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A Case Study of Lubrication of Heavy Duty Marine Platform in Mediterranean Environmental Conditions

By

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Abstract

A study of lubrication of wire ropes of heavy duty marine platform used in Mediterranean environmental conditions has been performed. Two different greases, namely Grease A and Grease B, have been studied for physical properties and their performance. The used grease A was found to be contaminated with undesirable materials. The contaminants contain zinc and iron which confirms the visual observation of zinc removal at many sites of wire ropes due to corrosion. Grease A alone (without blending with other lubricant or fluid) was found not suitable for lubrication of heavy duty marine platform; in Mediterranean environmental conditions. However, Grease B can be used alone under these conditions.

1. Introduction

This study is concerning the selection of lubricants for wire ropes used in a heavy duty marine service platform under Mediterranean environment. The Mediterranean sea hydrological conditions are shown in Table 1. The platform is made to lift the marine vessels (boats and ships) from Mediterranean sea to be transferred to maintenance and servicing platform. This platform has twelve rolling motors on each side and it is hoisted with the wire ropes. These wire ropes are 35 mm in diameter and are manufactured from the galvanized steel wire. Zinc coating is provided as a sacrificial anode to provide protection to steel wires against corrosion.

The wire ropes require lubrication because the assembly strands and wires constitutes a vertible machine in which motion can occur more or less continually between the surfaces. The primary purpose of lubrication is separation of moving surfaces to minimize friction and wear. The life and durability of the wire ropes depend upon the protection of these surfaces by lubrication. The rate of movement or the service in which the rope operates is, of course, an important factor. In this platform hoisting ropes run over drums and are subject to frequent bending or flexing. When exposure of the elements involved, the lubricant not only prevents friction between the strands but also protect the strands and wire ropes against rust or corrosion.

This paper presents comparative study of performance of two greases namely Grease A and Grease B on lubrication of wire ropes of a heavy duty platform working in Mediterranean environment.

Table (1): Mediterranean sea hydrological conditions[1]

Salinity	NaCl (ppm)	O_2 (ppm)	Ca (ppm)	Mg (ppm)	pH
Surface	35.340	5.5-5.0	440	1390	7.72
- 90 m	35.920	_	440	1400	7.91
- 144 m	35.920	4.5-3.9	440	1390	7.80

2. Experimental

This study is concentrated on Grease A and Grease B. The first grease is a high temperature lithium soap grease incorporating high pressure additives as the manufacurer claims. The second grease is made from a solvent refined oil, a thickner, an adhesive and preferential wetting material. The manufacturers of both greases recommended them for the use of wire rope lubrication of heavy duty platform. The samples of these greases were obtained from manufacturers.

The samples of unused greses were analyzed for their following quality control tests:

2.1- Dropping Points:

The dropping point is a static test and it is useful to assist in identifying the grease type and for establishing and maintaining standards for quality control.

The dropping point of these grease samples were determined by standard method joint ASTM D566 and IP 132[4] The ASM-IP dropping point is: (a) the temperature at which a conventional soap-thickened grease passes from a semi-solid to a liquid state under the conditions of test or (b) the temperature at which certain other non-soap-thickened greases rapidly separate oil.

The dropping point of both these greases were determined and presented in Table 2.

2.2- Penetration:

A joint method of ASTM D217 an Ip 50 5 was adopted to determine worked and unworked penetration of Grease A and Grease B samples. The results are given in Table (2). The penetration was determined at 25 °C by releasing the cone assembly from the penetrometer and allowing the standard cone to drop freely into the grease for five seconds.

The worked penetration is generally used to establish the consistency of lubricating greases within the NLGI (The National Lubrication Grease Institute) consistency grades. The value of worked penetation of Grease A and Grease B were found to be 286 and 355 which are within the range of NLGI grade of greases.

Table (2): Properties of Grases

Property	Grease A		Grease B	
	Obtained	Reported	Obtained	Reported
Dropping Point	165°C	185°C	61°C	82°C
Penetration Unworked	286°C	_	455°C	_
Penetration Worked	286°C	265/295°C	355°C	_

3. Field Experience of Grease (A)

Grease A was used to lubricate wire ropes of the platform for about one and half years. The users observed some contaminants in the used grease. The external surface of the installed steel rope syncrolift hoist was visually inspected. Visual examination revealed that zinc coating has been partially removed from many sites on the wires, exposing the substrate at these sites. The colour of the substrate was dark grey.

The wire rope surface was cleaned from grease, using organic solvent. The surface was rough to touch at the locations where zinc coating has been removed. At certain locations red colouration and white colouration were observed in the used grease of wire ropes. These samples were collected and analyzed. The results are shown in Table (3).

The ash content of used and unused grease samples were determined by using standard method of test 6 for ash from petroleum products (ASTM D 482 and IP 4 method). The ash content was found to be 1.63 wt% and 4.92 wt% of unused and used grease samples, respectively. The high amount of ash content of used grease samples clearly indicates the presence of undesirable impurities or contaminants.

On visual examination of used grease it was obseved that it contains some red colour deposits and some white coloured deposits. The samples were collected and metal contents were determined by using Atomic Absorption Spectrophotometer. The results are shown in Table (3).

Higher zinc content in used grease samples, collected from the wire ropes as compared to that in unused grease, indicate partial removal of zinc coating on the wire ropes confirming visual observation of zinc removal at many sites on the wire ropes. Presence of higher iron content in used grease may be due to corrosion product.

Table (3): Some metal contents in used Grease A

Grease	Iron (Wt.%)	Zinc (Wt.%)	Calcium (Wt.%)	Magnesium (Wt.%)	Sodium (Wt.%)
Unused	$0.19X10^{-2}$	$0.03X10^{-2}$	$1.92X10^{-2}$	$1.51X10^{-2}$	_
Used	0.96	1.97	0.70	0.15	0.36
Red Deposited	0.82	3.11	0.82	0.13	0.55
White Deposited	0.22	3.98	0.71	0.25	0.60

3.1- Separation of Contaminants From Used Grease and Their Chemical Analysis:

An accurately weighed (10.00 g) of used Grease A was dissolved in 200 ml of petroleum spirit (60/80). The insolubles were wighed and found to be 9.95 wt.%.

1.00 g fo air-dried sample of insolubles (contaminants) obtained from used Grease A was placed in a crucible and put in drying oven at 105 °C for one hour. Then it was cooled in a desicator and weighed. The difference in weight before and after drying represents the moisture and volatile content of the sample. For the sample of insolubles it was found to be 0.84 wt.%.

After determining moisture and volatile content, the sample was put into a muffle furnace at 900 °C for two hours. After that the sample was cooled in a desicalor and weighed. The difference in weight before and after ignition gave the amount of loss at 900 °C. This determination is generally indicative of the decomposition of organic components, however, this determination also includes loss of combined water. The process of heating to 900 °C results in the conversion of certain inorganic salts. For example, hydroxides and carbonates are converted to oxides. Therefore, the loss of weight after ignition at 900 °C also includes the loss during such type of phenomena. The loss of weight on ignition at 900 °C was calculated to be 5.5 wt.%.

The metal contents were also determined in the insolubles obtained from used grease. Atomic Absorption Spectrophotometric method was used for determining metals in this samples. The solution was prepared according to standard procedure given in ASTM D 2331 method.

Accurately weighed of 0.3745 g of air-dried sample was taken in a platinum crucible, 3 ml 1:1 sulphuric acid was added and then 10 ml hydrofluoric acid (40 to 45%) was also added. The platinum crucible was heated till most of the hydrofluoric acid has been volatilized then 1 ml of nitric acid (Sp. gr. 1.42) was added and heating was continued until strong fumes of sulphur trioxide were evolved. The crucible and the contents were cooled. After that 15 ml of water were added slowly and continuously and left for half an hour to digest. The contents of the crucible were transferred into 250 ml volumetric flask and then the volume was adjusted when it became cool. This solution was subjected for metal analysis by Atomic Absorption Spectrophotometer according to standard procedures and the results are reported in Table (4).

Table (4): Some metal contents in insoluable contaminants separated from used grease

Metal	Amount (Wt.%)
Iron (Fe)	3.40
Zinc (Zn)	7.93
Silicon (Si)	0.29
Calcium (Ca)	0.79
Magnesium (Mg)	1.02

4. Discussion

In the field experiment of using Greasae A, it was found that zinc coating has been partially removed from many sites on the wires exposing the substrate at these sites. The wire rope surface was cleaned of grease using organic solvent. The surface was found rough to touch at the locations where zinc coating has been romoved. This indicates that the zinc coating of wire ropes is partially dissolved due to corrosion.

By visual examination of the used grease on the wire ropes it was observed that the grease had red colouration and white colouration at certain locations. Samples were collected and analyzed for metal contents. The results are shown in Table (3). These results indicate that the zinc content in used grease samples is higer as compared to that in unused grease. This confirms visual observation of zinc removal at many sites on the wire ropes. The presence of higher iron content in used grease may be due to corrosion product.

The ash contents of used and unused greases were determined which were 1.63 wt.% and 4.92 wt.% for unused and used greases respectively. The high amount of ash content of used grease sample is indicative of the presence of undesirable impurities or contaminants in used grease.

The contaminants were separated from the used grease by using petroleum spirit (60/80). The insolubles were crushed to powder and the homogeneous powder was analyzed and the results are reported in Table (4). The airdried sample contains 0.84 wt.% moisture and volatile materials. The loss of weight of this sample after ignition at 900 °C for two hours was found to be 5.5 wt.%. This determination is generally indicative of the decomposition of organic components, however, this determination also includes loss of combined water. The process of heating to 900 °C results in the conversion of certain inorganic salts. For example, carbonates and hydroxides are converted to oxides. Therefore, this loss of weight after ignition at 900 °C includes the loss of weight of the decomposition of organic components, combined water and the weight loss during the conversion of inorganic salts.

The contaminants were also analyzed for metal contents by using Atomic Absorption Spectrophotometer and the results are given in Table (4). The metal analysis clearly indicates the presence of high contents of zinc and iron. This also supports the results of visual examination.

In this study for the lubrication and protection against corrosion, Grease A has been used. According to the literature and our studies, Grease A can not be used alone under marine environmental conditions.

The second alternate grease for wire ropes is Grease B. The quality control results of this grease are given in Table (2). Grease B has penetration value as 455 while the penetration value of Grease A was found to be 286. The viscosity of lubricant is related to penetration. The heavier the product, the less chance will there be for it to penetrate to any great extent. More recent trend has been to use comparatively fluid products which can be applied without heating and will penetrate more readily. Since Grease B has more penetration than Grease A, it is preferable in this respect.

The second advantage of Grease B over Grease A is that it can be used alone and does not need blending with any fluid or grease to protect from corrosion. The dropping point is also low as compared to Grease A.. Grease B forms a tenacious film which protects wire ropes from the corrosive tendencies of salt spray and moisture laden atmosphere throughout the extremes of temperature which may be encountered at Mediterranean sea. It has also good protection against mild acids and is strongly resistant to atmospheric corrosion.

5. Conclusions

1. In field experiment, used Grease A is found to be contaminated with some insoluble materials. These contaminants contain zinc and iron which confirms the visual observation of zinc removal at many sites on the wire ropes.
2. Grease A alone (without blending with other lubricant or fluid) is not suitable for lubrication of heavy duty wire ropes under Mediterranean environmental conditions. However, Grease B can be used alone under the same environmental conditions.
3. When Grease A is used, the corrosion was observed in the form of partial removal of zinc coating which protects the wire ropes.

References

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