Water Resistance Property of Greases – An Outlook

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Abstract

In rolling mills of steel plants, cold rolling oil emulsion is used as coolant and lubricant for rollers. Normally simple Lithium soap, mixed soap (Lithium and Calcium) based and Lithium Complex greases are used for lubrication of bearings. In recent time Overbased Calcium Sulfonate complex based grease is also being used predominantly as lubricant in the bearings supporting the rollers. But due to continuous high ingress of water/emulsion, in some cases this grease also gets emulsified due to absorption of water and looses its structure. Due to drop in consistency, the grease is washed away from the bearings. As a result frequent re-lubrication is required in bearings which causes production loss and high production cost. In order to maintain its structure, the grease is required to have good water repellency in addition to water tolerance property. By making grease water repellent, the water tolerance/resistance limit can be extended and resultant water washout and water spray-off property can be improved. Thus life of grease and bearings can be increased substantially. We have attempted to study the water washout resistant property of four different soap based greases by incorporating two different types of polymers viz. high molecular weight polymer and specially designed hydrocarbon resin polymer in these greases. The water washout and water spray off tests were conducted of these greases with these polymers. The water washout and water spray off tests were also conducted in base greases (without these additives). Other performance enhancing additives like EP/Antiwear, antioxidant and rust and corrosion inhibitor were also incorporated to meet requirement of high performance grease. These greases were tested for all other test parameters also. Lot of improvement was achieved in water washout resistant and water spray-off properties in these greases. The grease specimen has enhanced high temperature thermal/oxidation stability, rust and corrosion inhibition property, good shear/ mechanical stability and high load carrying capacity as expected.

Introduction

The present work relates to study the water washout resistance and water spray-off resistant properties of two different types of polymers in four different soap type greases. The greases used in steel plants are more susceptible to water washout due to heavy water ingress in hot & cold rolling mills. Therefore selection of proper grease is very important for successful running of rolling mills. Normally simple Lithium soap, mixed soap (Lithium and Calcium) based and Lithium Complex greases are used. These greases are emulsified with huge quantity of water thus not able to withstand the force of water sprayed on bearing and washed away from the bearing. Therefore Overbased Calcium Sulfonate complex based grease is introduced and being used predominantly. But due to continuous high ingress of water/emulsion it absorbs lot of

water and grease gets emulsified and deterioration of grease structure takes place. Normally 300 and 400 BN calcium sulfonate is used for making calcium sulfonate complex greases. Total Base Number (TBN) of calcium sulfonate used for making Calcium sulfonate complex grease, also play a crucial role in water resistant and water spray-off resistant property. Higher the TBN of Calcium sulfonate about 400, better the water wash out and spray-off resistant property, whereas, the calcium sulfonate with 300 TBN have less water resistance and tolerance than 400 TBN calcium sulfonate. Though the Calcium Sulfonate complex grease has good water absorption and water tolerance property at lower consistency and retaining its structure, but this tolerance limit decreases at higher consistency side, as a result break down of grease structure takes place and grease is washed away due to continuous spray/ingress of water. As a result frequent re-lubrication is required in bearings. Additionally, the water washout property and water spray off property is also related with consistency of grease and the viscosity of base oil used for making grease. Lower the consistency and higher the base oil viscosity, better the washout and spray-off resistance property. Grease in NLGI 3 range is not suitable for centralized lubrication system. But in rolling mills, the grease made with high viscosity oils also not able to withstand force of water and rolling oil emulsion. Since in steel plants bearings are lubricated through centralized lubrication system, the consistency need to be adjusted at higher side i.e. between NLGI 2 and NLGI 1.5 consistency range having high water resistant and water spray-off property, good structure/shear stability and the mechanical stability even in the presence of water ingress. In order to maintain its structure and remain inside the bearings, the grease is required to have good water repellency in addition to water tolerance property. By making grease water repellent, the water tolerance/resistance limit can be extended and resultant water washout and water spray-off property can be improved. This can be achieved by use of high molecular weight polyisobutylene and specially designed hydrocarbon resin polymer (neopolymer) in these greases. The greate advantage of hydrocarbon resin is they are very good water repellant, highly hydrophobic and shear stable. Due to better water repellency, they will not soften and washed away even in hot water. Thus the grease will remain in bearing and the life of grease and bearings can be enhanced substantially. They are more water repellant than polymers and penetration of water will be less in grease and retention of grease structure and water resistant will be higher. This hydrocarbon resin gives extra tackiness and embodiment to grease. Due to these characteristics they are preferably used in water resistant paint for longer life. The Performance of the grease was bench marked with respect to water wash out resistant, water spray-off resistant properties, the structure/shear stability and load carrying properties.

Experimental Details

Four different soap type greases were prepared by conventional method. The fatty acids for all the three types of greases were kept same. In first experiment the base oil viscosity of all the three grease types was kept in ISO VG 150, whereas of calcium sulfonate complex grease it was kept ISO VG 180. The consistency of all the four types different soap types greases was kept in NLGI 3 consistency range between 244 to 246. The water washout tests were conducted on these four greases. In second experiment the consistency was raised from NLGI 3 to NLGI 2 with consistency range between 274 to 276. Water washout test was conducted for these greases. In third experiment the base oil viscosity was further increased from ISO VG 250 to ISO VG 220 but consistency of the greases was maintained between 274 to 276. Water washout test was conducted for these greases. In fourth experiment the base oil viscosity was further increased from ISO VG 220 to ISO VG 320 but consistency of the greases was maintained between 274 to

276. Water washout test was conducted for these greases. In fifth experiment water wash out test was conducted for greases having different base number of over based calcium sulfonates used for making calcium sulfonate complex greases. Because Total Base Number (TBN) of calcium sulfonate used for making Calcium sulfonate complex grease, also play a crucial role in water resistant and water spray-off resistant properties. The base oil viscosity of both the greases was maintained in ISO VG 320 and consistency in NLGI 2 at 275. Since in steel plants water ingress is very high, the grease need to have very good water washout and water spray-off resistant properties, therefore the losses due to water washout and water spray should be minimal. In order to achieve these two different types of polymers viz. high molecular weight polymer and specially designed hydrocarbon resin polymer were tried at same treat level in these greases to enhance the water washout resistance and water spray-off resistant properties. Again water washout tests were conducted in all four different soap types greases. Other performance enhancing additives like EP/Antiwear, antioxidant and rust and corrosion inhibitor were also incorporated to meet requirement of high performance grease. These greases were tested for all other test parameters in addition to water washout resistance and water spray-off resistant tests. The water resistant properties were checked for all the four grease specimens before addition of these polymers. The details of types of greases are as under.

1. Simple Lithium soap grease
2. Lithium/Calcium mixed soap grease
3. Lithium Complex grease
4. Calcium Sulfonate complex grease

Results and Discussion

The test results of water washout and water spray-off properties of base greases prepared in NLGI 3 are provided in Table 1. The water washout value of simple lithium grease, Lithium/calcium mixed soap, lithium complex greases are about 5 to 6%, whereas in case of calcium sulfonate complex grease it is 3.6%. With rise in consistency of all the greases the loss due to water washout has almost doubled in all the greases. The results are provided in Table 2. It is clear that with increase in consistency the water wash out loss increase due to less adhesive property of grease as water can penetrates easily in thinner grease. However, when viscosity of base oil in grease is increased from ISO VG 150 to 220, the losses due to water wash out can be improved about 15 to 20%. The results are provided in Table 3 when the base oil viscosity was further increased from ISO VG 220 to ISO VG 320, the losses due to water wash out could be further reduced from 16 to 20% in different soap type greases. The results are provided in Table 4. In recent time, Overbased Calcium Sulfonate complex based grease is also being used predominantly in steel plants. As the Total Base Number (TBN) of calcium sulfonate used for making Calcium sulfonate complex grease plays a crucial role in water resistant and water spray-off resistant properties. The Water washout test was conducted of two calcium sulfonate complex greases having 300 and 400 TBN. The results are provided in table 5. It can be observed that calcium sulfonate used for making grease having high base number i.e. 400 TBN has shown better water washout resistant property than lower base number i.e. 300 TBN calcium sulfonate. The grease having 400 TBN has water washout loss 4.28% whereas grease is having 300 TBN has shown water washout loss 5.33%. But these losses are also very high. And grease will be

washed away from the bearing shortly. Therefore this limit need to be reduced minimal level. In order to make grease more water washout and water spray-of resistant two different types of polymers viz. high molecular weight polymer and specially designed hydrocarbon resin polymer were tried at equal treat level in these greases to enhance the water washout resistance and water spray-off resistant properties. The water washout resistances of simple lithium soap grease come down from 8% to 5% with both the polymers. In lithium calcium mixed soap grease from 6.4% to 2% and 2.1% with polymers with P1 and P2 respectively. In lithium complex from 6.5% to 4.4% and 4.5% with polymer P1 and P2 respectively. And in calcium sulfonate complex grease it has come down from 4.29% to 1.97% with polymer P1 and 2.1 with polymer P2. The results are provided in table 6.

Conclusions

The water washout loss of greases increases with increase in penetration/consistency of grease. The water washout loss of greases reduces with increase of mineral oil viscosity used for making greases. The base number of over based calcium sulfonate used for making calcium sulfonate complex grease also plays a role in improvement in water washout and water spray-off resistance properties. Higher the base number of calcium sulfonate used for making grease lower the losses of grease due to water washout. Use of water repellent is essential for making grease more water washout resistant and water spray-off resistant. By making grease water repellant water tolerance limit of greases can be extended thus greases will be most water resistant. The hydrocarbon resin polymer used for making water resistant grease has also comparable water washout resistant properties with high molecular weight polymer used currently.

Table 1. Test Results of water washout properties of base greases (grease consistency NLGI 3)

Grease type	Grease consistency 60 X (NLGI 3)	Base oil viscosity @ 40°C (cSt)	Water Washout, ASTM D1264 79°C % loss
Simple Lithium soap	245	150	6
Lithium/calcium mixed soap	244	150	5
Lithium Complex	246	150	5
Calcium sulfonate complex	245	180	3.6

Table 2. Test Results of water washout properties of base greases (grease consistency NLGI 2)

Grease type	Grease consistency 60 X (NLGI 2)	Base oil viscosity @ 40°C (cSt)	Water Washout, ASTM D1264 79°C % loss
Simple Lithium soap	274	150	12
Lithium/calcium mixed soap	276	150	10
Lithium Complex	275	150	10
Calcium sulfonate complex	276	180	6.8

Table 3. Test Results of water washout tests of base greases with higher viscosity base Oil (ISO VG 220)

Grease type	Grease consistency 60 X (NLGI 2)	Base oil viscosity @40°C (cSt)	Water Washout, ASTM D1264 79°C % loss
Simple Lithium soap	274	220	9.5
Lithium/calcium mixed soap	276	220	8
Lithium Complex	275	220	8
Calcium sulfonate complex	276	220	5.1

Table 4 Test Results of water washout properties with higher base oil viscosity (ISO VG 320)

Grease type	Grease consistency 60 X (NLGI 2)	Base oil Viscosity @40°C (cSt)	Water Washout, ASTM D1264 79°C % loss
Simple Lithium soap	274	320	8
Lithium/calcium mixed soap	276	320	6.4
Lithium Complex	275	320	6.5
Calcium sulfonate complex	276	320	4.29

Table 5. Test Results of water washout properties of Calcium sulfonate grease with different base number without polymer

Grease type	Grease consistency, 60 X	Base oil Vis @40°C (cSt)	Water Washout, ASTM D1264 79°C % loss	
			300 BN	400 BN
Calcium sulfonate complex	275	320	5.33	4.28

Table 6. Test Results of water washout tests of greases (with two different polymers)

Type of polymers

1. Hiigh Molecular Weight polymer (P1)
2. Hydrocarbon resin polymer (P2)

Grease type	Grease consistency 60X (NLGI 2)	Base oil Vis @40°C (cSt)	Water Washout, ASTM D1264 79°C % loss	
			P 1	P2
Simple Lithium Soap	274	320	5	5
Lithium/calcium mixed soap	276	320	2	2.1
Lithium Complex	275	320	4.4	4.5
Calcium sulfonate complex	278	320	1.97	2.1