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In This Issue Page No

“Synthetic esters: combining food safety and high performance”

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Lubrication in food industry

Food grade lubricants are formulated to be used in food industries such as meat processing, bakeries, dairy production, cooked food etc. and beverage processing equipment. Food grade lubricants must perform the same technical functions as their standard industrial analogs: provide protection against wear, friction, corrosion and oxidation, dissipate heat, and be compatible with rubber and other sealing materials. These lubricants must also comply with food/health and safety regulations, as well as be physiologically inert, tasteless, odorless and internationally approved.

A variety of equipment that needs food grade oils and greases include:

- Conveyor belts
- Chains
- Pumps
- Mixers, slicers, wrappers and packers
- Compressors
- Vacuum pumps
- Hydraulic systems

Modern day food manufacturing involves complex machines and innovative technologies. These machines need to be lubricated regularly to ensure their seamless operation. Typical challenges of lubricants in the Food Industry are: Food grade lubricants need to withstand high temperatures (bakery ovens upto 300°C), very low temperature as low as
-50°C, and contend entry of water/steam and other contaminants such as dust, salt, chemicals etc. Food grade lubricants provide the necessary lubrication of the equipment used to process food while reducing the chance of its contamination during processing. Yet, the possibility of contact between food and lubricants cannot be entirely eliminated due to unavoidable spills, over-lubrication and inappropriate lubricant application which may introduce small amounts of lubricants in food. The occurrence of Food contamination generate high costs due to product recalls and insurance coverage. In worst cases, liability situations may also be very detrimental to company’s image. It is in the best interest of food companies to make every effort to minimize food contamination and to give utmost importance to food safety.

Standards for food contact approval

The International Standards Organisation has issued two standards ISO 21469 and ISO22000 to help ensure food safety around the world.

ISO 21469 specifies the hygiene requirements for the manufacturing of lubricants used in the food industry. It deals with process considerations and good practices.

ISO 22000 lays out food safety management system guidelines. HACCP (Hazard Analysis Critical Control Point), part of ISO 22000 is a methodology guiding users through the assessment of food contamination risk. These standards are meant primarily for the food industry.

In spite of risk management and good industrial practices, food contamination remains unavoidable due to the below reasons:

- Over lubrication
- Inadequate lubricant application system
- Maintenance operations
- Leakage
- Mechanical failure
- Wrong equipment design etc.

Hence second aspect of industrial food safety management lies in the use of lubricants that do not pose a significant health risk in the event of contamination.

Until 1998, the U.S. Department of Agriculture (USDA) issued approvals for lubricants used in meat and poultry processing. Approvals based on positive list of substances issued by the Food and Drug Administration (FDA) in accordance with CFR 21-178.3570. Sections referenced in CFR 21-178.3570 lists out ingredients that are generally recognized as safe (GRAS) for use in food. Lubricant formulations may contain synthetic oils, edible oils such as soybean, cottonseed and corn oil, or white mineral oil.

In 1999, the National Sanitation Foundation (NSF) International, a not-for-profit, public health organization took over registration of lubricants based on USDA procedure. InS, UK also issues Certifications for lubricants according to USDA procedure.

The following definitions of food grade lubricants are provided by NSF International:

H1-Lubricants used in food processing equipment where there is the possibility of accidental food contact.

H2- Lubricants used in food processing equipment where there is no possibility of the lubricant coming into contact with food.

H3- Also known as soluble oils. These products are applied to hooks, trolleys and similar equipment to clean and prevent rust. The portions of the equipment that come in contact with edible products must be clean and free of the oil before reuse.

3H-Also known as release agents. These products are used on grills, cutters, chopping boards and other hard surfaces in which come in contact with meat and poultry food products to prevent food from adhering to the surfaces during processing.

HT1- These products are used as heat transfer fluids in primary and secondary heating and cooling systems in food processing facilities where there is possibility of incidental food contact.

HT2- Applies to heat transfer fluids where there is no possibility of food contact.

NSF also offers an ingredient category designated HX for components and additives that have been used in the formulation of finished H lubricants. Hence ingredients for use in H1, H2 and H3 lubricants are designated HX-1, HX-2 and HX-3 respectively. Similarly, components for use in heat transfer fluids HT1 and HT2 are designated HTX-1 and HTX-2 respectively.

Base fluids for food grade lubricants

H1 lubricants are produced from selected base stocks that include white oils, alkylated naphthalenes, Polyalphaolefin (PAO), Polyisobutylene, Polyalkylene glycol (PAG), Esters and Silicones. All base fluids must be registered with NSF as suitable for inclusion in food grade lubricants. In addition, the additives used in food grade lubricants must be registered as NSF HX-1 products and their concentration in the lubricant is typically limited to a relatively low concentration. For food grade greases, only certain thickeners may be used. Acceptable H1 approved grease thickeners are Calcium, Calcium complex, Calcium sulfonate, Aluminum complex, Silica, Clay, Polyurea and PTFE.

Early H1 lubricants formulated with white mineral oils were perceived as natural productsor even edible products. But these products suffered from a bad reputation with regard to their technical performance especially lower solubilization and lubricity. But today's incidental food contact H1 lubricants made with synthetic lubricants that combine performance and food safety is increasingly used in food industries.

Among the synthetic base fluids, Synthetic esters offer premium performance with regard to excellent high and low temperature behaviors, good Viscosity-temperature characteristics, low volatility, high flash points, increased lubricity, providing cleaner operations and in making products harmless to human health.

PAOs are preferred base fluids for food grade lubricants especially in air compressors which is almost dominated by PAOs. Nevertheless, esters can always be used in combination with PAOs in order to solubilize additives, balance the effect on seals, added detergency, cleanliness and improved resistance to oxidation.

Synthetic ester based high temperature chain oils deliver outstanding performance in volatility, longevity and cleanliness leaving minimal evaporation residue. Synthetic ester based grease is suitable for use in the food processing industry in applications which require grease with excellent performance at high working temperatures.

Summary

Lubricants for the food processing industry are subject to a number of requirements. On the one hand, lubricants have to comply with food regulations and be internationally approved, they also have to provide proper lubrication for the food processing equipment.The most effective way for food industries to manage contamination risks in their processes is by through risk analysis, manufacturing process management and ensuring use of good industrial practices so that the safest product possible is being produced. Among the various mineral or synthetic base fluids, saturated synthetic esters with their unique performance properties as base fluids or additives for incidental food contact lubricants offers outstanding performance.

A Case study of Calcium sulphonate grease in Continuous Slab Casters

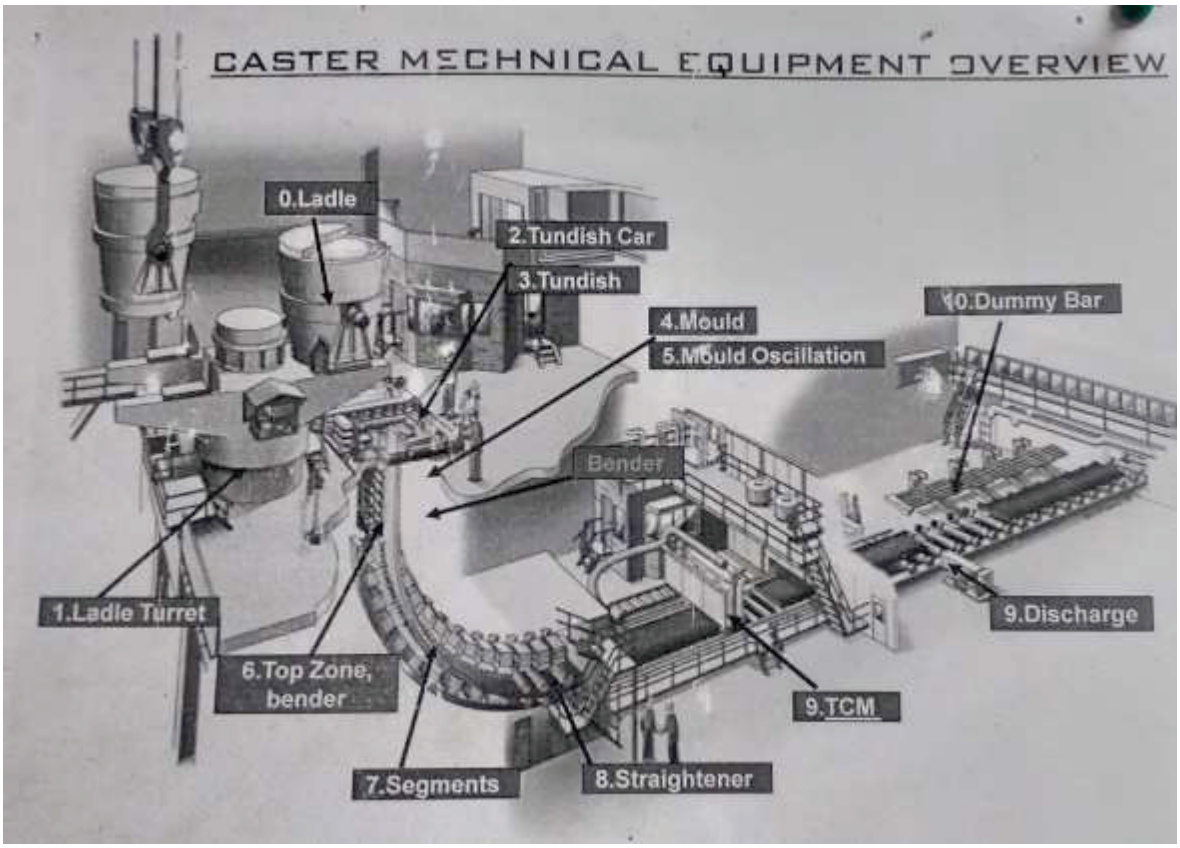
Francis J Xavier – M/s Raj Petro Specialities Private Limited.
Jai Ganesh. M, Swarup Brahma

Introduction

In modern steel industry lubrication of continuous caster bearings has been critical to the performance of the steel plant. Many lubrication theories have been applied and predominantly since it is a low speed application grease was preferred to lubricate them. The most important enemy that the grease has to encounter is water which is sprayed onto cool the slab . The intrusion of water to the grease affects the rheological properties of the grease. The grease which could overcome the impact of water is the best candidate for lubricating and improving the operational life of the caster roll bearings as they comprise 40% of the bearing cost in any integrated steel plant.

The operational life of bearings is often determined by the performance of the lubricating grease. The consistency of the grease prevents it from leaking out of the bearing and provides good sealing properties. The possible ingress of water into the bearing will have a considerable impact not only on this consistency but also on the lubricating ability of the grease. There are numerous applications where water ingress may occur, such as in the steel, food, pulp, and paper industries. Some greases are less sensitive to water than others. The goal of the paper is to contribute to the development of such guidelines for greases subjected to water ingress by studying the impact of water on grease rheology. Fully formulated, commercially available extreme pressure greases with the most common thickeners and base oils are used as model greases. It will be shown that water strongly influences rheological properties such as zero-shear viscosity, yield stress, and storage modulus. Calcium sulfonate greases were found to become stiffer after absorbing a considerable amount of water, leading to an increase in zero-shear viscosity and yield stress. However, lithium, lithium complex, and polyurea greases were found to soften, with appreciable changes in measured rheological properties.

Schematic of a Continuous Caster



Selection of Greases based on effect of water

In steel industry many EP greases are being used currently in critical applications where high pressure water is sprayed on the working area affecting the grease performance. In order to study the rheological properties of Lithium EP , Lithium Complex ,calcium sulfonate and Heavy duty Multi-complex calcium sulfonate grease when mixed with 10% water we had conducted a few tests to understand the effect ofwater on the above greases.

The details of the study are given below

TABLE-1

COMPARATIVE STUDY ON PHYSICO-CHEMICAL PROPERTIES

Sl.No	Parameters	Method ASTM	Lithium - EP	Lithium Complex	Calcium Sulfonate (CS)	Multi Complex Sulfonate (MCS)
1	Appearance	Visual	Smooth & Buttery	Smooth	Smooth & Tacky	Smooth & Tacky
2	Consistency	D 217	NLGI-2	NLGI-2	NLGI-2	NLGI-2
3	Dropping Point, deg C	D 2265	198	279	> 320	>320
3a	Dropping Point, deg C after mixing with 10% water	D 2265	140	226	>320	>320
4	Roll Stability @ 80 deg. C, PEN Number Change, %	D 1831	-			
	8 Hrs.		11	12	8.5	5
	16 Hrs.		13	14	10	7
	24 Hrs.		15	16	10.5	8.5
	32 Hrs.		18	19	12	9
5	Water Washout @ 80 deg. C, % washed out, mass	D 1264	3.5	2.2	0.8	0.3
6	Water Spray off @ 38 deg. C %, 20Psi	D 4049	32	45	25	21
7	Four Ball Weld Load, kgs.	D 2596	250	315	500	620
8	Do, after mixing with 10 % water		160	200	500	620

The newly developed semi synthetic Multi-complex calcium sulfonate grease was selected for Continuous slab caster bearing application based on the above evaluation.

The multi complex calcium sulfonate grease was trialed in two wide slab casters in one of the biggest steel plants in the country successfully. The trial details are given in brief for your reference.

First Trial was successfully conducted on 24th April 2017 in 12 MTA steel plant

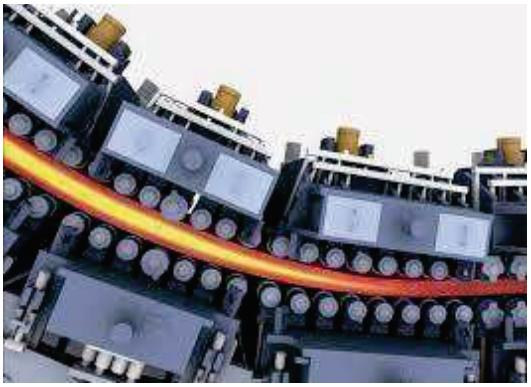
OEM: - SIEMENS DEMAG

Casting Capacity: - Slab Caster 2400 mm W X 240 to 300 mm H X 12 meters L /Weight25 MT.

Segment in which trial was undertaken: - Caster No 7 -12 (with 14 rolls & 42 bearings)No of heats taken: 1037 heats

Trial period: - 70 days

Temperature encountered: - 170'C to 200 'C



Section view of the caster segment

Second Trial is in progress from 10th July 2018 in 12 MTA integrated Steel Plant

OEM :- SIEMENS DEMAG

Casting Capacity: - 1400 mm W X 150 MM H X 6 meters L – 15 to 18 MT.

Segment in which trial is being taken: - Segment 8 with 10 rolls

No of Heats till date: - 3456 heats

Trial period till date: 120 days s On

Time 15 secs

Off Time – 60 mins

<u>The following parameters were monitored during the trials</u>

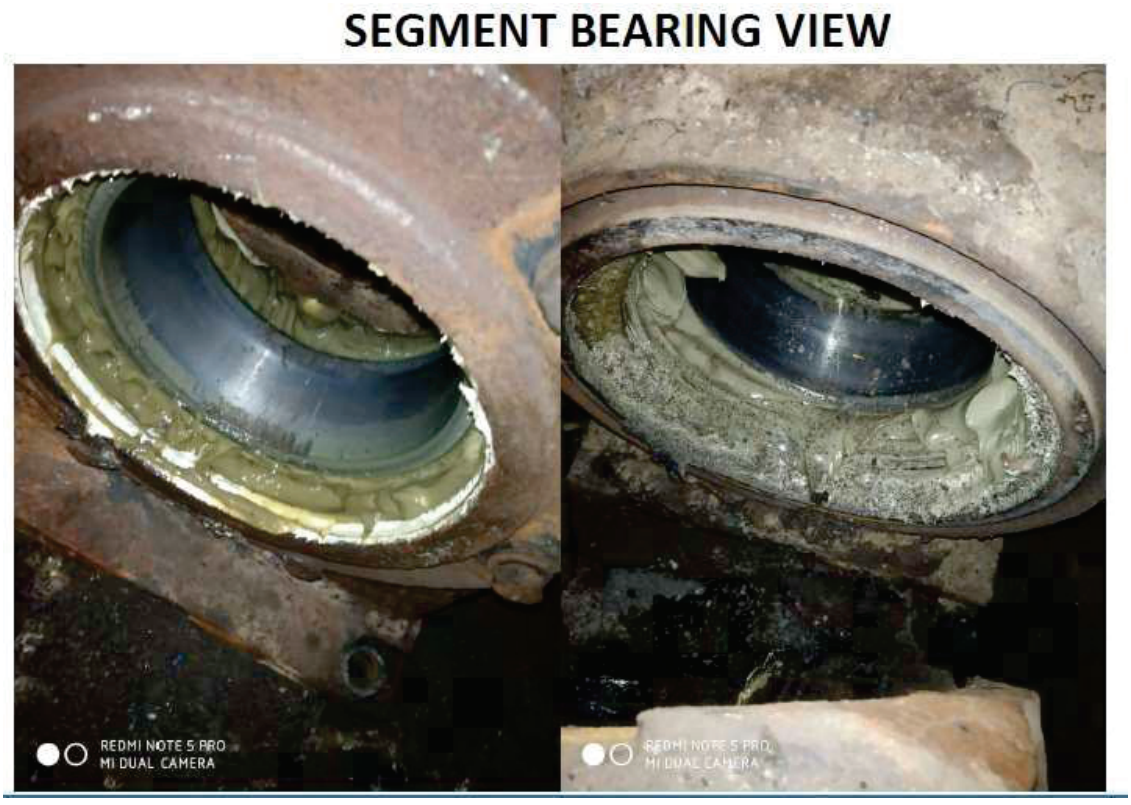
1. The pumping system pressure should be maintained between 50 to 150 Bar
2. The grease is reaching all the 10 bearings
3. Condition of the grease after usage in the bearings
4. Grease testing after usage

Existing grease performance (darkening due to temperature)

Performance of existing polyurea in Zone 11

No darkening observed in multi complex heavy-duty calcium sulfonate grease inZone 8 bearings.

Trial conclusion after 3456 Heats (120 days)



ROLLER NECK VIEW

Conclusion

1. The grease has performed satisfactorily for the trial period mutually agreed with the customer.
2. The pumpability of the grease was maintained even at high radiation temperatures up to 200'C .
3. The grease has resisted water washout in high pressure conditions.
4. There was no effect on the cooling water circuit due to grease as grease hadminimal wash off.
5. The grease had no issues of compatibility with existing Polyurea grease used by the customer.

Overall the Multicomplex calcium sulfonate has performed satisfactorily against the existing polyurea grease.

References:

1. Calcium sulfonate greases for the steel industry presented in NLGI 2015 by DrPrabir Pal, Jai Ganesh, Mr. Sukumar Mahanti
2. Effect of polymers with calcium sulfonate greases presented in NLGI 2016 by Mr.Jai Ganesh, Francis Xavier & Mr. Sukumar Mahanti

The author and co-authors wish to thank the management at M/s Raj Petro Specialtiesprivate limited for providing us an opportunity to present this technical paper.

End of Paper

Building Reliability through improved lubrication program in Metal Industry.

Francis Xavier – M/s Raj Petro Specialities private limited.
Anilkumar Patro; Jai Ganesh & Lalita Sahu.

Introduction

In today steel industry reliability is the buzzword as they are focused on increasing productivity with reduced maintenance and downtime costs.

In Steel plants equipment reliability & better maintenance practices are very important which directly affects the productivity & equipment Health. Specific Maintenance cost is to the tune of roughly around Rs 1500 per tonnes of crude steel. This is about 10-15 % of the total production cost. Proper lubrication can obviate various maintenance problems leading to smooth operation of steel plants. Cost of Lubricants is only a tiny fraction of maintenance cost. But improper lubrication can cause more than 30% of the breakdowns. Procuring superior quality of lubricant may slightly increase the spare cost however this will be rewarding in terms of trouble free working, reduced spares and optimum cost of maintenance.

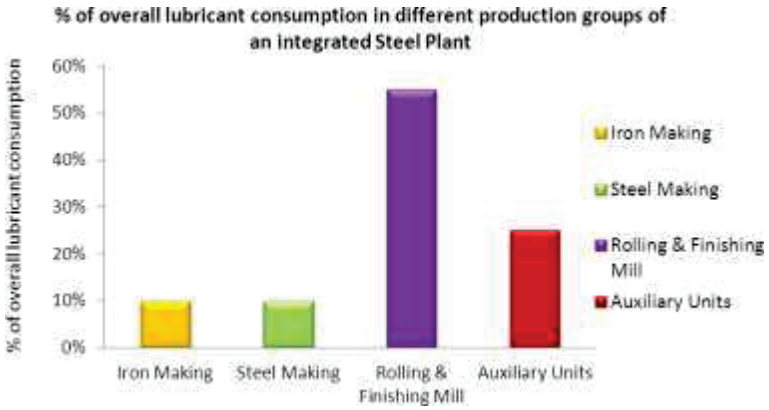


Figure 1 : Consumption details of lubricants in steel plant

While selecting lubricant for steel plants equipment these factors must be taken into consideration. Generally, OEMs recommend the type and grade of the lubricant based on the design, speed and load parameters of the equipment. However, in the absence of OEM recommendation or in case the recommended grade is not performing, a set of codes are to be made as guidelines by considering the afore-mentioned operational factors and select the lubricants accordingly. While selecting lubricant for an application, two very important aspects are to be looked at, namely, the factors concerning engineering requirements and the factors concerning requirements pertaining to the service condition.

One such challenge that was put to us was lubrication of an auxiliary equipment such as flue exhaust fans in metal industry. These fans are critical since they are linked to the safe operating conditions in a steel plant, hence reliability is most important, or we need to keep standbys ready as per existing conditions in heavy industry.

Case study No 1

In a 12.12 lakh TPA Nonferrous refinery plant the flue exhaust fans extracting flue gases from the sinter plant. The extraction of flue gases is critical since the plant would come to a stop if the flue gas fans trip. Hence the flue exhaust fan bearing temperature are monitored continuously in order to prevent stoppages. The bearing temperatures are maintained below 60 Ç.
They have been using an imported grease for the past decade and we had taken the challenge of providing an import substitute for the same.
We had studied the application and had selected a polymer grease for the application.

The details of the Equipment are as follows

Motor Capacity – 200 KVA

Fan Diameter – 3 meters

Bearings used Spherical roller bearings 22215

Figure 2: View of the flue exhaust Fans

Trial Methodology

The temperature of the flue exhaust fan bearings were monitored for a period of 6 months trial period and was compared against the existing fans using imported grease. The two graphs below explain the temperature profile over the six-month period initially the temperature was high due to the fresh grease but as days went by the grease stabilized and attained an equilibrium which was below the temperature profile of the existing grease.

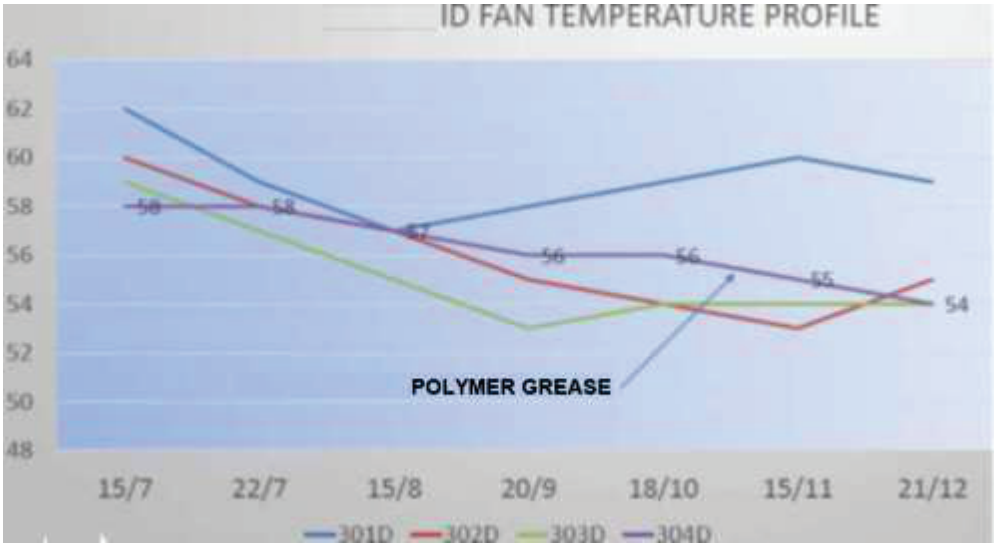


Figure 3: Temperature profile at the Drive End

Case study No 2 –

A 10 MTA integrated steel plant were using industrial EP 2 grease for the exhaust blowers and were facing issues of temperature rise in summer leading to external cooling of the Plummer blocks. We had recommended our Synthetic Polymer grease for reducing the bearing temperature and for extending the drain interval.

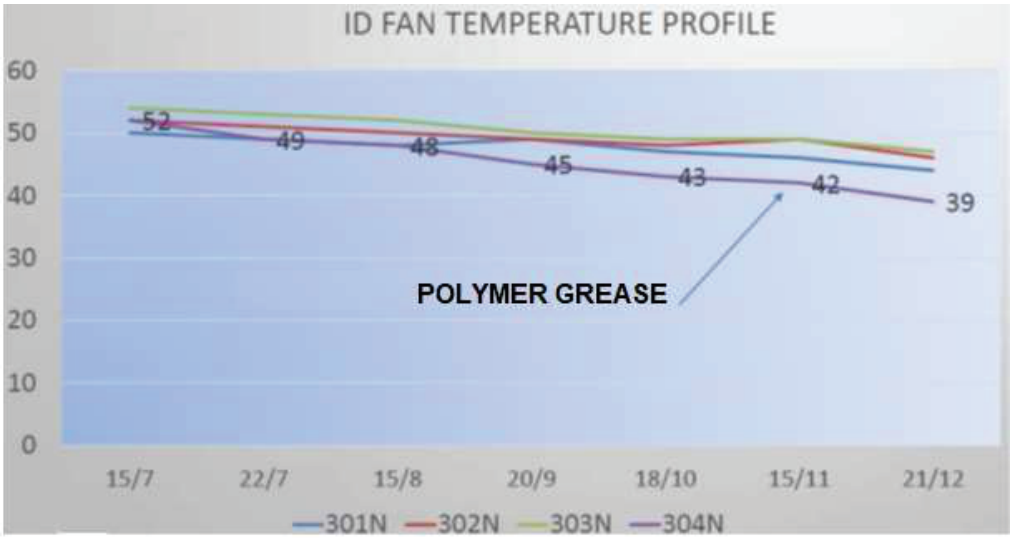


Figure 4: Temperature profile at the Non-drive end.

Figure 5 : Images of the exhaust Fan .

Trial Methodology

The Polymer grease was filled in the bearing in the non-drive end while the EP 2 grease was filled in drive end and the temperature was monitored across a period of 30 days to understand the difference between the existing grease.

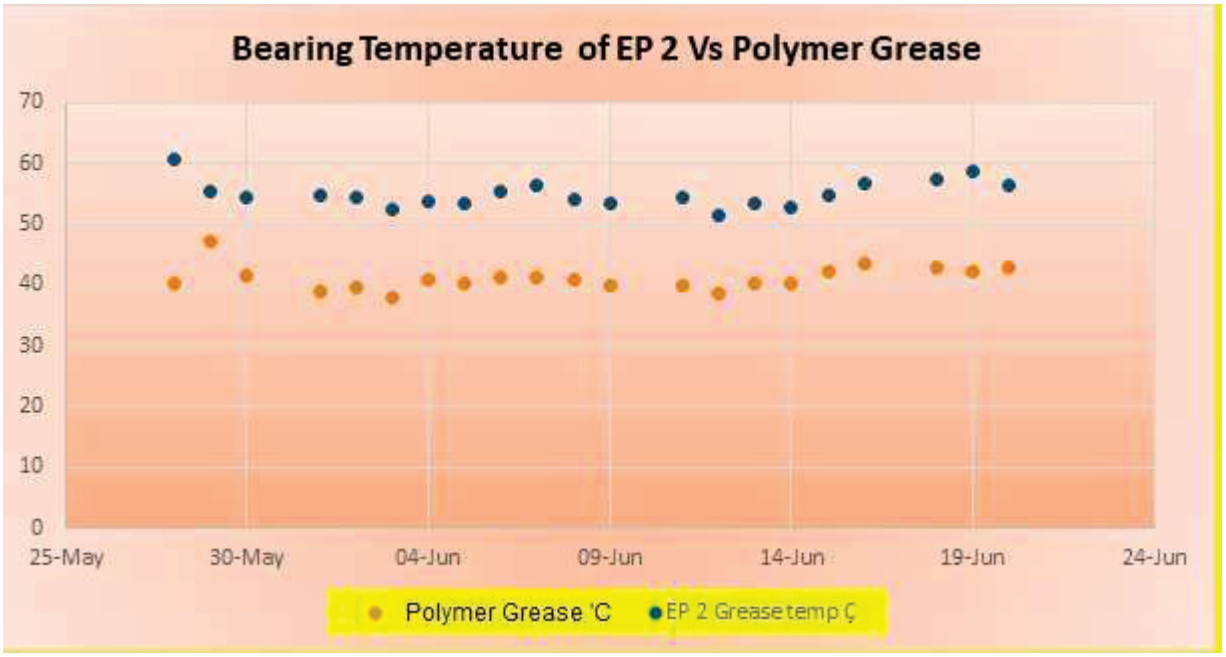


Figure 6 : Temperature Comparison of EP 2 Versus Polymer grease

Trial Conclusion

The trials have been concluded successfully and the client has replaced three ID fans and planning to extend to all the ID fans in the integrated steel plant. From the above graph the polymer grease reduces the bearing operating temperature= by 12 to 15' Ç.

This clearly proves the Polymer grease with reduced bearing operating temperature due to its unique lubrication regime increases the bearing life and simultaneously increases the grease drain interval.

The used grease was collected and was tested to understand the condition of the grease after 60 days of usage

Conclusion

The benefits with the Polymer grease are:-

1. Reduction in operating temperature by 12 to 15 'C
2. Reduced top up
3. Extended life
4. Improved reliability by maintaining consistent bearing temperature.

The above two case studies clearly illustrate how reliability can be built into critical operating equipment in the metal industry. Similar successful studies have been carried out with Multi complex calcium sulfonate greases for many applications in Integrated steel plant. Many More programs are planned to improve reliability of the critical operating equipment in modern heavy Industry.

References

1. Lubrication requirements of steel industry in Machinery Lubrication
2. New generation greases presented at ELGI by AXEL Technologies, Sweden.

Acknowledgements

The author and Co authors wish to thank the management at M/s Raj Petro Specialties private limited for providing an opportunity to present the technical paper.

End of Paper

Case Study of lubricating Grease challenge for Rock breaker attachment

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One of the greatest challenges for lubricating grease is for rock breaking applications. In rock breaking application the equipment durability is based on the prevention of wear.

The Hydraulic rock breaker is a construction equipment that is used for the demolition of a structure and breaking rocks into smaller sizes. It is an attachment on anexcavator and works on the principle of hydraulics. It applies high pressure from its small canister which has pressurized hydraulic oil stored in it. They are much more powerful than other hand-held hammers and its force is varied based on the force of piston strokes and its size.

The hydraulic hammer is of two types namely – inner valve type and outer valve type. Both types have mostly same components, such as a cylinder which is the most important part of the hydraulic system. A piston is also present in both types of a hydraulic hammer which converts kinetic energy into hammering energy and a front head is featured to support the machine, and one back head which contains the nitrogen gas.

Hydraulic rock breaker works on the principle of hydraulics by Pascal which states that "applying pressure on one part of a fluid transfers that pressure to all areas of the fluid, allowing for a multiplication of force". Since the oil used is incompressible, it allows the transfer of power instantly with negligible loss.

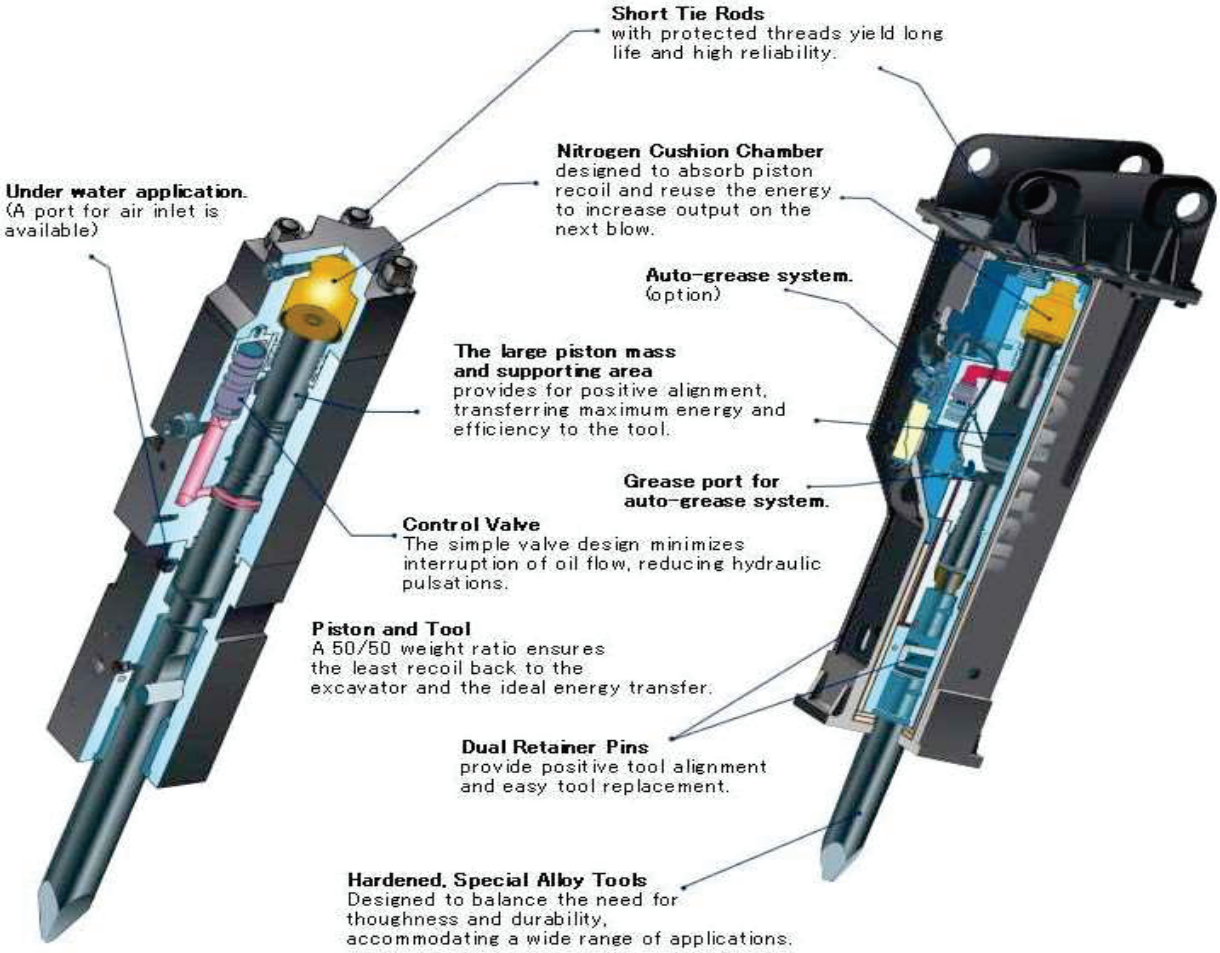
The hydraulic hammer starts with its main valve in the cylinder. The hydraulic oil is supplied to hammer through this valve. When upward stroke takes place, the pressure in the upper chamber is released by the main valve and through the outlet. Then the high pressure in the lower chamber pushes the piston upwards.

As the piston reaches the upper end of the stroke, the main valve directs the flow to upper chambers that make it high-pressure chamber. This causes the piston to move downward because of accumulated energy from the gas chamber, hence creating the impact stroke cycle. The energy is transferred to the tool that uses it to do various tasks.

At the point of impact, the main valve shifts and the pressure from upper chamber is released, enabling the upper stroke to take place.

Most of the hydraulic hammers come with fully enclosed housing over their parts not only to protect them from other materials but to ensure that they last longer. To increase the safety of equipment on which the hydraulic hammer is attached, the models comprise of shock absorbers at the top that absorbs all the impact and recoil energies. Moreover, the shock absorber also helps to protect the parts of the hydraulic hammer. Some of the hydraulic hammers are equipped with steel bushing in their bottom that isolates them from vibration.

Hydraulic hammers are environment-friendly because they produce less noise and pollutants. They are preferred in the places that are sensitive to vibration and noise, as a vibratory hammer may damage the existing structures.



In such applications, lubrication takes place in an abrasive environment of mud and rockparticles below the earth's surface. The journal bearings are subject to extremely high loads, because the bit generally turns at slow speeds and has the weight of the drill stringon top of it. Furthermore, there is shock loading due to the bouncing and vibrating of the drill string. Because all of the power delivered to the bit must be transferred through thebearings, a grease that minimizes

scoring, galling, and wear of the bearing surfaces is highly desirable. A grease that can function at such harsh temperatures and which possesses extremely good thermal and oxidative stability is therefore desirable.
Accordingly, a grease with a special composition for rock breaker lubrication and other applications was developed. This grease is here after referred to as the subject grease.

Composition of subject Grease

Special Lithium Soap
Anti wear additive
Extreme Pressure Additive
Anti Rust
Anti Oxidant
Special friction Modifier combo with Tack

The subject grease was compared with two different reference greases of different composition. The reference greases A & B are the techno-commercially acceptable benchmark grease for rock breaker application. The subject grease was tested for foundto be better or equal to the reference greases in terms of physico-chemical properties like penetration, drop point, weld load, oxidation resistance, copper & steel corrosion resistance.

Trials of the subject grease was done in a 34 Tons Excavator having engine power of 276 BHP with a 2.9 Tons Breaker operating at pressure of 180 bar. A trial protocol was set components, temperature of operation, noise level and running hours. which measured the parameters of grease consumption, wear of the breaker.

Comparison of Grease A & B Vs Subject Grease

	Grease A	Grease B	Subject Grease
Drop Point	180	180	>200
Weld load	250	315	500
Copper Corrosion	Pass	Pass	Pass
Steel Corrosion	Pass	Pass	Pass
Roll Stability Test	Pass	Fail	Pass
NLGI Number	2	2	2
Storage Stability	Not Checked	Not Checked	3 Years +
Oxidation Stability	>5 psi drop in pressure	> 5 psi drop in pressure	Drop in pressure less than 2 psi at 100 deg C

Measurement undertaken during the trial

	Grease A	Grease B	Subject grease
Noise	High (72 Db)	High (>80 Db)	Low (>80 Db)
Wear	Slight Wear measurable in 500 hours	No wear	No wear
Consumption	High (2 shots pershift)	High (2 shots pershift)	Low (1 shot per shift)
Temperature rise	30 deg more than ambient	30 deg more than ambient	Almost at ambient

Greasing of Rock Breaker

CHISEL Part of Breaker

Biscuit Part of Breaker

CONCLUSIONS :

The subject grease gave normal temperature of operation as compared to reference grease A and B. All other things being equal implies the use of subject grease can lead to energy savings for rock breaking application.

The subject grease also had low noise levels during operation as compared to reference greases A & B.

The subject grease had lower wear as compared to grease A

The grease consumption was reduced with subject grease as compared to reference grease A and B.

The author would like to thank Shri B S Nagarkoti – DGM R&D for developing the grease and supporting the trial. Special thanks to Akash Sahani Sales Engineer for carrying out the trials.