

# Study on the Properties of Wire Rope Grease Added with Lithium Grease

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**Abstract:** Hydrocarbon grease is used to lubricate and protect wire rope usually, but there are some problems have been found during lubricating process, such as high and low temperature working conditions resistance and waterproof performance and so on, in this paper we try to employ lithium grease to lubricate wire rope, according to the experiments, it comes a conclusion that lithium grease has the advantages which hydrocarbon grease doesn't have by comparing the performance of both, the properties of wire rope grease have been successfully improved by adding some lithium grease, and the percentage of addition is a key factor.

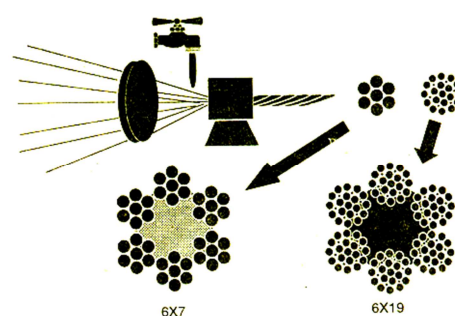
**Keywords:** Lithium Grease, Hydrocarbon Grease, Blending, Performance Test

## 1. Introduction

Wire rope is one of the key factors for usual operation of many lifting equipment, which is widely used in mining, forestry, industrial production, agriculture, transportation and housing construction [1]. Extreme temperature conditions, dust and corrosion, water washing and heavy loads are common in these working environments, and many authors believe that proper lubrication can improve the service life of the wire rope [2]. Wire rope is comprised of continuous wire strands wound around a central core (Figure 1). The individual wires and strands rub against each other in order to adjust themselves to the curvature of the rope wound around the core. Research shows the life-time of wire rope lubricated properly is about 2 times of which didn't lubricated properly at least [3].

Firstly, Some unique requirements for the selection of wire rope grease are put forward on account of the extremely weather, rain and snow, wind and sand, corrosive gas and so on in the working environment [4]. The grease should not be brittle in freezing weather, not blown at high temperature and not thrown off during long time operation, because of this, wire rope grease should have high and low temperature resistance, adhesion, water resistance and shear stability.

Secondly, lubricating performance is essential to the motional wire rope, lubrication prevents to wear on the individual wires and strands [5, 6].



**Figure 1.** Construction of steel wire rope.

Hydrocarbon grease is usually used for anticorrosion and lubrication of wire rope, which is prepared from the blending of solid hydrocarbons and mineral oil at a certain proportion, the mineral oil lost the flowability and formed the grease by net structure which is formed in the cooling process. The grease has the following advantages: 1) It has excellent chemical stability and colloidal stability and will not become softening due to the metamorphism and decomposition of the

thickener. 2) It is almost insoluble in water and non-emulsifying, prevent water and air from entering the surface of the wire rope [7]. 3) With added the functional additives, the grease show better lubricating, anti-rust and anti-wear performance [8].

The general lithium grease is suitable for lubrication of rolling, sliding bearing and other friction parts of mechanical equipment because of its advantages of great lubricating property, water-resistance property, mechanical stability and anti-rust property, etc [9]. When external forces are applied its soap particles are relatively soft and easy to deform, which are widely used in industry but rarely in steel wire rope lubricating [10]. But, in this paper, we tried to add lithium grease to hydrocarbon grease and want to improve the performance of wire rope grease.

## 2. Experiment Part

### 2.1. The Base Oil Used in the Experiment

Table 1. Analysis data of base oil A.

Items	Oil A
Kinematic viscosity(40°C)/(mm <sup>2</sup> /s)	114
Kinematic viscosity(100°C)/(mm <sup>2</sup> /s)	8.5
pour point /°C	-30

### 2.2. Thickener Used in the Experiment

Table 2. Date of thickener A.

Items	thickener A
melting point /°C	101
acid value /mg KOH/g	7.08

Table 3. Date of thickening agent B.

Items	Agent B
melting point /°C	142
acid value /mg KOH/g	3.34

Table 4. Date of 12 hydroxy stearic acid.

Items	12 hydroxy stearic acid
iodine value(gI/100g)	2.5
hydroxyl value(mg KOH/g)	152

Table 6. Correlation table of lithium grease and hydrocarbon grease.

Items	Thicker A	Thicker B	Lithium grease
Dropping point/°C	68	87	199
Low temperature performance test(-30°C, 30min)	pass	Non-pass	pass
Low temperature performance test(-40°C, 30min)	Non-pass	Non-pass	pass
Slid test(55°C, 1h)	Non slip on six side	Non slip on six side	Non slip on six side
Water spray(38°C, 5min)/%	33.6	24.3	83.9

The results show that the lithium grease had excellent performance in the wire rope grease performance test. The grease prepared by thickener A shows good low-temperature performance, its low dropping point indicates it is better used in a relative low temperature situation. The grease prepared by thickener B has high-and-low temperature performance can meet the requirements of the use of wire rope grease. But compared with lithium grease, under -40°C the semi-solid

Table 5. Date of lithium hydrate.

Item	lithium hydrate
LiOH contents /wt%	56.5

### 2.3. Specimen Preparation

The preparation of wire rope grease: Weighed two equal parts of base oil, heated to 100°C stirring for 1 hour, then added thickener A and thickener B to the two base oils separately, heated to 145±5°C, continue stirring for 2 hours. And then the sample was cooled and analyzed

The preparation of lithium grease: Add about a half of the base oil and 12 - hydroxy stearic acid to the kettle and heat up to about 90°C, then add the lithium hydroxide aqueous solution, heat up to 100°C, stirring for 30 minutes, up to about 170°C to dehydrate for 10 minutes, continue up to 200°C~205°C keep 5~10 minutes. Add the rest half of oil and cooling the mixture.

## 3 Results and Discussion

### 3.1. Properties Comparison of Lithium Grease and Hydrocarbon Grease for Wire Rope

Dropping point, low temperature performance and slid test are the three main performances in analysis of wire rope grease. In summer, coating on the surface of wire rope, after sun baking and friction heating, the temperature at this point can be up to 50~60°C, higher dropping point of grease will guarantee it not to flow, to drip and to adhere to the surface of steel wire rope firmly to lubricate and protect the wire rope. In winter, wire rope grease which has excellent low temperature performance, under - 30°C, still lubricate and protect the wire rope, not cracked, not drop off. Adhesion is an important performance of lifting rope grease in field operation. Good adhesion grease can adhere to the surface of wire rope without shedding, so as to protect and lubricate the wire rope effectively for a long time and improve the service life of wire rope. Comparison of the properties of lithium soap and hydrocarbon thickeners shows in table 6

hydrocarbon lubricant become brittle. However, lithium based grease not only has good performance at high temperature, but also shows better anti-brittle performance at low temperature, and the lithium grease performed well in the sild test.

### 3.2. Water- Resistance Test

At present, there is no requirement to test the

water-resistance property of wire rope grease in domestic standard, while Hildebrandt and Slack of imperial oil company of Canada proposed to test the anti-water spray of the steel wire rope grease at the 58th annual conference of international grease association [3], ASTM D4049 method is equivalent to the domestic standard SH/T 0643-1997(2005) test method, testing the water-resistance performance of wire rope grease, in order to test the application effect of the product in the presence of water. Thickener B has better water resistance while lithium soap has poor water resistance. Under the condition of water washing, 83.9% of the samples are washed, which will lead to the exposed or semi-exposed state of the wire rope rusting and breaking. So the blend of

lithium grease and hydrocarbon grease were anticipated to solve the problem.

### 3.3. The Experiment of Blending Lithium Grease and Hydrocarbon Grease

Lithium grease has shown good performance in the wire rope grease performance test, but water-resistance performance is not so good. Accordingly, the hydrocarbon grease and lithium grease were mixed in proportion to test the properties, Table 7 shows the specific experimental scheme and test results.

Table 7. Date of mixing of two type grease.

Items	Thickener A/lithium	Thickener B/ lithium
Mixed proportion (lithium 5%)	95/5	95/5
Dropping point /°C	70	91
Slide test (55°C, 1h)	Non slip on six side	Non slip on six side
Low temperature performance (-30°C, 30min)	pass	pass
Water spray (38°C, 5min) /%	33.1	22.8

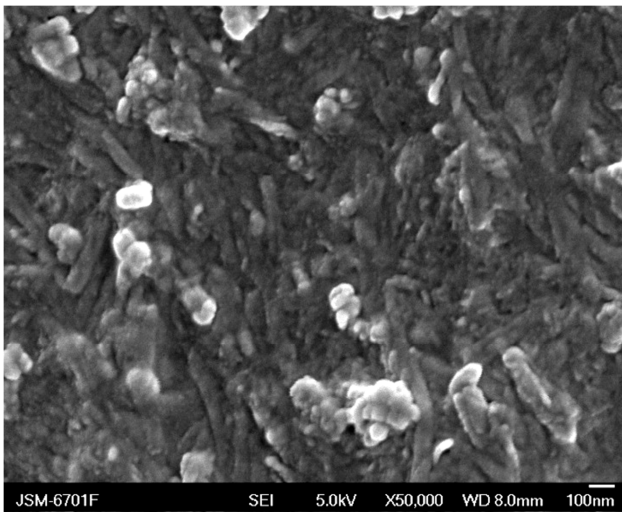


Figure 2. Contraction of Hydrocarbon thickener.

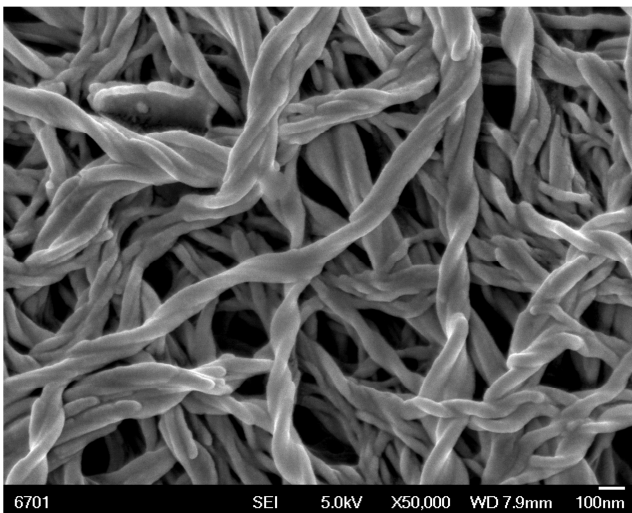


Figure 3. Contraction of lithium thickener.

Table 7 shows, it can be seen that the slid test of the wire rope grease are non-slip on six sides after adding 5% lithium grease to the hydrocarbon grease, which was not affected by the addition of lithium grease, and the dropping point, low-temperature performance and water-resistance have been improved, which enabled the product to have a wider range of operating temperature. Compared with the hydrocarbon wire rope grease, the water-resistance has not been reduced by the adding of lithium grease. Based on the same base oil they used it is believed that different thickeners lead to this situation. Scanning electron microscopy measured the thickeners A fiber and lithium soap fiber, as shown in figure 2 and figure 3 respectively.

As can be seen from the microscope photograph structure diagram of the thickener A and lithium based thickener, the latter has longer twisted fiber structure, while the fiber of the thickener A is short and not evenly distributed, but the fibers are close to each other and denser, and this compact fiber can prevent water vapor from immersing in thus having better water-resistance property. Lithium based thickener, a long, twisted fiber structure, is prone to roll when water washing, so it has poor water-resistance. However, when the lithium based thickener is mixed with the hydrocarbon thickener A, the content of lithium based thickener is less and distributed among the hydrocarbon thickener. Surrounded by this compact structure, it is difficult to move under the condition of water washing, and it can wrap the big fiber in the hydrocarbon grease so that it does not move. Therefore, the water-resistance performance is improved.

### 3.4. Increase the Proportion of Addition of Lithium Based Grease in the Mixture

The samples were prepared to increase the proportion of addition of lithium grease in the mixture and its' properties were tested see in table 8.

**Table 8.** Analysis date of increase lithium soap mix proportion experiment.

Items	Thickener A/lithium grease	Thickener B/lithium grease
Blending proportion(Add 5% lithium grease)	85/15	85/15
Dropping point/°C	82	98
Slid test(55°C, 1h)	Non-slid on six side	Non-slid on six side
Low temperature(-30°C, 30min)	pass	pass
Water spray(38°C, 5min)/%	98.9	99.8

As shown in the table 8, when the proportion of lithium based thickener increases, the slip tests are still passed. The dropping point increase and the low-temperature property become better, but the water-resistance become worse. According to the electron microscope images of the two thickeners, it can be concluded that when the proportion of lithium based thickener added increases, the hydrocarbon based thickener A is dispersed between the twisted fibers of lithium based thickener, forming a structure similar to that of a net holding a stone. Therefore, when washed, the main structure of the twisted fiber net moves. Under the action of gravity of the dense hydrocarbon fiber, the movement is increased, and more samples are lost and the water-resistant becomes worse.

#### 4. Conclusion and Suggestions

It comes the conclusion from our tentative experiment of using lithium grease to lubricate wire rope as the following: compared with hydrocarbon grease, lithium based grease not only has good performance at high temperature, but also shows better anti-brittle performance at low temperature, and the lithium grease performed well in the slid test. When lithium grease is added to the hydrocarbon grease at a proportion of 5%, the properties of the sample prepared become better than pure hydrocarbon grease, especially the water resistance performance. The dropping point of the sample become higher as the proportion of amount of lithium grease was increased, but its water-resistant performance was greatly changed, which was worse than pure lithium grease, its water washing lost weight reaches to more than 98%. Therefore, it is suggested that adding a small amount of lithium grease into the hydrocarbon grease can not only

improve the high and low temperature performance of the samples, but also improve the water-resistant spray performance of the samples.

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