range 135° – 160° C for Grease A1 indicating re-structuring of sheet-like fiber network to accommodate more oil. To understand this better, an amplitude sweep run (Strain from 0.1 to 100 %, ω = 25 rad/sec) was done at 177° C on Grease A and A1. The results are given in Figure 6. It can be seen that storage modulus (G′) which is an indicative of the solid-like behavior of samples became nearly half for Grease A1 when compared with Grease A. A clear indication of the structure transformation with Ester1 which made grease sample more flexible and fluid like. Grease A1 was selected for study of extreme pressure additives.

Figure 5 – Temperature sweep for lubricating greases A, A1, A2 & A3

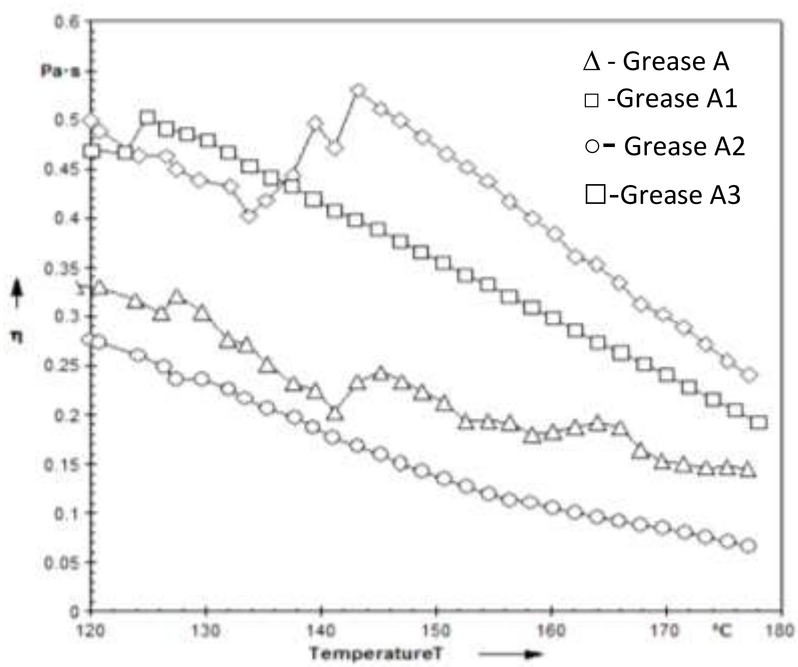
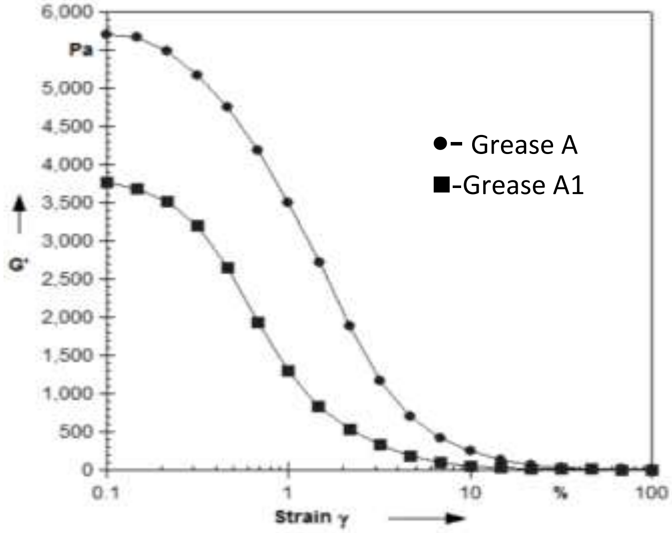
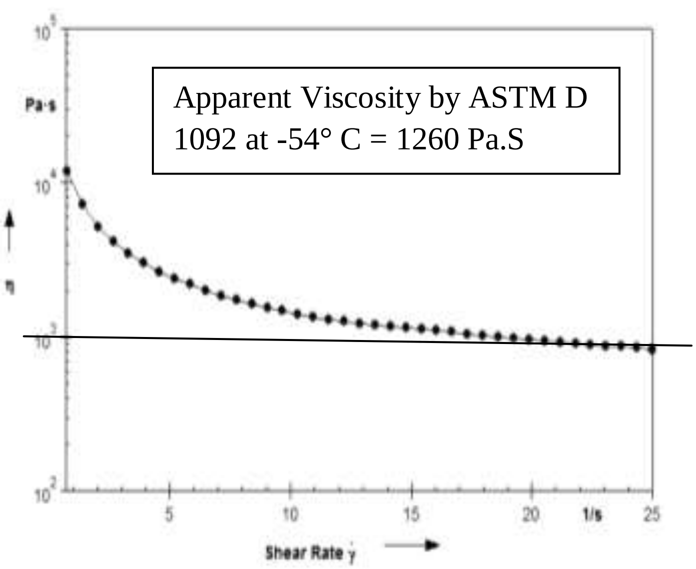


Figure 6 – Amplitude sweep for lubricating greases A & A1 at 177° C



Keeping in view 'wide temperature operability' criteria for the development, low temperature behavior of Grease A1 was assessed through ASTM D 1092 test method and Rheometry. ASTM D 1092 test method is used to estimate the pressure-drop or required pipe diameters in a distribution system for grease to flow. However, the method takes nearly 2-3 days time for one sample testing say at (-)54° C. Rheometry can be a quick assessing tool for as it requires only half an hour's time for one experiment. Rheogram in Figure 7 shows low temperature shear stability of Grease A1 at (-)54° C. Apparent viscosity at $25 sec^{-1}$ by ASM D 1092 was 1120 Pa.S whereas by Rheometry it was 1025 Pa.S. This data is encouraging as it falls well within the reproducibility limits mentioned in ASTM D 1092. However, more number of greases are to be tested at different subzero and ambient temperatures at different shear rates to increase the confidence interval in results interpretation obtained using rheometry.

Figure 7 – Dependence of viscosity of Grease A1 on shear rate at (-) 54° C



Enhancing High Temperature Life

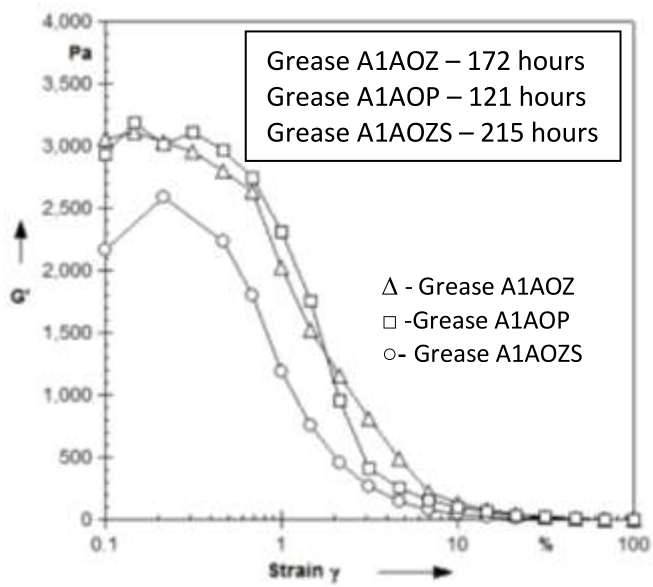
First step taken to enhance the high temperature life was prevention of the oxidation of grease at test temperature. Three types of anti-oxidants were doped in equal dosage in Grease A1 and Grease A1AO (Aminic antioxidant), Grease A1PO (Phenolic antioxidant) and Grease A1APO (Amine Phosphate antioxidant) were prepared. Around 3 psi drop in oxygen gas pressure was observed for all greases as per ASTM D 942. However, PDSC data at 200°C clearly distinguished between the type of anti-oxidant and its efficacy. OIT was maximum for aminic type of antioxidant.

Table 2 – OIT values of greases doped with different types of anti-oxidants

S. No.	Property	Grease A1AO	Grease A1PO	Grease A1APO
1.	OIT, minutes	53	35	44

Grease A1AO was selected for study of extreme pressure and solid additives. Three greases were prepared namely Grease A1AOZ (Zinc chemistry EP additive), Grease A1AOP (Phosphorus chemistry EP additive) and Grease A1AOZS (Zinc with solid additive). FAG FE 9 test rig were employed for study of the high temperature life. Greases were also studied using oscillating Rheometry (strain sweep from 0.01 to 100% equivalent to shear rate variation from 0.001 to 1.0 Sec^{-1}) for structural strength at 177° C. Rheogram is shown as Figure 8 and data obtained for high temperature life from FAG FE 9 test rig at 140° C are given in inset.

Figure 8 – Amplitude sweep for Greases A1AOZ, A1AOP and A1AOZS at 177° C



Generally when solid additives are added in a liquid dispersion medium an increase in G′ or system viscosity is observed with increasing shear rate. Interestingly, when solid additive is doped in Grease A1AOZ the resulting sample behaved more like a fluid (lower G′ values) indicating flexible nature of the thickener fiber-network. Similar observations for solid additives life Graphite, MoS_2 and PTFE have been reported earlier for Lithium greases [10].

Conclusions

1. A multi-purpose Lithium complex grease with appropriately chosen complexing agent, lubricity additive, anti-oxidant and solid additive developed and resulted in more than 200 hours high temperature life as determined using FAG FE 9 test rig.
2. Complexing agent has a great effect on the thickener fiber structure as seen through SEM and rheological analysis.
3. Addition of esters as lubricity enhancing additive greatly alters the structure of the Lithium complex grease.
4. Rheometry is a very useful tool in determination of the flow properties of the greases and structural determination. It was successfully used to correlate apparent viscosity data obtained as per ASTM D 1092 test method at subzero temperatures.
5. Aminic anti-oxidant had better compatibility with complexing agent and lubricity additive. PDSC successfully distinguished efficacy of various types of the anti-oxidants.
6. Use of solid additive with Zinc type extreme pressure additive significantly enhanced high temperature life of the Lithium complex grease.

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Latest developments in Steel Plant Lubrication

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Tata Steel

ABSTRACT:

The trend to run plant at higher speeds and for longer periods has increased the technical demands on lubricants. The new technologies are the drivers for major lubricant companies to develop better lubricants to meet the higher requirements of modern mill equipment. Higher speeds, greater loads, more production, longer lifetimes and lower friction are the main demands for high performance lubricants. By designing and building larger and faster mill equipment, both the OEMs and steel producers have demanded better lubricants with higher performances to keep the lubricating systems running reliably and to avoid bearing and other component failures.

Some of the recent developments which have taken place at Tata Steel regarding lubrication area are,

Use of lubricants formulated with Group 2 base oil

Use of Greases with higher base oil Viscosity

Increased usage of Polyurea Grease

Usage of Synthetic Oil & Grease in specialized applications

Usage of Fire Resistant Grease

Energy Efficient Hydraulic Oil

Polymer fortified and Dual Thickener Greases etc.

Present paper deals with some of the case studies related with above developments and benefits achieved.

INTRODUCTION:

In the demanding conditions of steel industry, plant managers are realizing that lubrication best practices can help improve equipment reliability, optimize maintenance and reduce energy consumption and CO_2 emissions. By combining top-notch lubrication techniques, high-quality lubricants and effective staff training, steel industries can improve productivity and their bottom line.

The basis of an effective lubrication program is to provide; the right product, in the right location, in the right amount, at the right time, in the right condition and by the right person. This paper will deal with the first part i.e. Right Product.

The first, and most important step, is selecting and using the correct equipment-specific lubricants. By simply selecting the proper lubricant, the life of both the equipment and lubricant will be extended, which should be a cornerstone goal of the lubrication program.

Many organizations think that the task of selecting the correct lubricant ends at either the directions outlined in the Original Equipment Manufacturers (OEM) manual or general recommendations from a lubricant supplier. This information is only the starting point and should be considered along with current operating conditions, the operating environment, equipment criticality, historical information, reliability requirements, and the chosen maintenance strategies (CM, PM, PdM, PaM, etc).

Armed with the equipment specific OEM advised lubricant, it does not mean that we have necessarily chosen the best lubricant for the application. This selection is just the starting point, as the final selection should include a process of past operating experience and the equipment criticality outlined within the facility's maintenance strategic objectives.

Operation and maintenance activities that have historically utilized a lubricant which provides acceptable equipment reliability within the desired operating costs could remain the lubricant of choice. However, to remain globally competitive, avenues for continued improvement should be explored. These improvements could be in the direction of:

• Advanced equipment protection
• Improvements in Worker Health and Safety
• Compliance with environmental regulations
• Lower yearly energy requirements

Described below are some of the improvements brought about in the lubrication area at Tata Steel resulting in improved equipment reliability as well as lower maintenance cost.

USE OF LUBRICANTS FORMULATED WITH GROUP II BASE OILS:

Lubricant base oils made by modern hydro processing technologies show generally better performance compared to older processing routes. This prompted the American Petroleum Institute (API) to categorize base oils by composition (API Publication 1509) in 1993, as shown in Table 1.

Table 1. API Base Stock Categories

Group	Sulfur, Wt %		Saturates	VI
I	>0.03	and/or	<90	80 – 119
II	≤ 0.03	and	≥90	80 – 119
III	≤ 0.03	and	≥90	≥120
IV	All Polyalphaolefins (PAOs)			
V	All Stocks Not Included in Groups I-IV (Pale Oils and Non-PAO Synthetics)			

The table shows that Group II base oils are differentiated from Group I base oils because they contain significantly lower levels of impurities (less than 10 percent aromatics, less than 300 ppm sulfur). They also look different. Group II oils made using modern hydro processing technology are so pure that they are almost colorless.

From a performance standpoint, improved purity means that the base oil and the additives in the finished product can last much longer. More specifically, the oil is more inert and forms fewer oxidation byproducts that increase base oil viscosity and deplete additives. Table 1 shows graphically the difference between an API Group I and Group II base oil. The very large difference in impurities is the main reason for Group II's higher performance.

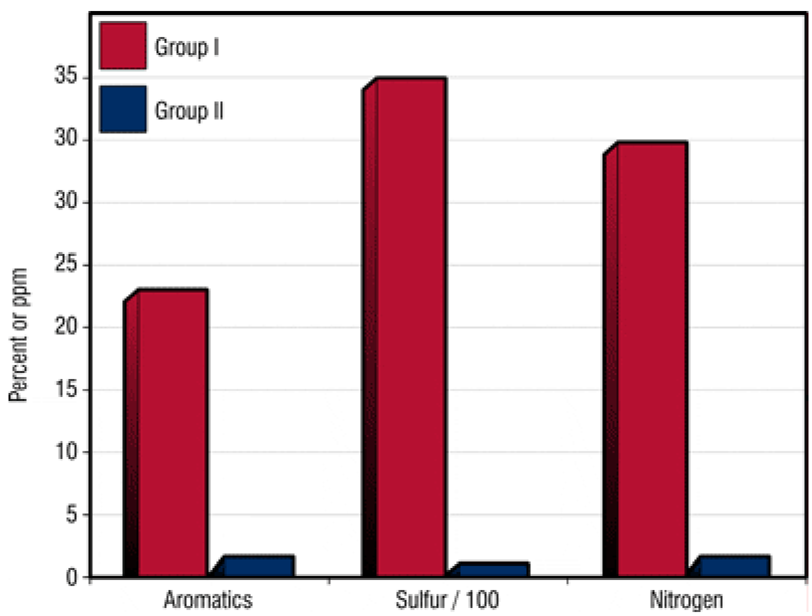


Figure: Group II Stocks Have Lower Impurities

Group II-based lubricants can provide competitive oxidation resistance to traditional synthetics. Group II base oil technology, along with specially designed additives, can match traditional synthetic oils made from PAO in applications such as turbine oils. The benefits of severe hydro processing are shown in Figure below, which compares a Group II oil with a Group I.

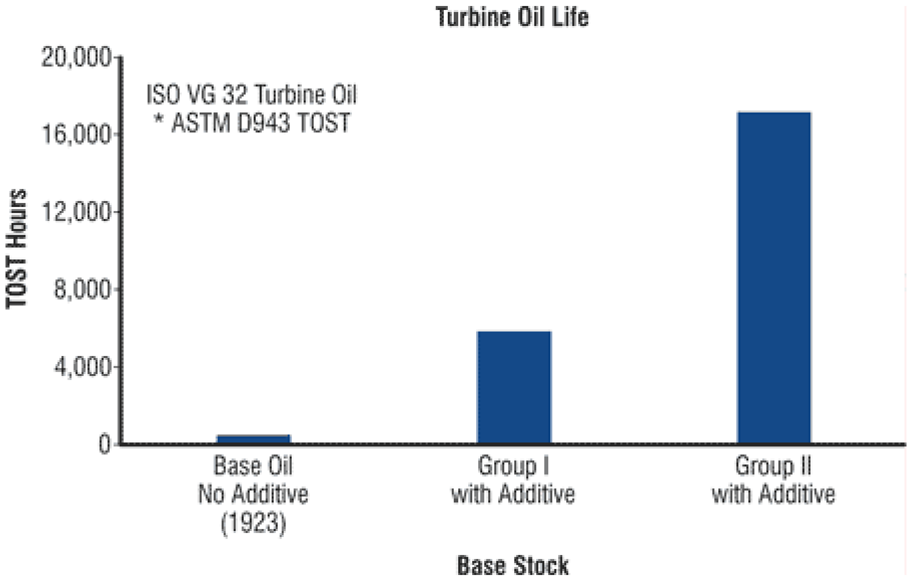


Figure: Higher Base Oil Quality Extends Turbine Oil Life as Measured by the Turbine Oil Stability Test (The Turbine Oil Stability Test (TOST), or ASTM D943, measures the time required for a turbine oil to oxidize to the point where the acid number reaches 2.0 mg KOH/g)

The benefit of Group II base oils in oxidation stability is illustrated in Figure below for hydraulic oils formulated by using the same additive system in four different base oils.

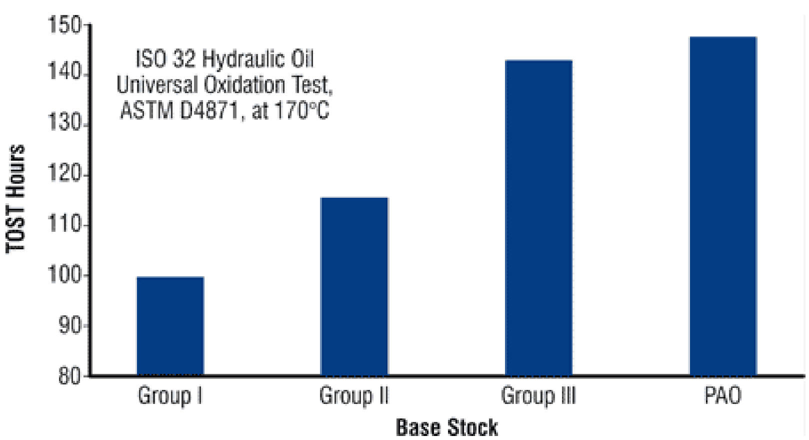
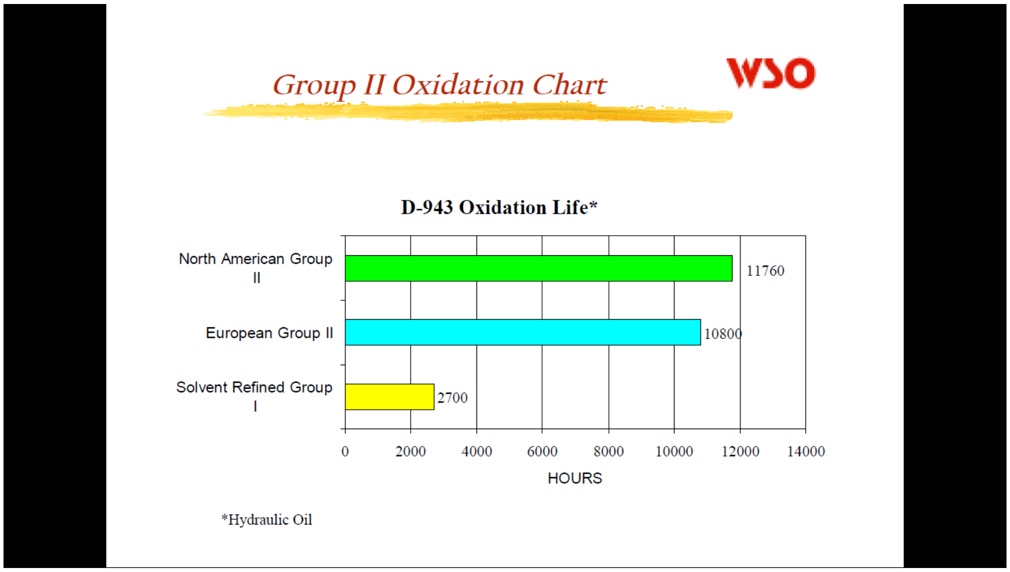


Figure: Oxidation Stability, Acid Number in Hydraulic Oils

Here, the time required to reach an acid number of 2.0 (defined by neutralization of 2.0 mg of KOH/g of oil) in the Universal Oxidation Test (ASTM D4871), a common measure of oil oxidation, was substantially longer for the Group II formulation than the Group I.



Present-day lubricant demand is for maximum oxidation stability, superior low-temperature performance, low volatility, and improved additive response which can be achieved by using lubricants with Group 2 Base Oil Stock.

At Tata Steel, we have already changed over to Group II Base oils in the following areas

Hydraulic Oils (HLP 46 & HVI 46)

Turbine oils

Mill BUR Bearings

Mill Gear boxes

NTM Gear boxes

USE OF GREASES WITH HIGHER BASE OIL VISCOSITY:

oil is the lubricant in a grease—*and the most important property of an oil is viscosity*. Therefore, the correct viscosity must be selected for the application. The grease manufacturer provides this information. Although viscosity of grease is not usually listed on its container, it is listed on the product data sheet.

A common mistake when selecting grease is to confuse the grease consistency with the base oil viscosity. Because the majority of grease-lubricated applications are element bearings, one should consider viscosity selection for those applications. There are several common methods for determining minimum and optimum viscosity requirements for element bearings, most of which use speed factors, commonly denoted as DN or NDm. Speed factors account for the surface speed of the bearing elements and are determined by the following formulas:

DN = (rpm) * (bearing bore) and
NDm = rpm * ((bearing bore + outside diameter) / 2)

The NDm value uses pitch diameter rather than bore diameter because not all bearings of a given bore have the same element diameter, and thus have different surface speeds. Knowing the speed factor value and likely operating temperature, the minimum viscosity requirement can be read directly from charts like Figure 1.

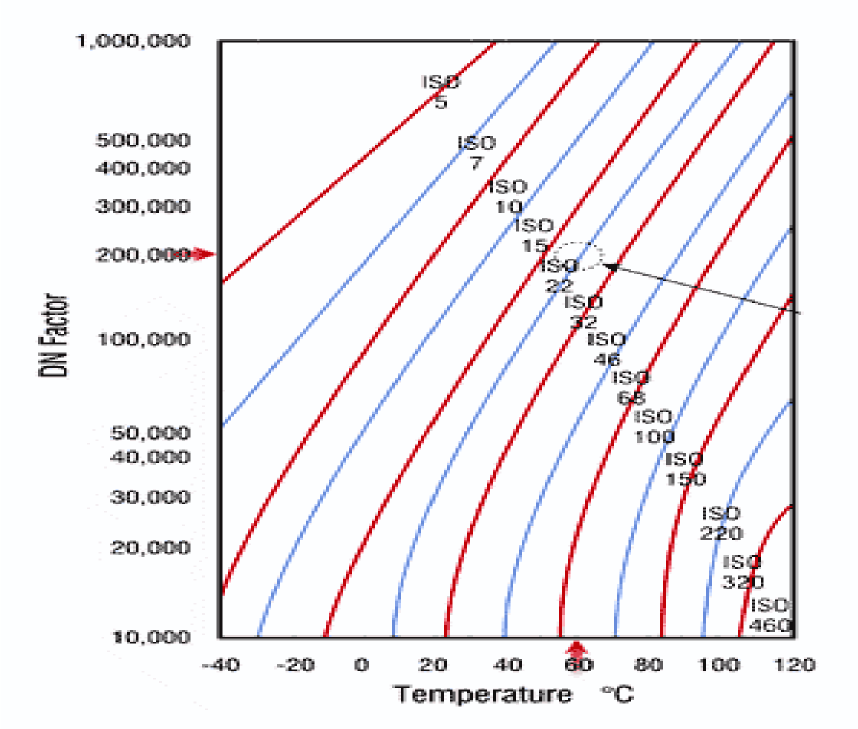


Figure1. (Courtesy of ExxonMobil)

Figure 1 assumes the base oils' viscosity index. To be more precise, one would need to use a chart that identifies the viscosity at operating temperature, and then determine the viscosity grade from a viscosity/temperature chart for a given lubricant.

Table given below gives some guideline regarding viscosity selection based on application.

Table: Correct Viscosity Selection for an Application

Viscosity	**Application**
ISO 100	Electric motors and high-speed bearings > 3600 rpm
ISO 150 & 220	Multipurpose grease operating at moderate speeds
ISO 460	**High loads and good water resistance**
ISO 680*	High-speed couplings

ISO 1500	Very low speed, high loads and good water resistance
ISO 3200*	High-speed couplings

Coupling grease can have ISO 680 or ISO 3200 depending on the manufacturer.

In Steel Plants, many of the applications demand base oil viscosity in the range of 400+ because of higher loads (higher Dm in the bearing). Conventionally, we were using General Purpose Greases with Base Oil Viscosity of 150 & 220 without really looking at actual requirement. Now, we have started calculating the actual base oil viscosity requirement and accordingly selecting suitable grease.

Apart from taking higher load high base oil viscosity also has following benefits.

1. Better sealing effect which is very effective at high water ingress and dusty atmosphere, both are very predominant in a steel industry.
2. High apparent viscosity at high temperature thus providing lubricity at high temperature.
3. Better film building capacity specially required at low speed condition.

One such case study from Wire Rod Mill is given below.

Between years 2001 to 2007, there were 27 bearing failures in Roughing & Intermediate Stands. Failures in Roughing Mill Stands were more (68%). On analysis, it was found that base oil viscosity (220 Cst) of the grease being used was not adequate for Roughing Mill Stands. Different oils are used in roughing & intermediate mill gear boxes but same grease was being used in all roll chock bearings. Hence a need was felt to use different grease in the Roughing Mill Stands with higher base oil viscosity.

Calculation of required Base Oil Viscosity:

Example-Std. # 3

- Bearing number- 313824
- Bearing RPM- 32
- Operating Temperature- 60deg C
- Roll Separating Force (Eq Dynamic Load)- 536 KN.

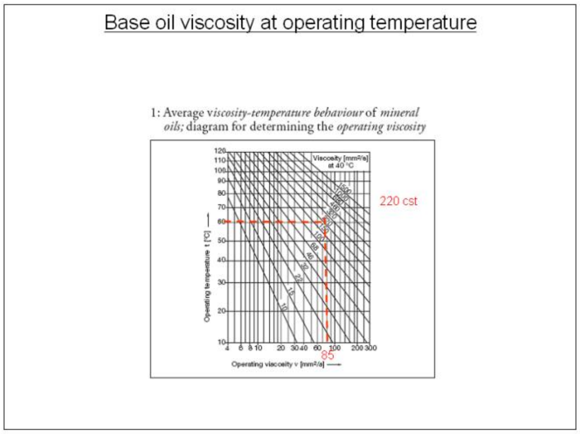
Mean bearing diameter= (ID+OD)/2 = (330+230)/2 =280mm

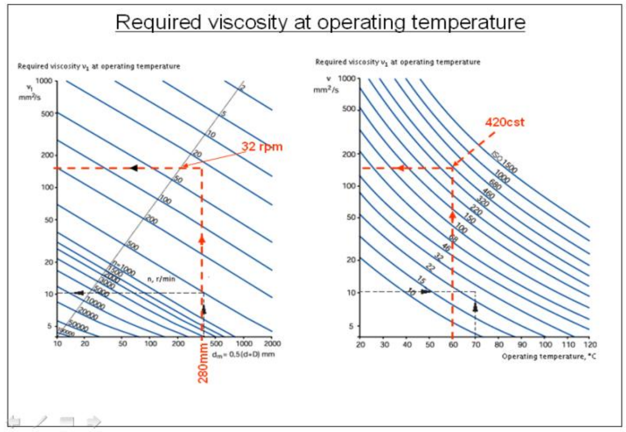
Required base oil viscosity is 125 cst at working temp as per the chart given below whereas existing grease with base oil viscosity of 220 Cst (at 40 deg. C) had base oil viscosity of only 85 Cst at working temperature (60 deg. C).

Viscosity ratio (Viscosity at Working Temp. / Viscosity at 40 deg C) should be between 1 & 1.5 to attain nominal life of the bearing .

For Stand # 3, Viscosity Ratio with existing grease was 85/125= 0.68 which is below normal.

A grease of 420 Cst Base oil viscosity is needed to get desired viscosity of 125 at operating temperature.





Based on above calculation, a separate centralized grease lubrication system was designed and installed for Roughing Mill Stands. Original Grease in Roughing Mill Stands was replaced with Special lithium complex grease with 430 base oil viscosity.

Trial was conducted for one month and following parameters were monitored.

1) Chock Temperature
2) Grease Quality (Color, Texture, emulsification etc.)
3) Pumpability of grease

Following observations were made in stand 1 and 3.

1) Average Temperature of Chock came down by 10 deg (from 65 deg to 55 deg) in Stand 1 and by 8 deg (from 55 deg to 47 deg) in Stand3.
2) Quality of grease after dechoking was found similar to the new grease.

Since January, 2008 after the modification, there has not been a single bearing failure till date. Incorrect selection of grease base oil for this particular application, was root cause of the problem and with the new grease, bearing failures have been completely eliminated.

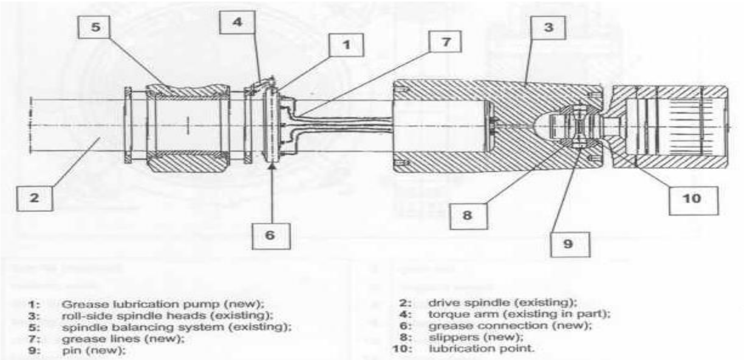
2nd Case study at HSM for slipper pad:

Two Electric Motors of 7500 HP drive the roughing stand of the Tata Steel hot strip Mill via two gigantic shafts. Besides transmitting the enormous torque (required to pull the hot steel slab through the ever converging gap between the work rolls), the shafts are designed to swivel in order to follow the vertical gap adjustment of the mill. Over the swiveling action, an axial gliding motion (originating from the change in shaft length due to very high torque induced torsion) gets superimposed.

A normal universal joint would never have a chance to accommodate this movement under the prevailing forces, so gliding brass coupling surfaces are therefore utilized.

Previously grease with less oil viscosity (220cst) was used. Expensive slipper pads (due to boundary friction between inadequately separated surfaces) were wearing out and it was leading to knocking sound.

Presently we have started using grease having high base oil viscosity (400 +) with solid lubricant (8%). This grease gave a better lubricity and higher water resistance. As a result we have no knocking problem and slipper pad life has increased. Consumption of grease also came down by 50%.



Slipper Pad

INCREASED USAGE OF POLYUREA GREASES:

At the present time polyurea thickened greases account for 4.97% of all the grease produced. The polyureas are comparable to the complex greases in that they have high drop points, although generally slightly below 500 deg F (260 deg C). They are buttery smooth products that have found use in high temperature applications, and can be used up to 350 deg F (176 deg C). This puts them on equal footing with the complex greases for upper temperature operability.

These greases have good thickening efficiency with 7 to 12% thickener generally required to produce a grease of NLGI 2 consistency. The polyurea thickeners produce greases with excellent performance characteristics, in that they:

1) have high dropping points (approximately 500 deg F, 260 deg C)

2) have excellent water resistance

4) shows low oil separation

5) have excellent fretting characteristics.

In addition to the above, these thickeners have outstanding resistance to oxidation. They are ash-less, non-metal containing thickeners, and their superior oxidation characteristics are attributed to lack of any metal components. They are highly suited to "fill for life" applications.

While as a general group polyureas have had a tendency to exhibit poor mechanical stability and age hardening, there are newer formulations that show mechanical and storage stability characteristics comparable to lithium greases. However, they continue to show poor response to conventional rust inhibitor and extreme pressure additives. Alternate additive approaches are therefore utilized to secure excellent corrosion inhibition in this product family. The manufacturing process, being virtually instantaneous, is highly sensitive to minute fluctuations from the set stoichiometric process parameters and the purity of the raw materials. No exotic equipment requirements are existing, however; special care and procedures are required by the handling of iso-cyanates.

The benefit offered by the polyurea-technology (above commodity products) is the synthetization of large molecular assemblies with high intramolecular affection and high molecular weight. The strong bonding power makes them inherently more oxidation stabile, thus capable of sustaining elevated temperatures for longer times. Through their decreased mobility, inherent from the higher molecular inertia; advantages such as higher surface separation (more lubricant in the contact), higher sealing capacity (better resistance against ram water impact) and longer technical grease life clearly manifest themselves. Emanating from the same physical feature is also the only drawback. Pumpability in centrally administered lubrication systems at temperatures below -20°C becomes difficult due to the largeness of the molecules and special pre-heating arrangements may be required.

Recent technological advancements within the largest urea group (tetraurea) enables safe operation at temperatures exceeding 200°C without consistency change. Neither a hardening- nor a softening tendency is accepted since the lubrication will suffer dearly from both degradation processes. Today; customers benefit globally from longer campaign lives, higher system robustness and all trailing benefits from a reduced lubricant consumption (e.g. reduced process water maintenance, reduced warehousing and logistics, increased environmental awareness etc.).

Overall, they are excellent grease thickeners with many excellent performance characteristics, especially in the area of oxidation resistance and high bearing speed applications.

In Slab Caster Segment Bearing application at Tata Steel, Polyurea Grease has performed very well.

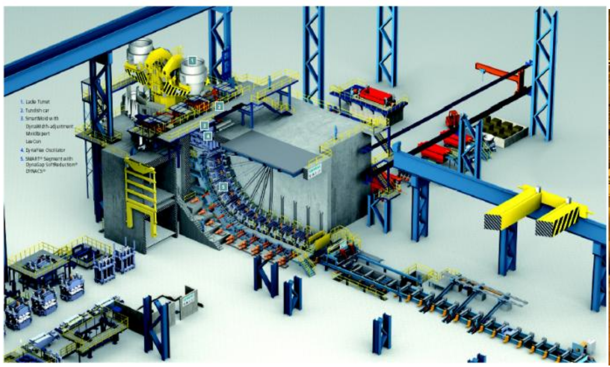
Calcium Sulfonate Grease was being used in the Caster for the last few years. Few years back, productivity of the plant was increased by adopting following measures:

(a) Increased Casting Speed by 25%

(b)Increased slab width from 1450 mm to 1550 mm

Change in the above parameters adversely affected the grease performance and severe problems related to premature bearing failures, roll jamming and choking of central lubrication lines were registered.

We were looking forward to a bearing life equal to or higher than the ‘campaign life’ of the segments. A study of the premature failure of bearings revealed that the grease was forming hard lumps inside the bearing as well as the lubrication pipe lines. This proved beyond doubt that the Calcium Sulfonate grease was unable to withstand the high temperature in the lubrication lines as well as the bearings. The maximum temperatures in the lubrication pipe lines were recorded to be 210 Degree C. The Roller table bearings had a maximum temperature of 200 degree C. Such high temperatures were the main cause of failure for the grease.



After an in-depth study of all operating parameters of the caster, we changed over to Poly-urea Grease from Calcium Sulfonate Grease. A 6 month trial produced very positive results which are as follows:

1 Bearing failure was minimized by 20%

2. Grease consumption was reduced by 25%

3. The frequent blockage / clogging of the lubrication pipelines due to radiation heat were arrested.

4. Roll Jamming reduced (from45 to11 numbers) with overall increase in the segment roller life.

5. Higher caster productivity.

Taking into consideration all tangible benefits, we were able to save around 1 Million INR in 6 months for both the casters (No. 2 & 3) just on better maintenance. We were extremely happy with the trial results and Poly-urea Grease was thereafter gradually established in all 3 Casters.

Starting with this breakthrough in the Caster, Poly-urea Grease has been introduced in few other High temperature applications like:

1. Hot Strip Mill- Rollers of Reheating furnace,

2. Rollers in HSM Roughing Mill area.

3. Wire Rod Mill- Reheating furnace.

4. Blast Furnace- High temperature areas including BLT Chute system.

USAGE OF SYNTHETIC GEAR OIL IN SPECIALIZED APPLICATIONS:

Synthetic gear oils are used whenever mineral gear oils have reached their performance limit and can no longer meet the application requirements; for example, at very low or high temperatures, extremely high loads, extraordinary ambient conditions, or if they fail to meet special requirements such as flammability. Even though additives can improve many properties of mineral oils, it is not possible to exert an unlimited influence on all their properties. This applies especially to physical properties like the following:

- thermal resistance
- low temperature properties (fluidity, pour point)
- flash point
- evaporation losses

Synthetic oils provide a number of advantages. However, they do not necessarily out-perform mineral oils in all respects and may even result in some drawbacks despite their advantages. The advantages of synthetic lubricating oils (depending on the base oil) include:

- improved thermal and oxidation resistance
- improved viscosity-temperature behavior, high viscosity index (in most cases)
- improved low temperature properties
- lower evaporation losses
- reduced flammability (in some cases)
- improved lubricity (in some cases)
- lower tendency to form residues
- improved resistance to ambient media

Possible disadvantages include:

- higher price
- reactions in the presence of water (hydrolysis, corrosion)
- material compatibility problems (paints, elastomers, certain metals)
- limited miscibility with mineral oils

Application-related advantages often prevail, increasing the use of synthetic lubricants as gear lubricants, especially under critical operating conditions. Synthetic lubricants based on synthetic hydrocarbon oils (SHC), polyglycols (PAG) and ester oils (E) have proven particularly efficient in gear systems.

The following application-related advantages result from the improved properties of synthetic lubricating oils as compared to mineral oils:

- improved efficiency due to reduced tooth-related friction losses
- lower gearing losses due to reduced friction, requiring less energy
- oil change intervals three to five times longer than mineral oils operating at the same temperature

- reduced operating temperatures under full load, increasing component life; cooling systems may not be required

Potential Reduction of Gearing Losses and Improvement of Efficiency if Using a Synthetic Gear Oil Instead of a Mineral Oil.		
	Type of Gear	
Effect	**Worm Gears, Hypoid Gears**	**Spur and Helical Gears, Bevel Gears with Axis Not Offset**
Reduction of Total Losses	30% and more	20% and more
Improved Efficiency	15% and more	up to 1%
Reduction of Operating (Steady-State) Temperature	68°F (20°C) and more	up to 54°F (12°C)

Synthetic oils have better resistance to aging and high temperatures and a longer service life than mineral oils. Depending on the base oil (SHC or PAG), the oil change intervals may be three to five times longer at the same operating temperature.

Approximate oil change intervals of gear oils at an operating temperature of 176°F (80°C) are:

- **Mineral oil: 5,000 operating hours**
- **SHC oil: 15,000 operating hours (extension factor 3)**
- **PAG oil: 25,000 operating hours (extension factor 5)**

Synthetic oils have a lower friction coefficient than mineral oils in a gearbox and a more favorable viscosity-temperature relationship. This generally permits the use of synthetics at lower viscosity grades and also offers the possibility of reduced oil temperature during operation. In such cases, the life extension factors for oil change intervals of synthetic oils are longer than the values stated above, which refer to identical oil temperature. The following comparison of test results illustrates this advantage. Three lubricants were tested in a splash lubricated worm gear test rig.

The test records show the following oil sump temperatures after 300 operating hours:

Mineral oil: 230°F (110°C)
SHC: 194°F (90°C)
PAG: 167°F (75°C)

The life extension factors of synthetic oils as compared to mineral oil are as follows:

Mineral oil = 1
SHC = 9.5 times longer
PAG = 31 times longer

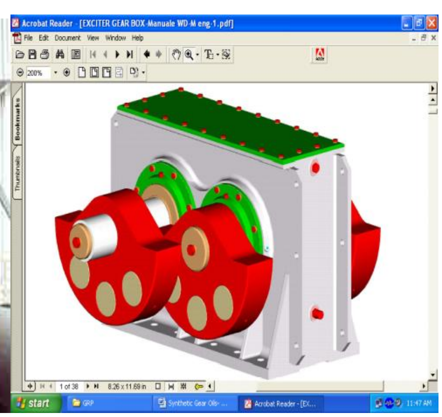
	Mineral oil	Polyalpha-olefin	Polyglycol	Ester
Viscosity-temperature behaviour	0	+	++	+
Ageing resistance	0	+	++	+
Low-temperature behaviour	---	++	+	+
Wear protection	0	+	++	+
Friction coefficient	0	+	++	+
++ = very good / + = good / 0 = satisfactory / --- = poor				

At Tata Steel, some of the applications where synthetic gear oils have been used are following.

1) Sinter Plant Exciter Gear Boxes
2) G Furnace Screen Exciter Gear Box
3) Slab Caster Discharge Roller Table (DRT) Gear Boxes
4) RPD Mixer Gear Box

Case Study from Sinter Plant has been described below in detail.

Sinter Plant Hot Screen Exciter Gear Boxes: There are two Hot Feeders, designated by 1080 and 2080 in Sinter Plant #1. Each hot feeder has two exciter gearboxes.



Sinter Plant **Exciter Gear Box**

Exciter gearboxes of hot sinter screen were failing due to high temperature of the gearbox. The oil recommended was industrial gear oil, ISO-VG-460 (Mineral Type). The viscosities of the oil at 40 deg. C and at 100 deg. C were 460 and 31 cSt respectively. Due to high working temperature (more than 110 deg. C) the oil was getting oxidized. There was leakage as well from the cover. The synthetic gear oil was used in these gearboxes (Material No. 0168B0014). The viscosities of the chosen synthetic oil at 40 deg. C and 100 deg. C are 460 and 46 cSt respectively. The life of exciter gearbox has improved drastically. The problem of lubrication has been solved even while working at continuous high operating temperature.

Hot Feeders

Photographs of burnt oil inside exciter gearbox and seized bearing

Following is the specification of Synthetic Gear Oil (460) being used.

ISO Viscosity Grade	460
Kinematic Viscosity @ 40 deg C cSt 100 deg C cSt (IP71)	 460 45.5
Viscosity Index (ASTM D 2270)	155
Density @ 15deg C Kg/m3 (ISO 3675)	857
Flash Point deg C (ISO 2592)	245

Pour Point deg C (ASTM D 97)	-42
FZG Load Carrying Test Failure Load Stage	>12
Timken OK Load, lbs	>80

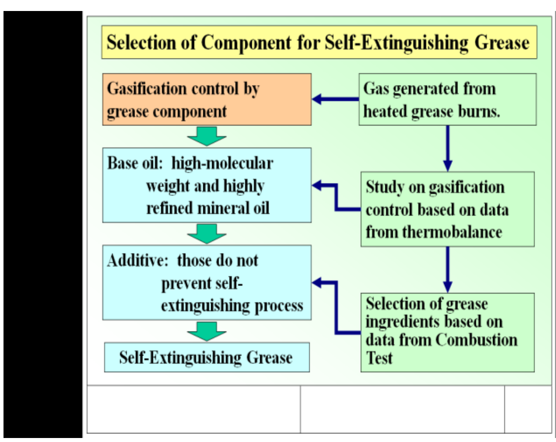
It is high performance synthetic oil based on **poly-alpha-olefin (PAO)** and has specially selected additives. It has improved thermal and oxidative stability, which minimizes sludge formation and viscosity increases, to help increase oil life and reduce maintenance costs, while its excellent anti-wear performance offers longer gearbox life in steel-on-steel applications. Designed to provide excellent low friction properties, it reduces power losses and lowers operating temperatures, contributing to energy and cost saving benefits compared to gear oils manufactured from mineral base oils.

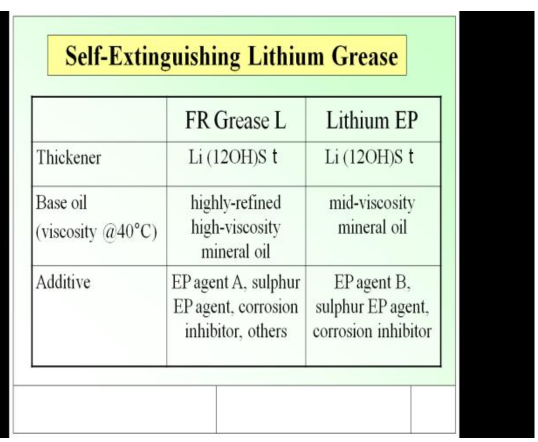
USAGE OF FIRE RESISTANT GREASE:

Steel Plants have many equipment running very close to fire source like Stamp Charging Machines in Coke Plant, Discharge Roller Table in HSM Furnace etc. There have been instances where leaked grease from the equipment has caught fire.

Recently, we have started using Fire Resistant Grease in Coke Plant and HSM to overcome this problem. In a self-extinguishing lithium EP grease, even if ignited, fire easily goes out in a short time (self-extinguishing property). The grease prevents fire spread.

Grease does not burn itself but flammable gas from grease (fume, cracked gas) burns when mixed with air. Combustibility depends on gas concentration. Fire goes out when the gas concentration is below the lower combustible limit. In a self-extinguishing grease, gas generation after burning is much lower compared to conventional grease. Hence Fire easily goes out even if grease ignites.





Following is the specification of the grease being used.

FR Grease L No. 1

FR Grease L No. 1 is nonconventional self-extinguishing lithium EP grease for centralised system. Even if the grease catches fire, fire dies down quickly. FR Grease L No. 1 resists fire spread, and thus provides safe operating environment where fire potential is a concern.

Typical Property

Operating Temperature: -10°C ⇔ 130°C

Test Item		Test Method	FR Grease L No. 1
Thickener		———	lithium soap
Base oil		———	mineral oil
Base oil kinematic viscosity @100°C, mm²/s		ASTM D 445	32.6
Appearance		———	dark brown, buttery
Worked penetration		ASTM D 217	325
Dropping point, °C		ASTM D 566	195
Copper strip corrosion (100°C, 24h)		ASTM D 4048	no colour change to green or black
Oil separation, mass% (100°C, 24h)		FTMS 791C-321 Mod.	5.6
Oxidation stability, kPa (99°C, 100h)		ASTM D 942	10
Worked stability		FTMS 791C-313	349
Apparent viscosity @0°C, Pa•s	shear rate 10s-1 / 100s-1	ASTM D 1092	97 / 32
Bearing corrosion (52°C, 48h)		ASTM D 1743-73	#1
High-speed 4-ball EP, N	L.N.S.L. / W.P. / L.W.I.	ASTM D 2596	784 / 2452 / 392

We also had two fire cases in Scarfing Machine at LD2. After that, we have changed over to Fire Resistant Grease there also.

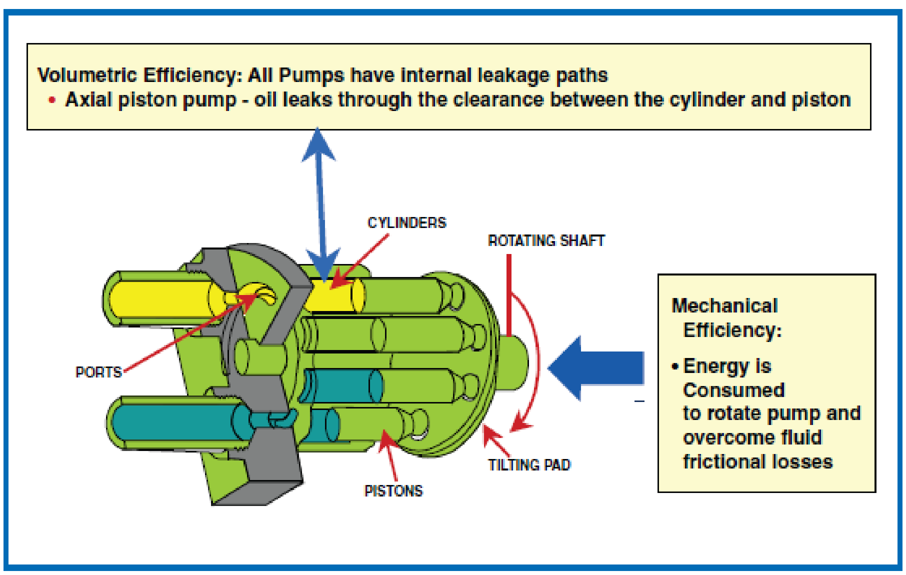
Scarfing Machine at LD2

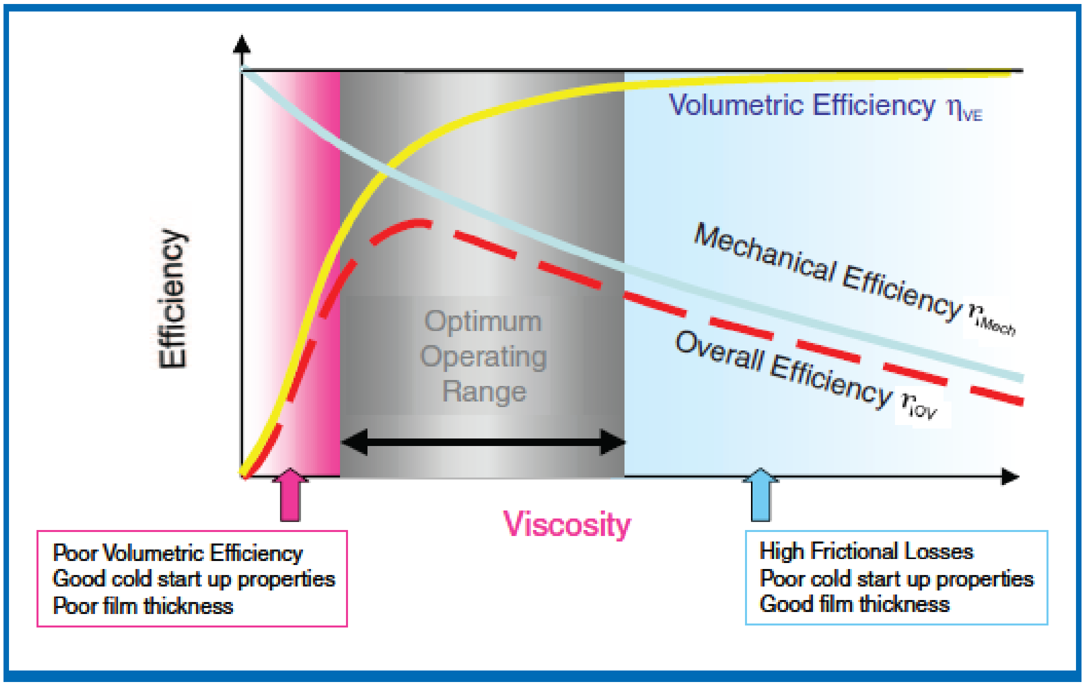
ENERGY EFFICIENT HYDRAULIC OIL:

The amount of mechanical and volumetric loss in a pump is primarily a function of the fluid's viscosity and lubricity properties.

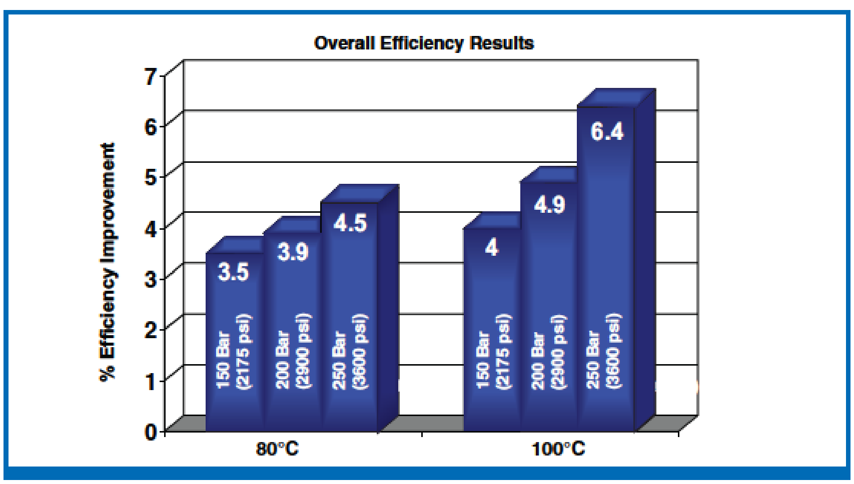
Specially formulated hydraulic fluids can reduce the magnitude of these losses by utilizing a high viscosity index to maintain fluid viscosity in the optimum range across a wide operating temperature range.

In addition to the hydraulic efficiency benefits from maintaining hydraulic fluid viscosity in the optimum range, additional efficiency gains can be achieved through selection of optimal base fluids and additive technology to reduce traction – the inherent resistance of the fluid to shear under Elasto Hydrodynamic Lubrication (EHL) conditions.





The following graph shows this comparative data between a typical ISO VG 46 anti-wear hydraulic fluid and specially formulated high VI test fluid. The test fluid demonstrates a hydraulic efficiency increase between 3% and 6% in this bench test. Note that as temperature and pressure increase, the efficiency benefit of the test fluid increases.



A trial of Energy Efficient Hydraulic Oil Mobil Mobil DTE 10 Excel 46, is being conducted in the following Equipment.

Equipment: Tata Hitachi Excavator (093)

Model ZAXIS – 450 H

Make TELCON

Type of Operation- Slag Handling

2. Equipment History & Record:

Current Product Competitor Hydraulic oil, ISO VG 46

Total No of running hrs. 575

Pump Make Kawaski

No of pump 2

No of filter 2

Filter size 10 micron

Hydraulic oil System capacity 560 L

Oil Drain Interval Recommended 2000 hrs

Filter Change Interval Actual 500 Hrs

Hydraulic Oil Temp 72 deg C

Hydraulic Pressure 320 Bar (Max)

Fuel Consumption 35 Liter per Hrs (3 months average)

POLYMER FORTIFIED GREASE:

Polymer additives improve shear stability, enhance water resistance and impart excellent grease tenacity.

A trial of Polymer Fortified Lithium Complex Grease Mobil XHP 461, is being conducted in following equipment:

Merchant Mill - Roughing & Intermediate Stands

(Stand No. 1 to 10)

Application Work roll bearings

Lubrication Method Centralized greasing system

Equipment History & Record:

Current product Competitor grease, NLGI 2, ISO VG 320

Thickener/ Base-oil Calcium Sulphonate / Mineral oil

Grease Consumption : 8 drums per month

Temperature of the bearings 50 ^{0}C (Max)

Grease Pump Pressure 110 Kg/cm^2

Time b/n successive strokes 15 minutes

Max length of travel 50 m (from grease pump to stand)

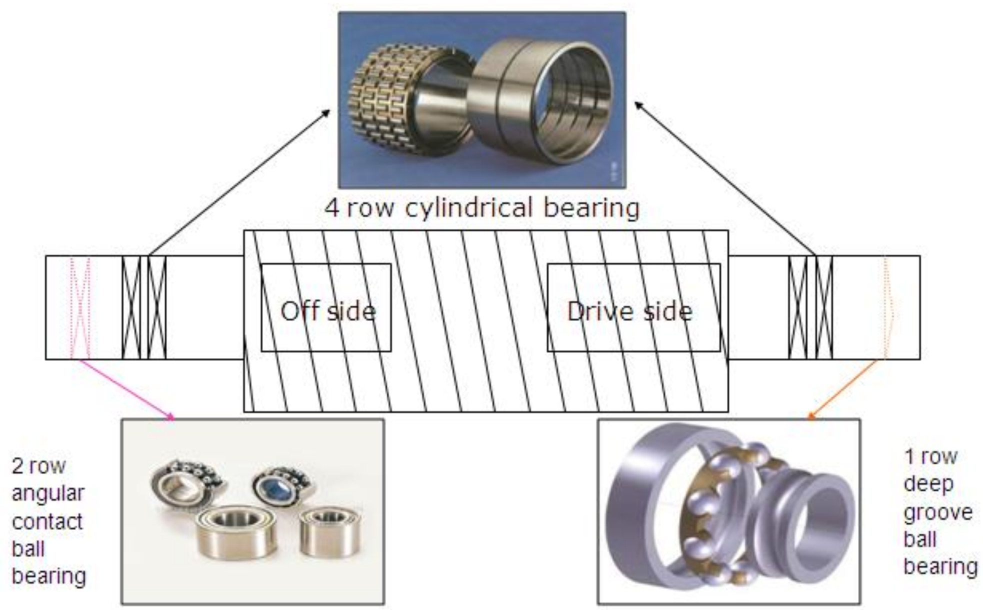
Mill speed 7.2 m/ s (max)

Existing bearing failures 17 for stand number 1 to 10 in Merchant Mill (in 1 year)

Type of bearing in stands Deep groove ball bearings

Angular contact ball bearings

4 row cylindrical roller bearings



GREASE WITH DUAL THICKENER:

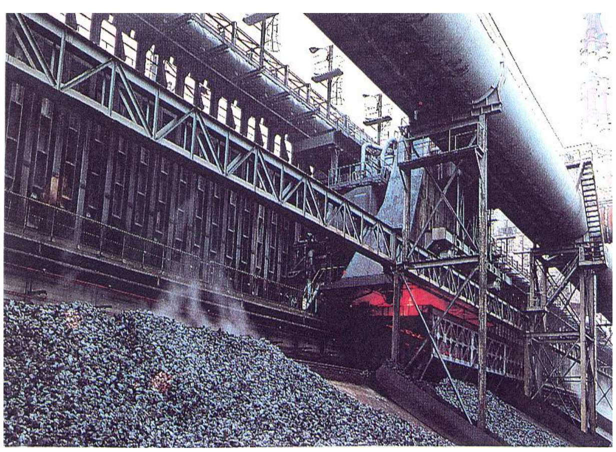
Lithium Calcium Greases have proved to be very successful in Rolling Mill application because they have best properties of both lithium grease as well as calcium grease. They have following properties.

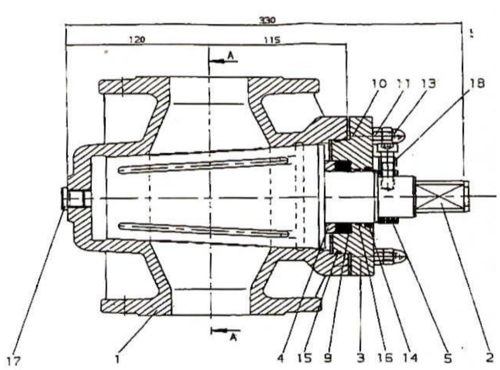
- Best properties of both and some better than either
- Very good water resistance
- Very good mechanical stability
- Slightly higher operating temp. than lithium
- Better lubrication than lithium complex at ‘normal’ operating temperatures

Lithium Calcium Grease with 460 base oil viscosity has given excellent results in Mill Stand Work Roll Bearing Lubrication at our Hot Strip Mill.

Another dual thickener grease, we have used in Coke Plant Gas Reversing Valves. It is a Poly Urea + Al Complex Grease, specially designed for this application with following properties

- Can take radiation temperature up to 280deg C.
- Provides excellent lubrication in sliding friction due to presence of dual thickener.
- No residues after burning.
- High resistance to temperature.
- High pressure absorption capacity.
- Good protection against wear.
- High film building capacity.
- Good sealing effect due to tetra urea chain and high base oil viscosity.





CONCLUSION:

Different groups and process departments in an integrated steel plant pose different challenges to lubrication of equipments. Ensuring reliable lubrication needs consideration of a variety of factors like load, speed, temperature, water/moisture and working environment. Optimum solution for the best performance requires selecting right lubricant and methods of application.

Even if a lubrication program was perfectly designed and implemented, it would still require changes from time to time. Changing conditions such as production demands, new equipment and new technologies require some aspects of the program to undergo continuous improvement. Methods should be in place to perform root cause analysis on machine failures. Recurring failures should be addressed by considering alternate lubricants or machine design modifications to eliminate or resist the suspected root cause.

Because lubricants typically make up only 1% of a company’s total cost, many lubrication programs do not receive the attention they deserve. However the surprising truth is that the lubricants a company chooses can have a significant impact on high-visibility and high-value items such as energy, labor and equipment costs.