11. Grease lubrication

11.1 Grease

Grease is a semi-solid ointment type lubricant that provides a stationary continuous supply of lubricant to the bearing surface. It is a suspension of thickener in base oil with some chemical additives added to enhanced the chemical and physical properties. The type of additives that is added to the grease depends on the temperature of the operation and other desired properties.

Careful selection of grease is important because there are many qualities of greases for each type of grease. Variety of grease types and their qualities are summarized in Table 11.1

<TABLE 11.1> Grease type and quality

Grease type (common name)		Thickener	Physical appearance	Melting point (℃)	Water resistance	Mechanical stability	Operating temperature range(℃)	Speed range	Usage
Calcium soap (cup grease)		Ca	Butter like	80~90	Good	Good	-10 ~ +70	Medium ~ Low speed	Regular use, low speed and light load, cup grease for regular plane bearing
Calcium complex soap		Ca	Butter like	200~280	Good	Good	-10 ~ +150	Medium ~ Low speed	All purpose roller bearing
Mixed Calcium & Lithium soap		Ca	Butter like	170~190	Good	Excellent	-10 ~ +130	Medium ~ Low speed	Medium size ball bearing, typical roller bearing
Sodium soap (fiber glass)	Long fiber	Ca	Fiber like	150~180	Good ~ Poor	Good	-10 ~ +100	Medium ~ Low speed	Less than medium speed bearing
	Short fiber	Na	Short fiber ~ Butter like	150~180	Good ~ Poor	Excellent ~Good	-10 ~ +100	High ~ Low speed	Medium to high speed bearing, relatively high temperature roller gearing
Aluminum soap		Al	fluid	70~90	Good	Good ~ Poor	-10 ~ +80	Medium ~ Low speed	High vibration bearing, automobile window gear(especially where adhesion is required)
Calcium and lead mixture		Ca+Pb	Short fiber ~ Butter like	70~80	Good	Excellent ~ Good	-10 ~ +90	Medium ~ Low speed	In rolling machine, automobile windows with shock loading
Calcium + sodium mixture		Na+Ca	Short fiber ~ Butter like	150~180	Good ~ Poor	Excellent ~ Good	-10 ~ +120	High ~ Low speed	Rolling bearing, large ball bearing for high speed operation
Lithium soap	Metallic fiber	Li	Butter like	170~190	Good	Excellent	-30 ~ +130	High ~ Low speed	Medium~small size ball bearing typical rolling bearing
	Silicon ester	Li	Short fiber	170~220	Good	Good	-50 ~ +130	Medium ~ Low speed	Ball bearing with wide operating temperature range, extended operating time
Lithium complex soap		Li	Butter like	200~260	Good	Excellent	-30 ~ +150	High ~ Low speed	Medium to samll size ball bearing, typical rolling bearing
Non soap		Silicagel, Bentone	Butter like	Over 250 (no dropping point)	Good ~ Poor	Good ~ Poor	-10 ~ +200	Medium ~ Low speed	All purpose, rolling bearing

11.2 Grease selection

Grease can be separated into three main ingredients. They are the base oil which provides the lubricating characteristics, the thickener which provides the special consistency of grease and finally the additives, which provides the additional enhanced properties of the grease.

(1) Base oil

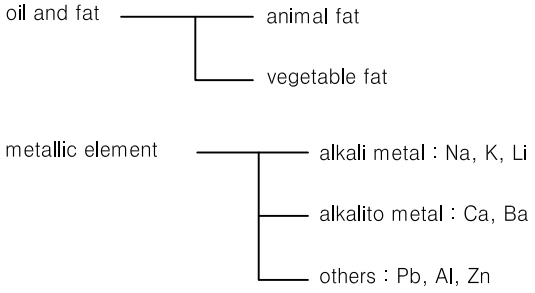
Base oil can be divided into mineral and synthetic types. Based on temperature, mineral oil is widely used as a low to high viscosity base oil.

The most important determining characteristic for grease is the base oil viscosity. Proper viscosity base oil should be selected based on operating conditions.

Commonly, for high load, low speed and high temperature lubrication, high viscosity base oil is used. For light load, high speed and low temperature lubrication, low viscosity base oil is used. Synthetic base oil should be used for extremely low temperature, relatively high temperature or for other special applications.

(2) Thickener

Metallic soap is the most widely used thickener, but grease can also be porduced with non-soap thickeners. Metallic soap is made by chemically combining fat and alkali metal or alkalito metal. The following list represents typical materials for the thickener.



(3) Additives

Based on the operating temperature, various types of additives are added to the grease. Commonly, grease with extreme pressure additive is used in medium load and shock load operating conditions. Grease with anti-oxidant additive is used when the grease is not intended to be re-supplied for a very long time. In addition, tackiness agents, rust inhibitors, film strength increasing agents, stabilizers and protection agents are also used as additives.

11.3 Grease properties

(1) Consistency

Consistency of grease describes the way the internal physical characteristic is changed by external influences. It is expressed by NLGI(National Lubricating Grease Institute) determined grades. 9 grades of the NLGI consistency is shown in Table 11.2. The higher number indicates higher consistency. The most commonly used classes are NLGI 0, 1, 2 and 3.

<TABLE 11.2> NLGI Grease classification

Grade No. (NLGI)	Consistency	Operating condition and usage
0	355 ~ 385	For concentrated supply, when fretting is possible
1	310 ~ 340	Closed supply, low temperature, when fretting is possible
2	265 ~ 295	Regular use, sealed style ball bearing
3	220 ~ 250	Regular use, sealed style ball bearing, high temperature
4	175 ~ 205	High temperature, when grease is used to seal

Remark : Consistency ; expresses the penetration depth (1/10 mm) of a fixed weight cone into the grease. Larger number means softer.

(2) Dropping point

Drooping point is the minimum temperature at which the grease structure changes from a semi-solid to a liquid as the grease temperature is increased. The maximum operating temperature for the bearing is not directly expressed by the dropping point, but is related to the overall heat resistance of the grease.

Commonly,

Calcium grease : less than 100℃

Sodium grease : 170℃ ~ 200℃

Lithium complex grease : dropping point is above 230℃

11.4 Grease supply amount

The inserted grease lubricates the internal parts of the bearing and teh seal. The grease also prevents entrance of dust and moisture. But, if the grease is over filled, it can cause excessive temperature increase due to additional friction caused by the grease. The grease can then soften and leak through the seal. Ball bearing unit is properly filled by filling about 30 to 35% of the internal volume of the bearing.

Appropriate amount is based on operating conditions and cannot be determined systematically. In order to avoid excessive filling, about 80% of the filling amount is appropriate for most application. The standard amount filled by JIB is listed in Table 11.3.

<TABLE 11.3>
Amount of grease supplied based on bearing style No.

(unit : g)

Style No.	Supply amount	Style No.	Supply amount
UC201 / UC205	1.4	UC305	3.0
UC206 / UCX05	2.5	UC306	4.5
UC207 / UCX06	3.0	UC307	6.0
UC208 / UCX07	4.0	UC308	9.0
UC209 / UCX08	4.5	UC309	11.0
UC210 / UCX09	5.5	UC310	14.0
UC211 / UCX10	7.0	UC311	17.0
UC212 / UCX11	9.0	UC312	21.0
UC213 / UCX12	11.0	UC313	26.0
UC214 / UCX13	13.0	UC314	33.0
UC215 / UCX14	14.0	UC315	37.0
UC216 / UCX15	20.0	UC316	46.0
UC217 / UCX16	24.0	UC317	51.0
UC218 / UCX17	31.0	UC318	63.0
UCX18	40.0	UC319	72.0
UCX20	58.0	UC321	90.0
		UC320	105.0
		UC322	130.0
		UC324	150.0
		UC326	190.0
		UC328	240.0

* the listed amount must be multiplied by 1.5 to 2 times in severe dust or moisture environment.

11.5 Grease re-supply

Appropriate time for re-supplying the grease to the bearing is at about 1/3 to 1/2 of the calculated grease life time. When the unit is operated above 100℃, the grease should be resupplied at 1/3 of the calculated life time to allow for some safety margin. Pratical grease supply time based on bearing operating temperature is shown in Table 11.4 for reference. Also, when the operating environment is severe or when the operating temperature is above 120℃, grease resupply period should be appropriately shortened.

<TABLE 11.4> Period between grease re-supply(assume 8 to 10 hours operation per day for normal operation)

Bearing operating temperature(℃)	Period			Bearing	Grease
	good environmental condition	Dusty condition	High dust and moisture condition		
under 50 under 70 under100	No need to re-supply 1year 6montys	1 year 4 months 2 months	4 months 1 month 2 weeks	Regular	Shell Alvania SYNCO G2
under 120 under 150 under 180 under 200	2 months 2 weeks 1 week 3 days	2 weeks 5 days 2 days 1 day	5 days 2 days 1 day 1 day	Heat resistant (EN2)	Super Lube

※ The greases listed in the table may be changed without notice to improve the quality.

11.6 Grease life

The grease that is supplied and sealed in the bearing reduces the friction and wear and thus reduces the generation of heat by the bearing and at the same time prevents seizure and rusting of the bearing.

Although the greases used by JIB are carefully chosen to be of a very high quality grease, the aging and oxidation of the base oil is not prevented because of the intense physical action of the ball and the retainer during rotation. The continuous physical shearing of the grease by the contact points of the ball and the rotating race can physically breakdown and age the supplied grease. The ultimate life of the bearing unit is dependent on the life of the grease when grease is not re-supplied to the unit. Therefore, in operating ball bearing units, the life of the grease used in the unit should be checked before starting operation. In normal operating conditions, the sealed bearing's grease life is determined by the following equation.

$$\log t = 4.73 - (T - 17.2) \times (0.0104 + 8.46n \times 10^{-7}) - 0.03 \frac{n \cdot Fr^{1.5}}{C^{1.9}}$$

Hear, t : Average life of grease (hour)
T : Bearing operating temperature (℃)
n : Rotation speed (rpm)
Fr : Radial load (Kgf)
C : Equivalent static radial load rating (Kgf)

The calculation shows that grease life is strongly dependent on the operating temperature.

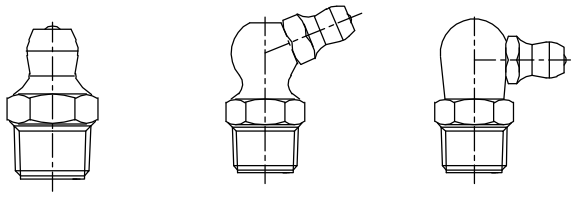
The grease life is also shortened from the calculated value if the grease operated above 100℃ temperature and if the bearing unit is operated in severe dust and moist environment. Therefore, the bearing unit's grease should be periodically checked and maintained ahead of time in severe operating conditions.

11.7 Grease mixture compatability

For proper maintenance of the ball bearing unit, different grease should not be used to re-supply the unit because the physical structure of the grease could be destroyed by mixing grease with two different types of thickeners. Even for greases with the same type of thickeners, differences in additives could cause adverse or unexpected effects on the grease, especially at operating conditions near the maximum speed of the bearing.

11.8 Grease nipple

There are 3 different nipple styles based on shapes as shown in Figure 11.1. The basic diameter of grease nipple screw threads in JIB is M6×1. On demand, we supply the applicable setscrew as shown in Table 11.5.



A style nipple (regular sytle) | b style nipple (L style 67.5°) | C style nipple (L style 90°)

[FIGURE 11.1] Nipple types

<TABLE 11.5> Nipple fitting screw threads

Bearing style No.	Basic screw threads	Applicable screw threads
UC201 ~ 210 UCX05 ~ X09 UC305 ~ 308	M6 × 1	$\frac{1}{4}$ - 28UNF
UC211 ~ 218 UCX10 ~ X20 UC309 ~ 328	M6 × 1	PT-$\frac{1}{8}$