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# Tribology of 2-Mercaptobenzothiazole in Lithium Complex Grease

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## 1. Introduction

There has been no much difference in usage pattern of EP/antiwear additive chemistry of additives in greases and other lubricants like cutting fluids and gear oils. These additives perform very well in some greases but not able to perform up to desired level in other applications. Due to high active sulfur content, they need supplementary additive with them for non-ferrous metal corrosion protection. Additive chemistry plays a vital role in performance of greases, none the less base fluid and thickener play an important role. As the greases is worked and churned in bearing, the grease is required to liberate some oil to lubricate race way surfaces. Some of the additives also released with oil but not able to go back in grease's jell structure. As a result depletion of additive takes place gradually and performance level of grease decrease. Thus the life of grease and bearings reduced. In view of this, the usage of solid additives with nano particle size is increasing in high performance greases in recent times. The biggest advantage of solid additives with nano particle size in greases is it provides the structure to grease by working as the thickener/fillers and support the development of lubricating film on friction contact surfaces. Thus reduces the chances of depletion of additives with oil due to break down of grease structure due to high temperature and high load during operation. Analyzing the properties of 2-Mercaptobenzothiazole, we have attempted to study the performance of this additive in lithium complex grease. We have evaluated this additive in wide perspective of tribological behaviour in different combination with antiwear additives. Though the primary use of 2-Mercaptobenzothiazole is vulcanization accelerator for rubber, fungicide, copper corrosion inhibitors in various lubricants and coolants at a very low treat level. 2-Mercaptobenzothiazole has very high sulfur content hence it can also be used as an excellent EP additive. Due to presence of two nitrogen atom in MBT, it is slightly basic in nature which helps to neutralize the acidic components formed in application thus increases the life of grease. Additionally, due to solid nature it can work as a filler in greases and subsequently increases the yield of greases.

## 2. Experimental details

Lithium complex grease was prepared by conventional method by using 12-hydroxy stearic acid and lithium hydroxide. Dodecanedioic acid was used as complexing agent in Lithium

soap grease. An ISO VG 220 mineral oil was selected as a base fluid for better lubricity at high temperature application. The grease consistency was kept in NLGI 2 range. This grease was fortified with commercially available antioxidant, rust inhibitor to meet other requirements i.e. Thermal and oxidation stability, rust & corrosion resistance, water washout resistance property. Series of extreme pressure properties of Lithium complex grease were checked in following combinations of EP and antiwear additives.

1. Lithium complex grease without any EP and antiwear additive
2. Lithium complex grease with only 2.5% 2-Mercaptobenzothiazole (MBT)
3. Lithium complex grease with combination of 2.5% 2-Mercaptobenzothiazole and 1.0% Zinc dialkyl dithiophosphate antiwear additive
4. Lithium complex grease with combination of 2.5% 2-Mercaptobenzothiazole and 1.0% ashless antiwear additive
5. Lithium complex grease with combination of 2.5% conventionally available sulfur-phosphorous chemistry based EP additive and 1.0% Zinc dialkyl dithiophosphate antiwear additive.

The coefficient of friction was tested by universal tribometer in following combinations of EP and antiwear additives.

1. Lithium complex grease with combination of 2-Mercaptobenzothiazole and Zinc dialkyl dithiophosphate antiwear additive
2. Lithium complex grease with combination of 2-Mercaptobenzothiazole and ashless antiwear additive

The testing conditions were as under.

1. Load - 300 N
2. Temperature - 60°C
3. Frequency - 50 HZ
4. Time - 120 minutes
5. Contact - Pin-on-disk mode

### 3. Results and discussion

The test results of Lithium complex grease with 2- Mercaptobenzothiazole and ZDDP vis-à-vis Lithium complex grease with conventional EP additive and ZDDP are provided in **Table 1**. The various regular properties of grease with new additive combinations i.e. combination of 2-Mercaptobenzothiazole and Zinc dialkyl dithiophosphate antiwear additive are similar with Lithium complex grease with combination of conventional EP additive and Zinc dialkyl dithiophosphate. This reveals that 2-Mercaptobenzothiazole has compatibility and good additive response in lithium complex grease. The series of extreme pressure properties of greases with different combinations of 2-Mercaptobenzothiazole with Zinc dialkyl dithiophosphate, ashless antiwear additive and grease with commercially available extreme pressure additive in combination with Zinc dialkyl dithiophosphate are provided in **table 2**. The four ball weld load of lithium complex grease 2 (only 2.5% MBT) has 500 kg weld load. The wear scar dia is 0.78 mm. After addition of 1.0% Zinc dialkyl dithiophosphate and 1.0% ashless antiwear additive respectively in this grease the wear scar dia has come down to 0.30 mm in grease 3 and 4 respectively. Additionally, the weld load is increased by 50 kg. Whereas, the grease with conventional EP additive & antiwear additive has shown a weld load of 315 kg and wear scar dia 0.42 mm. The Timken OK load is also slightly higher with MBT compared to conventional EP additive. These higher values

Characteristics	Lithium Complex Grease with 2 - Mercaptobenzothiazole and ZDDP	Lithium Complex grease with conventional EP additive and ZDDP	Test Method
NLGI Grade	NLGI 2	NLGI 2	NLGI
Consistency, @ 25°C Worked, 60 X Worked, 100, 000 X	281 305	283 309	ASTM D 217
Drop Point,°C	272	272	ASTM D 566
Copper Corrosion @ 100 °C, 24 hrs	1 a	1a	ASTM D 4048
Heat Stability, @ 100°C, 30 hrs % loss	1.85	1.76	ASTM D 6184
Wheel Bearing test, Leakage by mass, gm Slump test	2.63 Pass	2.66 Pass	ASTM D 1263
Water washout @ 80°C, % loss wt.	4.66	4.98	ASTM D 1264
Roll Stability, % change @ ambient, after 16 hrs @ 82°C, after 48 hrs.	6 16	7 18	ASTM D 1831
Oxidation Stability, @ 100°C Drop in psi, @ 100 hrs.	6	6	ASTM D 942
Emcor Rust Test, rating	0,0	0,0	IP 220

Table 1. Test Results of Lithium Complex Grease with 2 - Mercaptobenzothiazole and ZDDP antiwear additive vis-à-vis Lithium Complex grease with conventional EP additive and ZDDP antiwear additive

Characteristics	Grease 1	Grease 2	Grease 3	Grease 4	Grease 5	Test Method
Load wear Index, kg	66	132	166	166	112	ASTM D 2596
Four ball weld Point,kg	200	500	550	550	315	ASTM D 2596
Four ball Wear scar dia, mm	0.80	0.78	0.30	0.30	0.42	ASTM D 2266
Timken OK load, lb	15	40	50	50	45	ASTM D 2509

Table 2. Tribological properties of Greases

of four ball weld load, higher Timken load and lower wear scar diameter indicate that 2-Mercaptobenzothiazole has shown better response with lithium complex grease. The results of coefficient of friction of grease 3 (Lithium complex grease in combination of 2-Mercaptobenzothiazole and Zinc dialkyl dithiophosphate antiwear additive) and grease 4 (Lithium complex grease in combination of 2-Mercaptobenzothiazole and ashless antiwear additive) are provided in Figure 1. The coefficient of friction of 2-Mercaptobenzothiazole in combination with Zinc dialkyl dithiophosphate and ashless antiwear additive is very low.

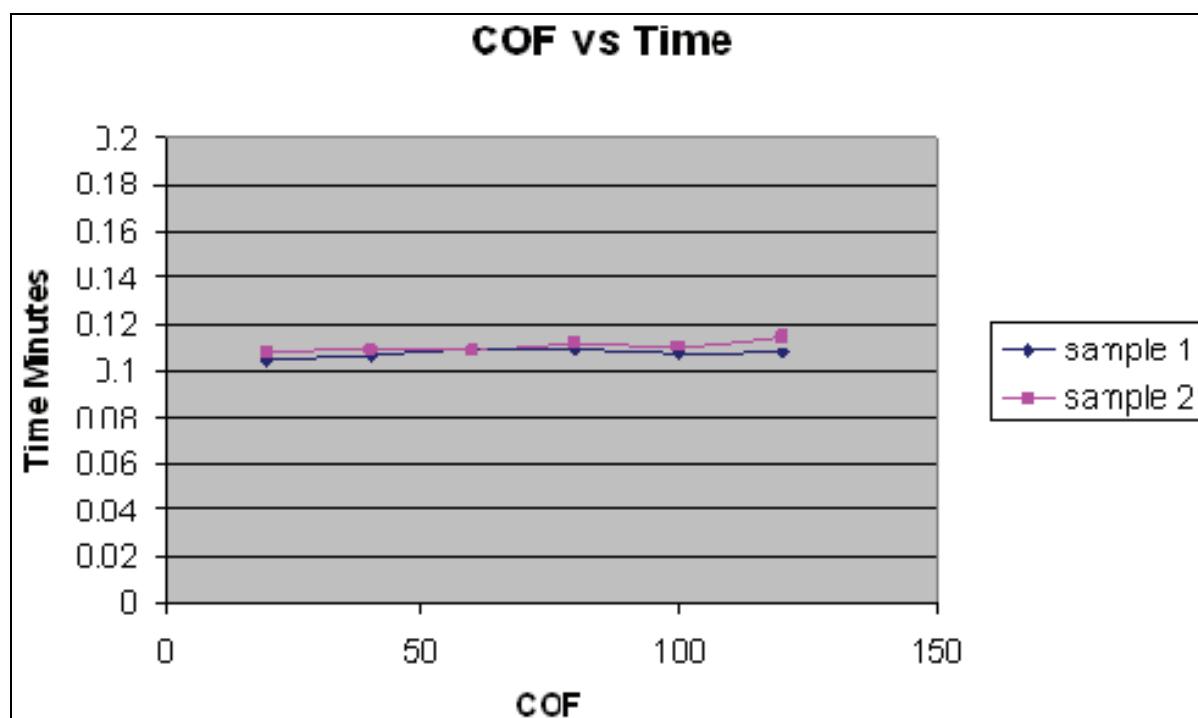


Fig. 1.

#### 4. Conclusions

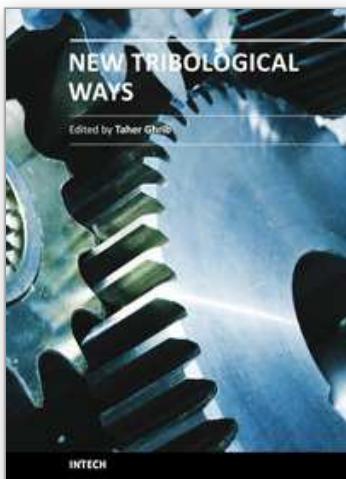
2-Mercaptobenzothiazole has shown better compatibility with Lithium complex grease and resulting good additive response.

Due to solid nature of 2-Mercaptobenzothiazole the yield of grease has increased marginally. The series of four ball EP tests and Timken Ok load test reveal that 2- Mercaptobenzothiazole has exceptional load carrying capacity compared to conventional EP additives.

This is supported by low coefficient of Friction of greases compared to conventional EP additives. The Based on these test results, it can be summarized that 2- Mercaptobenzothiazole has exceptional load carrying capacity compared to conventional EP additives.

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This book aims to recapitulate old information's available and brings new information's that are with the fashion research on an atomic and nanometric scale in various fields by introducing several mathematical models to measure some parameters characterizing metals like the hydrodynamic elasticity coefficient, hardness, lubricant viscosity, viscosity coefficient, tensile strength .... It uses new measurement techniques very developed and nondestructive. Its principal distinctions of the other books, that it brings practical manners to model and to optimize the cutting process using various parameters and different techniques, namely, using water of high-velocity stream, tool with different form and radius, the cutting temperature effect, that can be measured with sufficient accuracy not only at a research lab and also with a theoretical forecast. This book aspire to minimize and eliminate the losses resulting from surfaces friction and wear which leads to a greater machining efficiency and to a better execution, fewer breakdowns and a significant saving. A great part is devoted to lubrication, of which the goal is to find the famous techniques using solid and liquid lubricant films applied for giving super low friction coefficients and improving the lubricant properties on surfaces.

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