Shin-Etsu

Shin-Etsu silicone

Greases · Oil Compounds

Contents

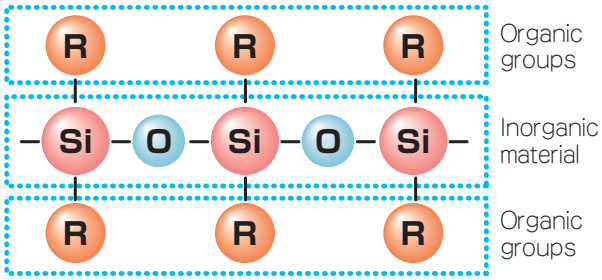
Facts about Silicone

【Chemical properties of silicones】

The main chain of a silicone is made up of inorganic siloxane linkages (Si-O-Si), to which are attached side chains which contain organic groups. Silicones are a sort of hybrid polymer with both inorganic and organic components.

■Features attributable to siloxane linkages

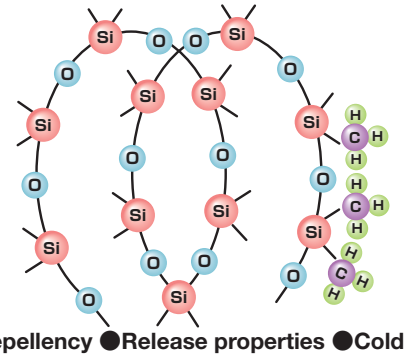
Silicones have a “backbone” of siloxane linkages, with attached side chains which contain organic groups.



●Heat resistance ●Weatherability
●Chemical stability ●Dielectric properties

■Features attributable to molecular structure

The molecules of dimethyl silicone exhibit a twisted, helical structure.



●Water repellency ●Release properties ●Cold resistance
●Low temperature-dependence

●Compared to organic polymers, which have a carbon skeleton (C-C bond energy: 85 kcal/mol), silicones have superior heat resistance and weatherability (UV light, ozone resistance). This is due to the greater stability of siloxane bonds, which have a bond energy of 106 kcal/mol.

● Siloxane bonds have a bond length of 1.64 Å and bond angle of 134°. Compared to carbon bonds (bond distance: 1.54 Å, bond angle: 110°), they have a long bond distance and high bond angle, and a low rotational energy barrier. As a result, siloxane bonds move more freely and intermolecular forces are weak. These characteristics manifest themselves in the features of silicone materials, which include softness, gas permeability, cold resistance, and little change in viscosity due to temperature changes.

● The backbone of dimethyl silicone exhibits a helical structure.
Hydrophobic methyl groups cover almost the entire surface of the silicone polymer molecules, and surface energy is low. This gives rise to unique properties including water repellency and easy release.

● Moreover, silicones are low-polarity polymers, so they exhibit minimal moisture absorption.

Silicone Greases・Oil Compounds

Silicone greases are products which consist of a base oil of silicone fluid compounded with thickening agents (such as metallic soaps) and other additives. They can be used in a wide range of temperatures and are used primarily on moving parts to provide lubrication and adhesion.

Silicone oil compounds are products which consist of a base oil of silicone fluid compounded with fillers such as silica powder or metallic oxides. The intended application will dictate the type of filler used.
They can be used in a wide range of temperatures and are used primarily on non-moving parts for thermal conduction, electrical insulation and sealing.

Features of silicone greases・oil compounds

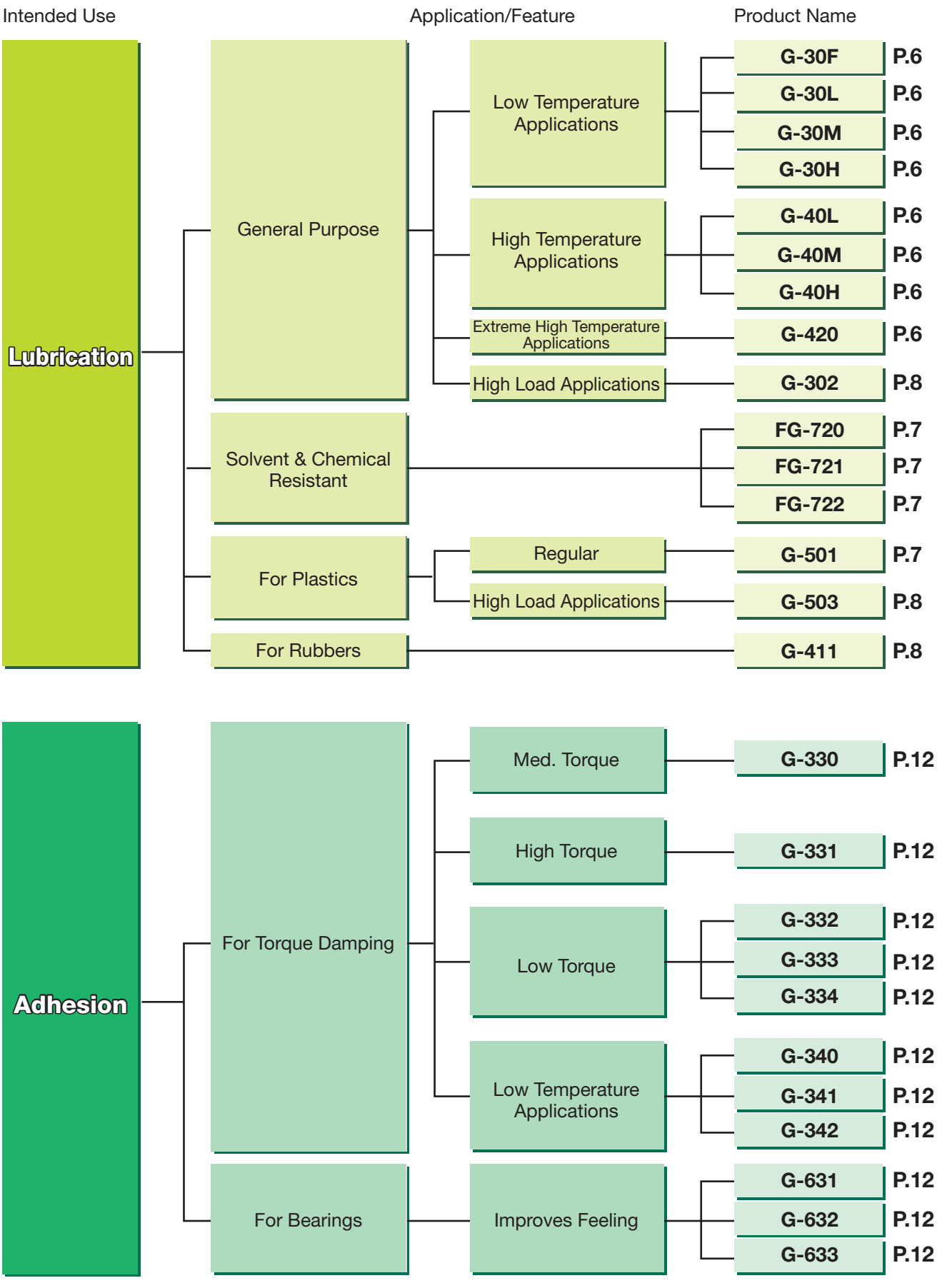
Because they use silicone fluid as the base oil, Shin-Etsu silicone greases and oil compounds offer the following advantages.

1. Outstanding heat and cold resistance, so they perform well in extreme conditions and will continue to do so over prolonged use.
2. Electrically insulating, so they can be used with confidence.
3. Outstanding moisture resistance and water repellency.
4. Non-corrosive.
5. Effective in small amounts.

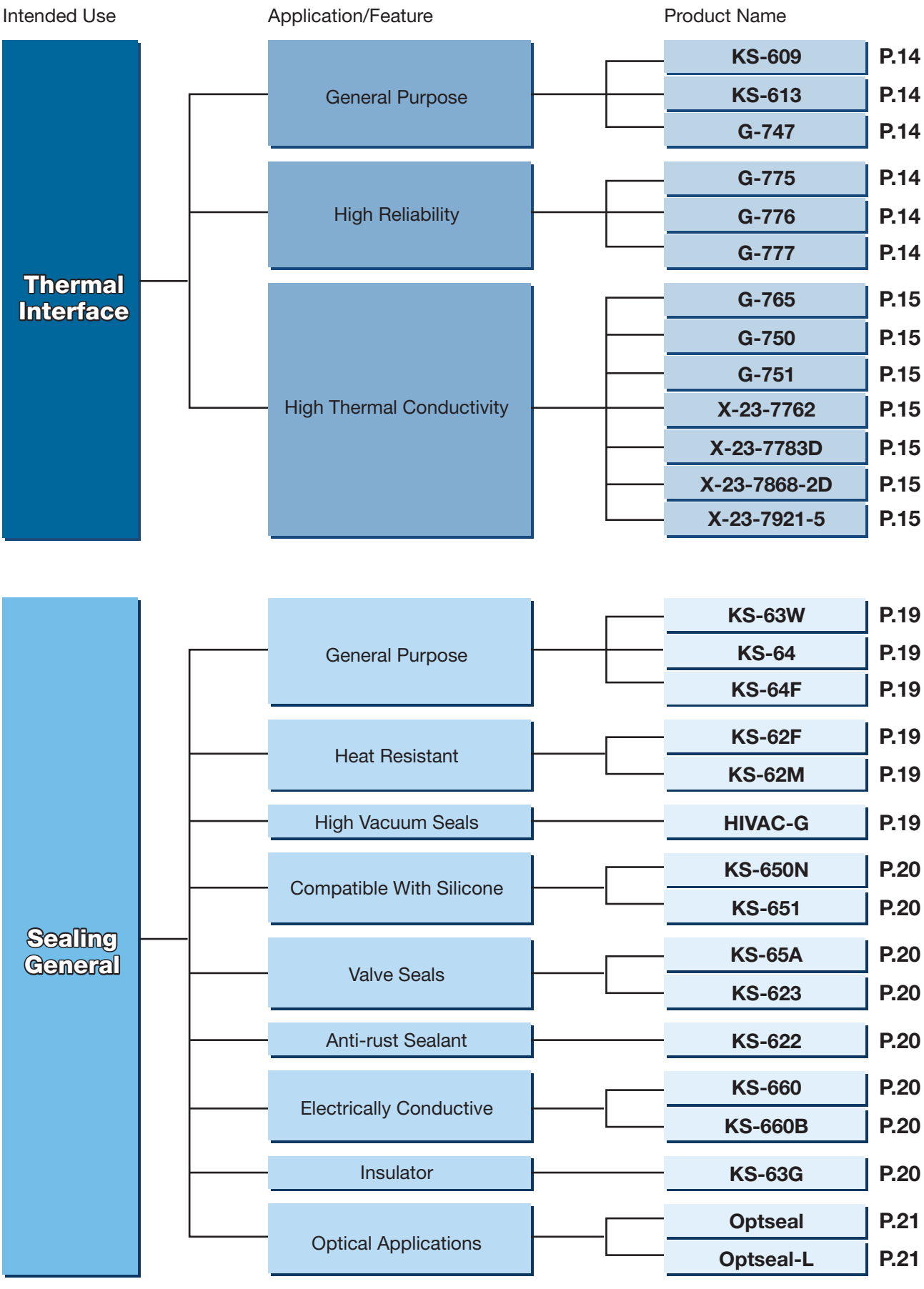
Heat resistance comparison (Left: mineral oil Right: silicone fluid)

※Before using any of these products, be sure to test beforehand to determine the product's suitability to the intended application.

Greases Selection Guide



Oil compound Selection Guide



Properties of grease products

Silicone greases are made using a silicone fluid as the base oil. This is compounded with other materials such as thickeners, oiliness improvers and antioxidants. Compared to common mineral oil greases, silicone greases have greater thermo-oxidative stability and moisture resistance, and have a wider range of use temperatures. Silicone greases are also chemically inert, and so are compatible with almost all types of equipment.

Low-temperature lubrication applications

G-30F G-30L G-30M G-30H

The greases in the G-30 series were specially designed to provide excellent lubrication at low temperatures. There are four grades of thickness: F, L, M and H.

Typical properties

Parameter				G-30F	G-30L	G-30M	G-30H
Appearance				Grayish white paste	Grayish white grease		
Specific gravity		25°C		0.99	0.99	1.00	0.99
JIS K2220 Test method	Penetration	25°C/worked		340 – 400	280 – 320	240 – 280	200 – 240
	Drop point		°C	—	200+	200+	200+
	Oil separation	150°C×100h	%	—	5.7	2.3	0.5
	Oxidative stability	150°C×50h*1	kPa	—	30	30	30
	Moisture resistance		%	—	1	1	1
	Worked stability	100,000 strokes		—	400 (max.)	400 (max.)	400 (max.)
	Low-temperature torque (Starting/Running)	-60°C	mN m	—	107/31	266/93	329/122
MIL-L15719A	Low-temperature torque	-60°C	2000 g-cm	—	Less than 1 sec	1 sec	1 sec
BTB	Free acid or free alkali			Neutral			
Use temperature range			°C	−60 to +180			
Volatile content		150°C×100h	%	—	0.35	0.41	0.35
Low-molecular-weight silicone content		ΣD_3-D_{10}	ppm	≤100			

*1 The oxidative stability test conditions prescribed in JIS K 2220 indicate 99°C/100 hours, but in this case measurement was done at 150°C×50 h. (Not specified values)
※G-30 greases are suitable for speed factors (bearing bore in mm _ bearing shaft speed in rpm) up to 200,000.

High-temperature lubrication applications


Bearing lubrication

G-40L G-40M G-40H G-420

The greases in the G-40 series were specially designed to provide excellent lubrication at high temperatures, and are ideal for lubrication of sealed bearings.
There are three grades of thickness: L, M and H. G-420 provides outstanding lubrication at very high temperatures.

Typical properties

Parameter				G-40L	G-40M	G-40H	G-420 *1
Appearance				Beige grease		Brown grease	White grease
Specific gravity		25°C		1.06	1.05	1.06	1.10
JIS K2220 Test method	Penetration	25°C/worked		280 – 320	240 – 280	200 – 240	281
	Drop point		°C	200+	200+	200+	200+
	Oil separation	150°C×100h	%	8.9	5.9	3.0	5.7*2
	Oxidative stability	150°C×50h*3	kPa	10	10	10	—
	Moisture resistance		%	1	1	1	1
	Worked stability	100,000 strokes		400 (max.)	360 (max.)	320 (max.)	310 (max.)
	Low-temperature torque (Starting/Running)	-20°C	mN m	66/29	83/46	117/57	41/25
MIL-L15719A	Low-temperature torque	-20°C	2000 g-cm	Less than 5 sec.	Less than 5 sec.	Less than 5 sec.	Less than 5 sec.
BTB	Free acid or free alkali			Neutral			
Use temperature range			°C	−30 to +200			−30 to +250
Volatile content		150°C×100h	%	0.4	0.3	0.3	0.3*2
Low-molecular-weight silicone content		ΣD_3-D_{10}	ppm	≤100			

*1 For information on safety, see page 22 (Safety & hygiene). (Not specified values)
*2 200°C×24h
*3 The oxidative stability test conditions prescribed in JIS K 2220 indicate 99°C×100 h, but in this case measurement was done at 150°C×50 h.
※G-40 greases are suitable for speed factors (bearing bore in mm _ bearing shaft speed in rpm) up to 200,000.

For lubrication of plastics

G-501

G-501 is compounded with a special silicone fluid as the base oil. This grease is ideal for blower bearings and plastic parts, where it provides both lubrication and noise reducing properties.
With its special formula, G-501 is much less likely to cause stress cracking of polycarbonate (PC), polyacetal (POM), ABS and other plastics.
It is also an excellent lubricant for steel/steel contacts.

Typical properties

Parameter				G-501
Appearance				White to pale yellow grease
Specific gravity		25°C		0.92
JIS K2220 Test method	Penetration	25°C/worked		306
	Oil separation	150°C×24h	%	2.5
	Low-temperature torque (Starting/Running)	-50°C	mN m	211／103
Use temperature range			°C	–50 to +150
Volatile content		150°C×24h	%	0.1
Low-molecular-weight silicone content		ΣD_3-D_{10}	ppm	≤100

(Not specified values)

Lubrication of plastic gears

Solvent resistant greases

Fluorosilicone greases

FG-720 FG-721 FG-722

The greases in the FG-720 series feature a fluorosilicone fluid as the base oil, compounded with fluoropolymer powder. These hybrid greases exhibit certain properties of both silicones and fluorine compounds, and offer outstanding heat resistance, solvent resistance and chemical resistance.
These greases provide excellent lubrication even in high speed, high load conditions.

Typical properties

Parameter				FG-720 *1	FG-721 *1	FG-722 *1
Appearance				White grease		
Specific gravity		25°C		1.40	1.44	1.43
JIS K2220 Test method	Penetration	25°C/worked		303	303	281
	Drop point		°C	231	246	295
	Oil separation	200°C×24h	%	3.9	2.6	0.2
	Oxidative stability	150°C×50h*2	kPa	10	10	10
	Worked stability	100,000 strokes		346	319	322
	Low-temperature torque (Starting/Running)	-30°C	mN m	63/44	214/127	199/185
	Copper strip corrosion	Room temp.×24h		Pass		
Use temperature range			°C	–30 to +200		
Volatile content		200°C×24h	%	0.3	0.5	0.4
Low-molecular-weight silicone content		ΣD_3-D_{10}	ppm	≤100		

*1 For information on safety, see page 22 (Safety & hygiene).
*2 The oxidative stability test conditions prescribed in JIS K 2220 indicate 99°C×100 h, but in this case measurement was done at 150°C×50 h.

(Not specified values)

Solvent resistance of FG-720, FG-721 & FG-722 (normal temp.)

Solvent	Solvent resistance
Methyl alcohol	○
Ethyl alcohol	○
Isopropyl alcohol	○
Ethylene glycol	○
Acetone	×
Methyl ethyl ketone	×
Methyl isobutyl ketone	×
Tetrahydrofran	×
Benzene	○
Toluene	○

Solvent	Solvent resistance
Xylene	○
Styrene	○
n-hexane	○
Kerosene	○
Perchloroethylene	○
Dichloromethane	×
Butane	○
Ethyl ether	×
Dimethyl silicone fluid KF96 (20 mm2/s) *	○
Water	○

*Mfd. by Shin-Etsu

○:Insoluble ×:Soluble

High load applications

G-302 G-503

G-302 and G-503 are compounded with chlorine- and sulfur-based extreme-pressure additives. These greases provide outstanding lubrication under high loads. G-302 offers the highest load resistance of any grade we offer. G-503 provides superior lubrication even under low loads.

Typical properties

Parameter					G-302	G-503
Appearance					White	Yellow
Specific gravity			25°C		1.13	0.97
JIS K2220 Test method	Penetration		25°C/worked		280	294
	Oil separation		150°C×24h	%	1.2	2.2
	Oxidative stability		99°C×100h	kPa	400	10
	Low-temperature torque -30°C	mN m	Starting torque		107	122
			Running torque		28	52
Volatile content			150°C×24h	%	0.3	0.5
Use temperature range				°C	–60 to +180	–50 to +150
Low-molecular-weight silicone content			ΣD_3-D_{10}	ppm	≤100	

(Not specified values)

Non-mineral-oil grease for lubrication of rubbers

G-411

G-411 is a non-mineral-oil grease for rubbers. It has excellent heat resistance and cold resistance and was designed for automotive applications. G-411 provides consistent lubricating properties and will not damage synthetic rubber cups.

Typical properties

Parameter					G-411
Appearance					Brown
Specific gravity			25°C		1.1
JIS K2220 Test method	Penetration		25°C/worked		303
	Drop point			°C	229
	Oil separation		150°C×100h	%	5.1
	Oxidative stability		100°C×100h	kPa	7
	Evaporation loss		100°C×22h	%	0.18
	Impurities	Impurities/cm³	≥10 μm		2930
			Over25 μm		220
			Over75 μm		0
			Over125 μm		0
	Humidity cabinet test		50°C×500h		Class A
Rubber swelling 70±2℃/120±2h	Base diameter	mm	SBR		+0.06
			NR		+0.28
	Change in hardness	Hs	SBR		–2
			NR		–4
	Appearance				No change
Rubber swelling 120±2℃/70±2h	Base diameter	mm	SBR		+0.07
			NR		+0.42
	Change in hardness	Hs	SBR		–3
			NR		–11
	Appearance				No change
Metal corrosion 100±2℃/120±2h	Condition of metal test strip	Change in mass mg/cm³	Tinplate		+0.004
			Copper		+0.007
			Aluminum		+0.010
			Cast iron		+0.058
			Brass		+0.008
			Steel		+0.012
			Zinc		+ 0.015
Use temperature range				°C	–30 to +200
Volatile content			150°C×100h	%	1.4
Low-molecular-weight silicone content			ΣD_3-D_{10}	ppm	≤100

(Not specified values)

Reference data

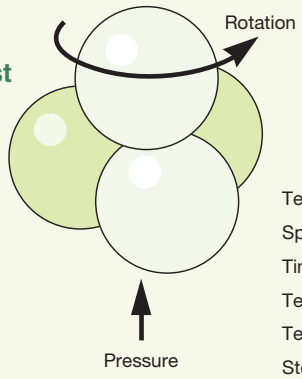
Boundary lubrication properties

●Properties of extreme-pressure greases

	4-ball weld load (kgf)
G-30M	102
G-40M	126
G-501	158
G-503	316
G-302	501
KS-660B	148
FG-721	348
Mineral oil type	183

kgf values: 1500 rpm/1 min.

●4-ball test

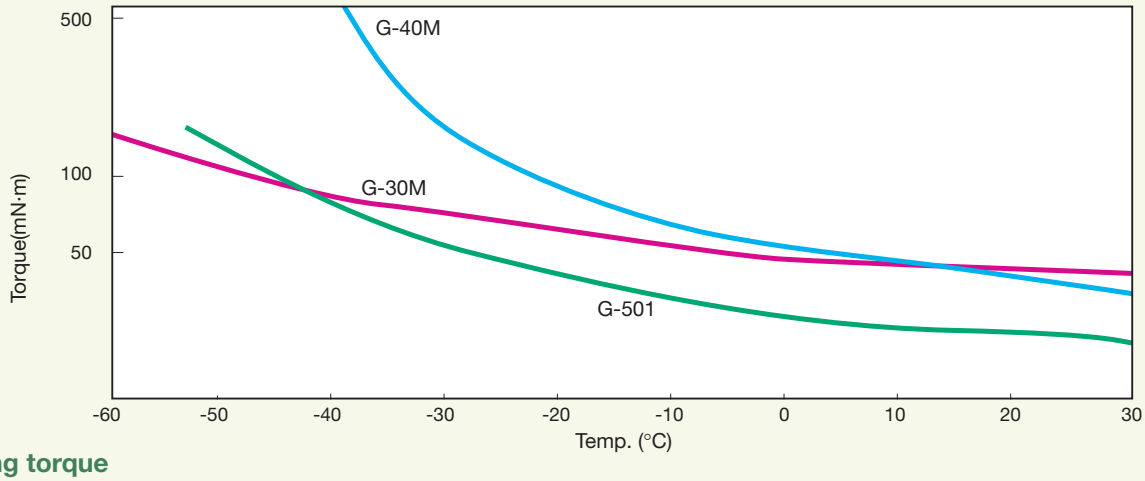


Test conditions
Speed: 1500 rpm
Time: 1 min
Temp.: room temperature
Test balls: 1/2 inch DIA
Steel ball bearings

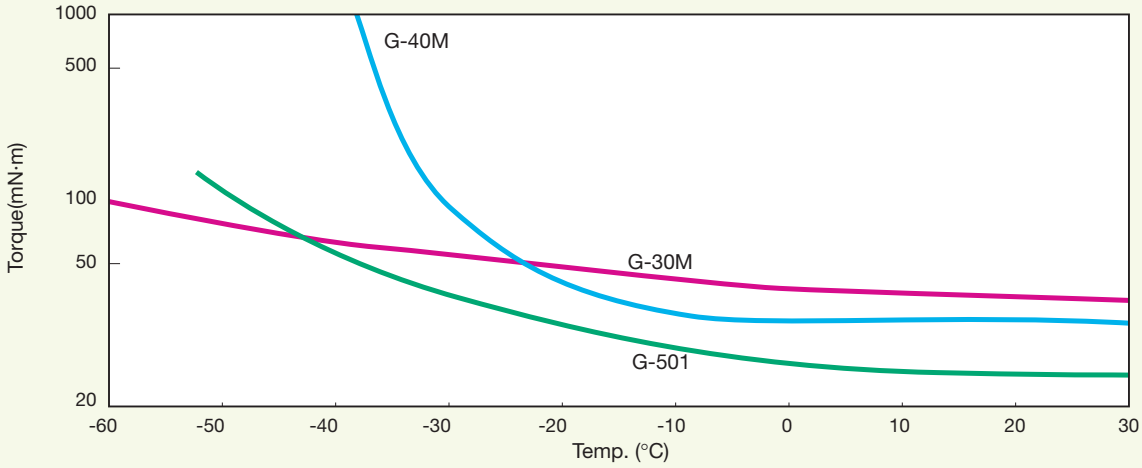
Torque (sliding resistance)

Measured in accordance with JIS K 2220. 6204 bearings, 1 rpm.
Grease is kept at a prescribed temperature for two hours, then starting torque is measured. Rotation is continued, and the torque value after 10 minutes is taken to be the running torque.

●Starting torque

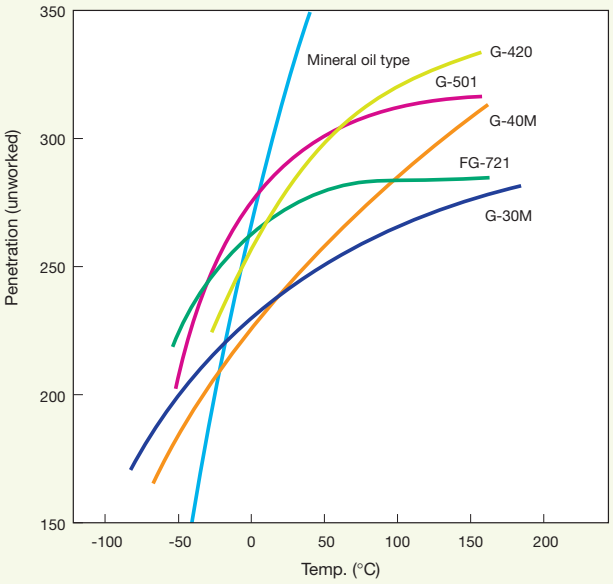


●Running torque

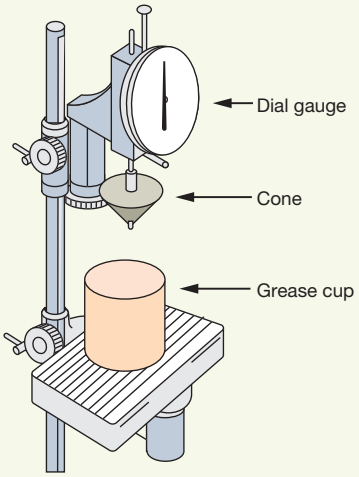


Penetration (hardness)

●Effect of change in temperature on penetration



●Penetration tester

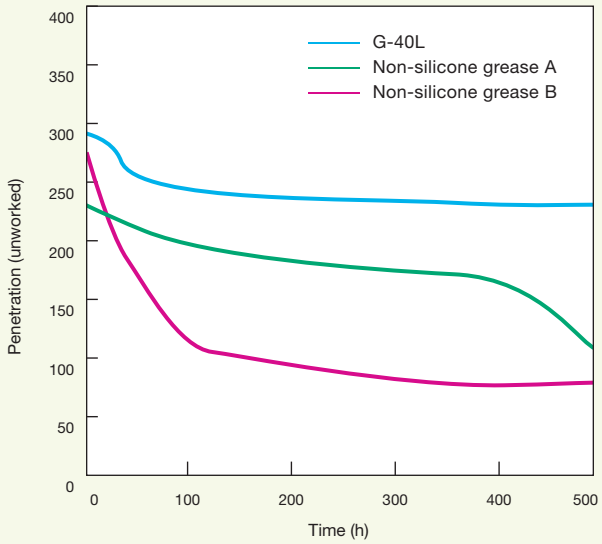


∗Penetration test

A penetration tester of the type prescribed in the penetration test method in JIS K 2220 (grease) was used. For the test, a sample is put into the prescribed grease cup and the surface is leveled, then the sample is kept at 25±0.5 °C. The cone is then lowered and allowed to press vertically into the grease for 5 seconds. The penetration depth is measured to a precision of 0.1 mm, and this value is multiplied by 10 to get the penetration of the sample. Worked penetration is the penetration measured after the grease has been worked for 60 strokes over 1 minute using a mechanical grease worker of the prescribed type.

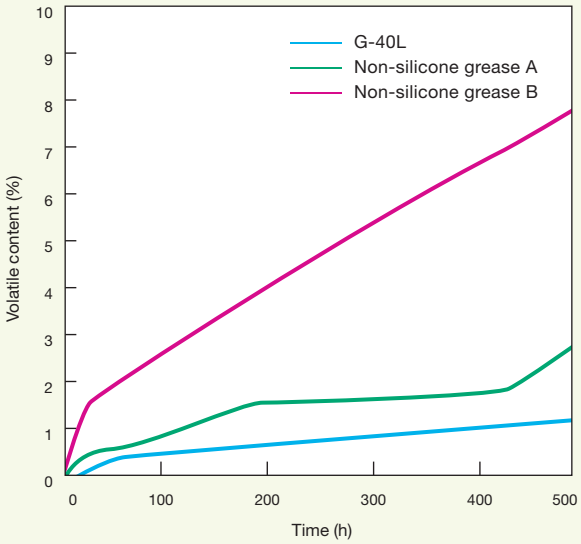
Reliability comparison: Silicone grease vs. Non-silicone grease

●Penetration



Test conditions: 150 °C × 500 h

●Volatile content



Test conditions: 150 °C × 500 h

Compatibility with plastics

○: No effect △: Mild effects ×: Significant effects

Plastic name / Product name	ABS	POM	PBT	PVC	PS	PP	PC	HIPS	PMMA	AS	ASGF	Nylon 6	Nylon 6-6	Nory	Duranex
G-330	○	○	○	○	○	○	○	○		○	○	○	○	○	○
G-332	○	○	○	○	○	○	○	○		○	○	○	○	○	○
G-334	○	○	○	○	○	○	○	○		○	○	○	○	○	○
G-340	○	○	○	○	○	○	○	○		○	○	○	○		○
G-342	○	○	○	○	○	○	○	○		○	○	○	○		○
G-631	○	○	○			○	△								
G-632	×	○	○			○	×								
G-30M	△~○	○	○	○		○									○
G-40M	△~○	○	○	○	○	○	△	×	×	○	○	○	○	×	○
G-501	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
FG-720	○	○	○	○	○	○	△~○	○	○	○	○	○	○	○	○
KS-63W	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
KS-64	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
KS-65A	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
KS-660	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
KS-62M	×	○	○	○	○	○	△	△	×	○	○	○	○	×	○
HIVAC-G	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
KF-96H-200000 mm²/s	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○

●Potential of silicone greases & oil compounds to cause stress cracking of plastics

When a stressed plastic is subjected to prolonged contact with certain chemicals, it may be more likely to crack at a much lower load than it would were it not in contact with the chemical. This phenomenon is commonly called stress cracking, and is characterized by glass-like cracking, usually with no whitening of the plastic.

Stress cracking of plastics can be a function of several factors which include stress, temperature, time and chemicals. Of these, exposure to chemicals is the most important factor. Silicone greases have also been known to cause stress cracking in plastics.

The particulars of the stress cracking will vary depending on the type of silicone grease and plastic involved. And even for molded pieces made using the same type of plastic, the effects of a grease may differ depending on the molding strain, orientation and other conditions.

Thus, before using a silicone grease where it will be in contact with a plastic, it is important to first determine how the grease will affect the plastic.

Shin-Etsu tests its products using the experimental method described below. The user should perform their own tests which simulate the conditions of actual use to make sure that the product will not cause problems when it is used.

【Test method】

1. A plastic test strip (140 mm long, 25 mm wide, 3 mm thick) is clamped in a jig set to a length of 130 mm.
2. Grease is applied evenly to the convex surface of the strip.
3. In this state, the strip is heated at 80°C for 16 hours.
4. After heating, the grease is wiped off and a visual inspection is made for cracking.
5. A visual check is done to look for cracking or surface deterioration.

The results are compared to those for a strip to which grease has not been applied.

Tacky greases (torque, damper applications)

■G-330 G-331 G-332 G-333 G-334
■G-340 G-341 G-342
■G-631 G-632 G-633

The products in the G-330 and G-340 series are highly tacky greases that exhibit little change in torque values due to changing temperatures.
These greases can be applied to sliding and rotating parts in a variety of equipment, where their high tackiness provides a superior damping effect.
G-330 has medium shear resistance (torque), while G-331 has high shear resistance. G-332, G-333 and G-334 are low-torque greases.
The greases in the G-340 series are specially formulated to ensure stable physical properties at low temperatures.
The greases in the G-631 series were developed as bearing greases for variable resistors, and can also be used as damping greases.
Note that the greases in the G-631 series are made using non-silicone base oils, and so the use temperature range will not be as wide as those of the other products.

■ Typical properties

Parameter				G-330	G-331	G-332	G-333	G-334
Appearance				White grease		Blue grease	White grease	Blue grease
Specific gravity		25°C		1.15	1.15	1.12	1.11	1.08
JIS K2220 Test method	Penetration	25°C/unworked		285	305	307	304	250
	Oil separation	105°C×24h	%	0.01	0.01	0.12	0.38	0.36
Torque	After 50 turns		N·m×10^{-4}*	23	34	9	7	5
Use temperature range			°C	−30 to +150				
Volatile content		105°C×24h	%	0.05	0.05	0.06	0.06	0.06
Low-molecular-weight silicone content		ΣD_3-D_{10}	ppm	≤100				

※Torque meter: Torque Tester MDT2-AMP made by Shinmei Electric. (Not specified values)
The sample is applied evenly to the shaft (4 mm DIA_8 mm) and in the bearing clearance (35 μm). The shaft is then turned 50 times (1 turn=360°) by hand at a rate of 1 turn per second. After 50 turns, the sample is loaded into the torque meter and the torque value is measured after rotation at 10 rpm for 1 minute. This value is taken as the test value.

■ Typical properties

Parameter				G-340	G-341	G-342
Appearance				Grayish yellow grease		
Specific gravity		25°C		1.01	1.02	1.04
JIS K2220 Test method	Penetration	25°C/unworked		158	182	168
	Oil separation	105°C×24h	%	0.03	0.06	0.02
Torque	After 50 turns		N·m×10^{-4}*	11	9	16
Use temperature range			°C	−40 to +100		
Volatile content		105°C×24h	%	0.06	0.08	0.07
Low-molecular-weight silicone content		ΣD_3-D_{10}	ppm	≤100		

※Torque meter: Torque Tester MDT2-AMP made by Shinmei Electric. (Not specified values)
The sample is applied evenly to the shaft (4 mm DIA_8 mm) and in the bearing clearance (35 μm). The shaft is then turned 50 times (1 turn=360°) by hand at a rate of 1 turn per second. After 50 turns, the sample is loaded into the torque meter and the torque value is measured after rotation at 10 rpm for 1 minute. This value is taken as the test value.

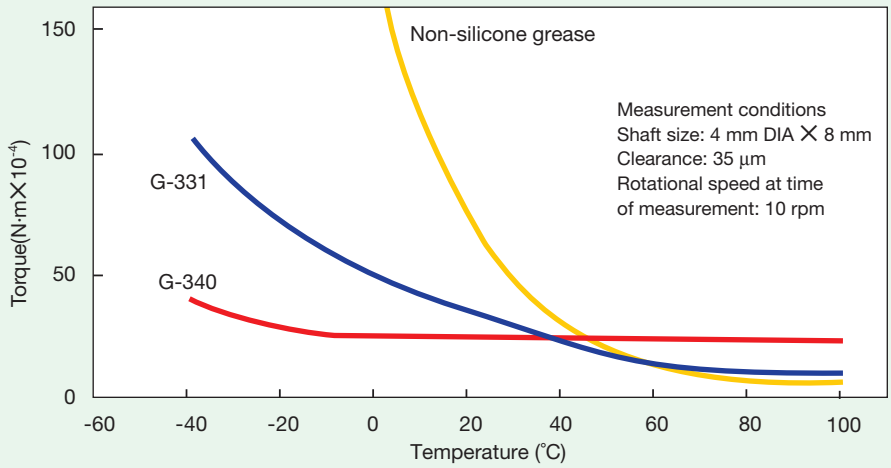
■ Typical properties

Parameter				G-631	G-632	G-633
Appearance				Creamy white translucent grease	Colorless to pale yellow transparent grease	Pale yellow to creamy white translucent grease
Specific gravity		25°C		0.89	0.98	0.87
JIS K2220 Test method	Penetration	25°C/unworked		213	228	235
	Oil separation	105°C×24h	%	0.78	0.02	0.04
Torque	After 50 turns		N·m×10^{-4}*	13	30	64
Use temperature range			°C	0 to +80		
Volatile content		105°C×24h	%	0.07	0.06	0.07
Low-molecular-weight silicone content		ΣD_3-D_{10}	ppm	≤100		

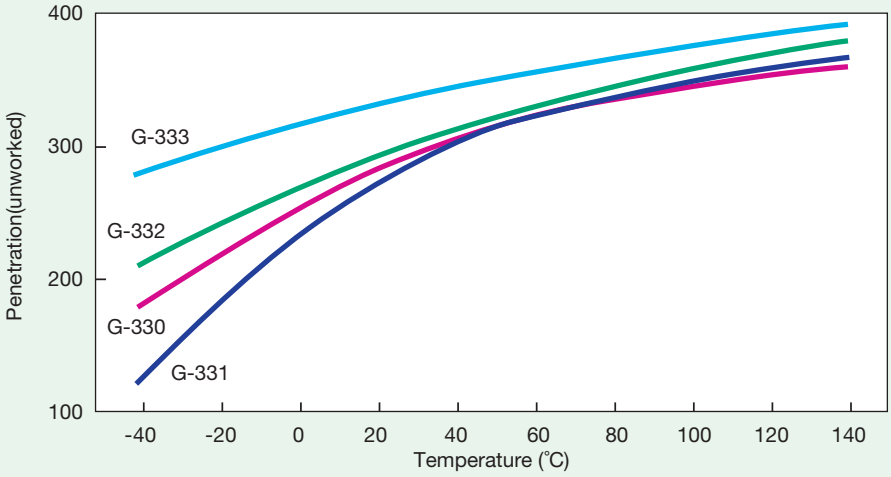
※Torque meter: Torque Tester MDT2-AMP made by Shinmei Electric. (Not specified values)
The sample is applied evenly to the shaft (4 mm DIA_8 mm) and in the bearing clearance (35 μm). The shaft is then turned 50 times (1 turn=360°) by hand at a rate of 1 turn per second. After 50 turns, the sample is loaded into the torque meter and the torque value is measured after rotation at 10 rpm for 1 minute. This value is taken as the test value.

Reference data

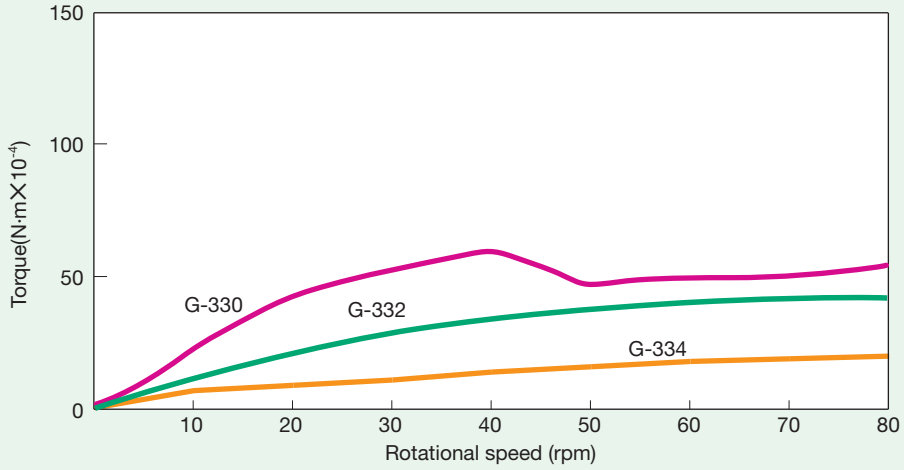
Temperature vs. Torque



Temperature vs. Penetration



Rotational speed vs. Torque



Properties of silicone oil compounds

A silicone oil compound features a base oil of silicone fluid, compounded with silica or metal powders. Silicone oil compounds have superior electrical properties and water repellency and are exceptionally stable against heat and oxidation across a wide temperature range. These products are thus used extensively as a dielectric material, as a thermal interface material, for sealing, and to improve water repellency.

◆ Thermal interface compounds (General purpose)

■KS-609 KS-613 G-747

All three feature silicone fluid as the base oil, plus thermally conductive fillers. These oil compounds offer excellent thermal conductivity and electrical properties.
They are ideal for use as a thermal interface and insulator for semiconductor elements (transistors, thermistors) and various types of heatsinks.
KS-609 is a general purpose product, KS-613 has enhanced heat resistance for potting of thermistors, and G-747 can be used as a thermal interface material for resin-encapsulated power transistors.

■ Typical properties

Parameter			KS-609	KS-613	G-747
Appearance			White grease		
Specific gravity	25°C		2.50	2.36	2.65
Viscosity	25°C	Pa·s	70	60	50
Penetration*2	25°C/worked		328	346	328
Oil separation*2	200°C×24h	%	0.3	2.3	0.01 *1
Thermal conductivity		W/m·K	0.73	0.76	0.90
Volume resistivity		TΩ·m	2.3	0.5	2.5
Dielectric breakdown strength	0.25mm	kV	3.5	9.9	3.7
Use temperature range		°C	–55 to +200	–50 to +250	–50 to +150
Volatile content	200°C×24h	%	0.3	0.3	0.06 *1
Low-molecular-weight silicone content	ΣD_3-D_{10}	ppm	≤100		

*1 Measured at 120 °C×24 h. *2 Tested in accordance with JIS K 2220. ※Hardness controlled as a measure of penetration.

(Not specified values)

◆ Thermal interface compounds (High reliability)

■G-775 G-776 G-777

All three feature a base oil of silicone fluid, compounded with thermally conductive fillers. These oil compounds offer excellent thermal conductivity and electrical properties.
Compared to general purpose products, these oil compounds offer better resistance against pump-out, creep and oil separation, meaning they can be used in spots where long-lasting reliability is required.
G-775 is high viscosity and offers the ultimate in creep resistance.
G-776 has been diluted with an isoparaffin solvent, to achieve properties which are normally at odds, namely low viscosity (ease of use) and low oil bleed.
G-777 is an all-purpose product that offers a balance of good working properties, heat resistance, thermal conductivity, and resistance against pump-out.

■ Typical properties

Parameter			G-775	G-776	G-777
Appearance			White grease		
Specific gravity	25°C		3.4	2.9	3.2
Viscosity	25°C	Pa·s	500	58	140
Penetration*2	25°C/unworked		250	354	190
Thermal conductivity		W/m·K	3.6	1.3 *1	3.3
Dielectric breakdown strength	0.25mm	kV	2.5	2.9	3.2
Use temperature range		°C	–40 to +150	–40 to +200	–40 to +200
Volatile content	150°C×24h	%	0.26	3.10	0.1
Low-molecular-weight silicone content	ΣD_3-D_{10}	ppm	≤300	≤100	

*1 Value after evaporation of solvent. *2 Tested in accordance with JIS K 2220. ※Hardness controlled as a measure of viscosity.

(Not specified values)

Thermal interface compounds (High thermal conductivity)

Thermal interface for CPUs

■G-765 G-750 G-751 X-23-7921-5

These oil compounds have excellent thermal conductivity. All feature a base oil of silicone fluid compounded with high thermal conductivity fillers.
G-765 and G-750 have high dielectric strength, while in G-751 and X-23-7921-5 the emphasis is on thermal conductivity, and their dielectric strength is lower than that of other silicone products. Thus, G-751 and X-23-7921-5 are not recommended for applications that require a material with insulating properties.
G-765 and G-750 can be used as a thermal interface for IGBTs, while G-751 and X-23-7921-5 are ideal for CPUs and MPUs.

■ Typical properties

Parameter			G-765	G-750	G-751	X-23-7921-5
Appearance			Gray grease			
Specific gravity	25°C		2.77	2.77	2.51	2.8
Viscosity	25°C	Pa·s	250	300	420	363
Oil separation*	150°C×24h	%	0.01	0.01	0.01	—
Thermal conductivity		W/m·K	2.9	3.5	4.5	6.0
Volume resistivity		TΩ·m	0.1	0.1	0.008	—
Dielectric breakdown strength	0.25mm	kV	4.5	4.5	Below measurable limit	
Use temperature range		°C	−50 to +120			
Volatile content	150°C×24h	%	0.06	0.28	0.10	0.44
Low-molecular-weight silicone content	ΣD_3-D_{10}	ppm	≤100			

* Tested in accordance with JIS K 2220. ※Hardness controlled as a measure of viscosity.

(Not specified values)

Thermal interface (High thermal conductivity, solvent diluted types)

■X-23-7762 X-23-7783D X-23-7868-2D

These oil compounds have excellent thermal conductivity. All feature a base oil of silicone fluid compounded with high thermal conductivity fillers.
They are compounded with around 2-3% isoparaffin based solvent so they not only have high thermal conductivity, but are also easier to work with. These products are ideal as a thermal interface for CPUs and MPUs.
X-23-7783D is essentially X-23-7762 compounded with a fine filler to give it a lower thermal resistance.
X-23-7868-2D has a lower viscosity than X-23-7783D, making it easier to work with and giving it an even higher thermal conductivity.

■ Typical properties

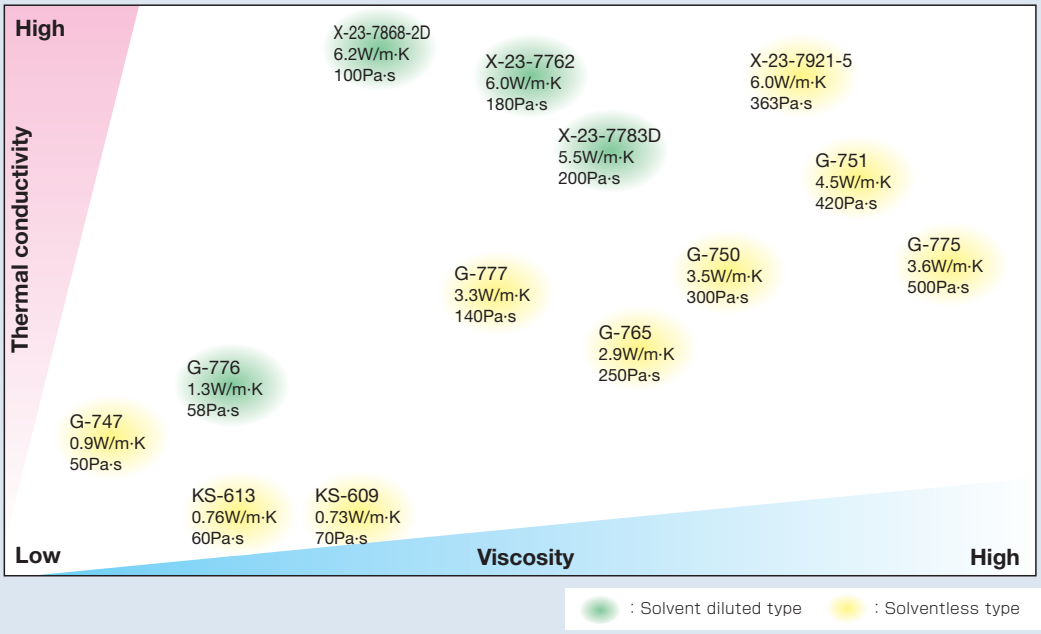
Parameter			X-23-7762	X-23-7783D	X-23-7868-2D
Appearance			Gray grease		
Specific gravity	25°C		2.55	2.55	2.5
Viscosity	25°C	Pa·s	180	200	100
Thermal conductivity		W/m·K	4.0 (6.0*)	3.5 (5.5*)	3.6 (6.2*)
Dielectric breakdown strength	0.25mm	kV	Below measurable limit		
Use temperature range		°C	−50 to +120		
Volatile content	150°C×24h	%	2.58	2.43	2.70
Low-molecular-weight silicone content	ΣD_3-D_{10}	ppm	≤100		

* Value after evaporation of solvent. ※Hardness controlled as a measure of viscosity.

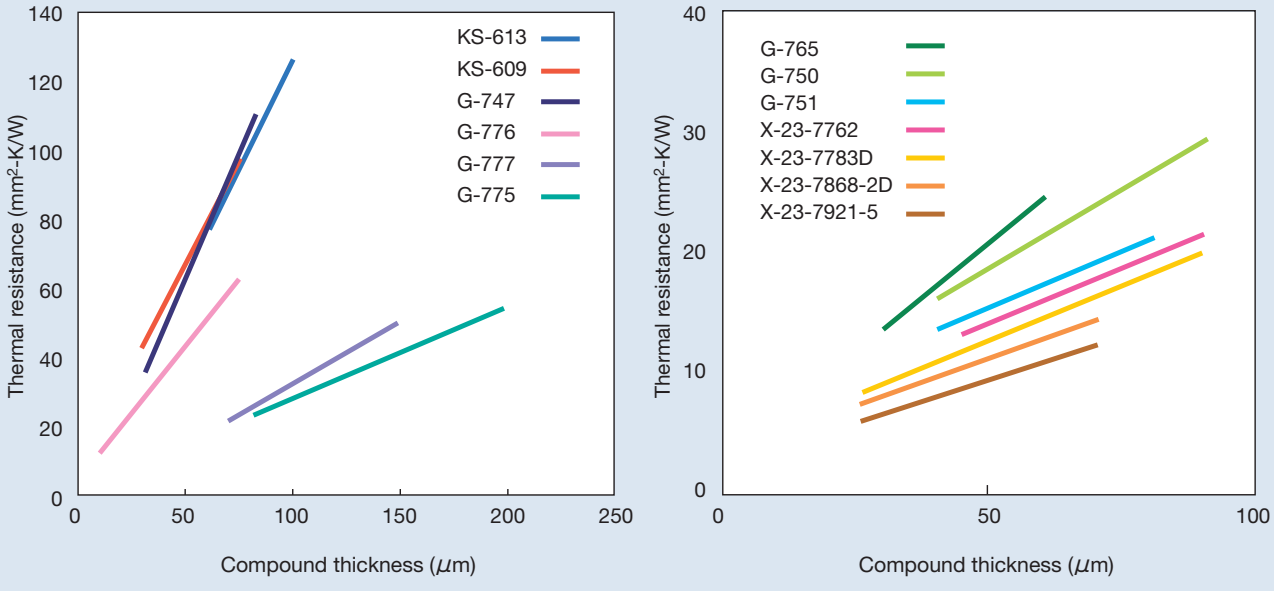
(Not specified values)

Reference data

Correlation between thermal conductivity and viscosity



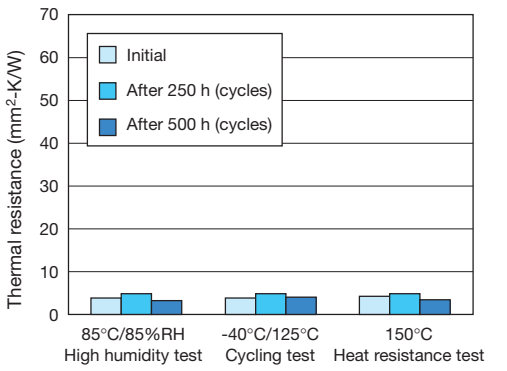
Correlation between thermal resistance and thickness of oil compound



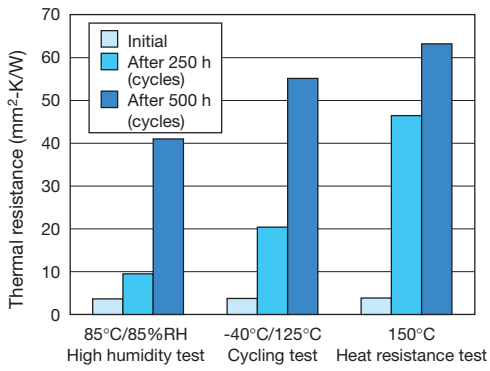
Reliability

●Reliability comparison: Silicone compound vs. Non-silicone compound

■Silicone thermal interface compound, mfd. by Shin-Etsu



■Non-silicone compound (competitor's product)

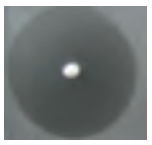
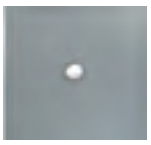


●Creep resistance of G-775

	Silicone compound from a competitor	G-775
After 100 cycles		
After 500 cycles		

[Test method]
1 A 0.1cc sample is sandwiched between a microscope slide (glass) and an aluminum plate, which are separated by a 0.3mm spacer.
2 This test piece is stood vertically, and a heat cycle test is conducted (cycling between -40 °C and +125 °C).

●Resistance to oil-bleed of G-776

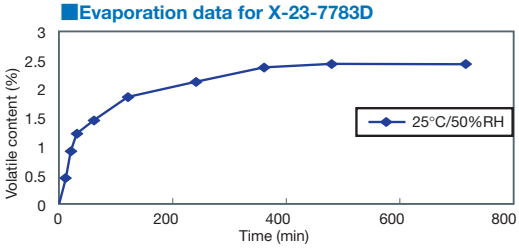
Conditions	23°C×64h		125°C×64h	
Sample	Conventional product	G-776	Conventional product	G-776
Photo				
Bleed distance mm	10.0	1.5	20.6	1.6

[Test method]
1 A 0.1 g sample is placed on a piece of frosted glass.
2 The oil bleed distance (radius of circle) is measured and oil separation is evaluated.
3 Bleed is measured after keeping samples at 23 °C and 125 °C.

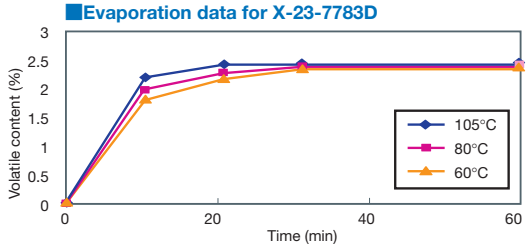
Solvent evaporation time

●Solvent evaporation conditions (guide)

■Evaporation data for X-23-7783D



■Evaporation data for X-23-7783D



※Solvent diluted products: G-776, X-23-7762, X-23-7783D, X-23-7868-2D

[Test method]
· Using a metal screen, X-23-7783D was applied (application size: 25 mm long × 25 mm wide _ 120 μm thick) to aluminum plates.
· The samples were kept at various temperatures, and the change in weight was measured.

Heat resistance: Evaluation & Measurement methods

●Thermal conductivity

●At a given temperature, thermal conductivity is a value intrinsic to a particular substance. According to Fourier's Law, in a steady state, the proportionality constant is the thermal conductivity.

Thermal conductivity λ

$$Q = \lambda \frac{(T_1 - T_2)\,A}{L} \Rightarrow \lambda = \frac{Q}{A} \times \frac{L}{(T_1 - T_2)}$$

From this we get

Q: heat flow rate A: cross-sectional surface area
T_1: temperature at high side T_2: temperature at low side

●Thermal resistance

●Thermal resistance is the sum of contact resistance plus the resistance as heat flows (Q) from T_1 to T_2.

Thermal resistance R

$$R_0 = \frac{T_1 - T_2}{Q} = \frac{L}{\lambda A} \Rightarrow R = R_0 + R_S$$

In reality

R_0: Intrinsic thermal resistance of substance R_S: Thermal contact resistance

●Thermal conductivity measurement method

Two "pouches" were prepared by wrapping grease samples in kitchen wrap. A sensor was sandwiched between the pouches as shown in Figure 1, and a constant current was applied to the sensor so as to generate a specific amount of heat. Thermal conductivity was calculated from the rise in temperature of the sensor.
The sensor is constructed with a double spiral of nickel metal, and can detect temperature changes as the change in electrical resistance of the sensor. Figure 2 shows the signals obtained from the sensor when the constant current is applied.
If we take the graph showing temperature rise (Fig. 2) and scale the X-axis (function of time and thermal diffusivity (α) of the sample) to D(τ), we get the graph in Figure 3.
From Equation (1), we know that the slope of this straight line is inversely proportional to the thermal conductivity (λ) of the sample. The temperature rise (ΔTave) of the sensor may be theoretically expressed by the following equation.

Fig. 1: Setup of samples

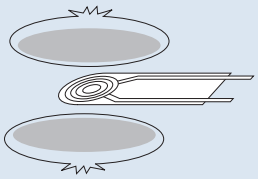


Fig. 2: Applied current and change in sensor signal over time

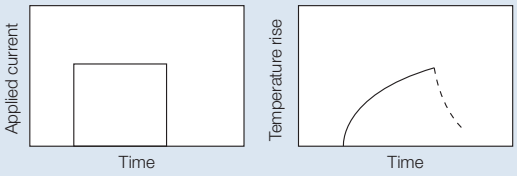
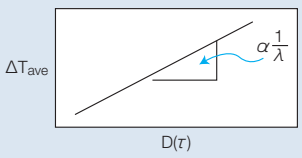


Fig. 3: Temperature rise curve vs. D(τ)



$$\Delta T_{ave}(\tau) = \frac{Po}{\pi^{\frac{3}{2}} r \lambda} \cdot D(\tau) \cdots (1)$$

Po : Total power (W) applied to the sensor
r : Radius (m) of sensor
λ : Thermal conductivity (W/m_K) of sample
τ : Dimensionless parameter, defined by $\sqrt{\alpha \cdot t / r^2}$
α : Thermal diffusivity (m^2/s) of sample
t : Test time (sec)
D(τ) : Dimensionless function of

●Method used to measure thermal resistance (laser flash)

Thermal resistance was measured by the laser flash method, which is one method used to measure thermal constants. In this method, one face of a sample is irradiated with a pulse laser to heat it. The temperature rise at the opposite face is measured using an infrared sensor, which does not touch the sample.

For dielectric & sealing applications (General purpose)

KS-62F KS-62M KS-63W KS-64F KS-64

These oil compounds have superior electrical properties and water repellency, and are chemically inert. They are ideal for use as insulating and sealing materials for electric and electronic equipment.
KS-63W, KS-64 and KS-64F are general purpose products, while KS-62F and KS-62M are heat resistant products.

Typical properties

Parameter			KS-62F	KS-62M	KS-63W	KS-64F	KS-64
Appearance			Off-white paste	White translucent grease	White grease	White paste	White grease
Specific gravity		25°C	1.13	1.18	1.02	1.01	1.05
JIS K2220 Test method	Penetration	25°C/worked	—	229	225	385	246
	Oil separation	200°C×24h %	—	1.3	2.9*1	18*1	5.8
Dielectric breakdown strength		0.1mm kV	3.4	3.5	3.8	3.6	4.0
Volume resistivity		TΩ·m	0.15	56	130	230	620
Permittivity		60Hz	2.96	2.88	2.84	2.80	2.80
Dissipation factor		60Hz	2.5×10^{4}	3.2×10^{4}	2.4×10^{4}	1×10^{4}	2.3×10^{4}
Thermal conductivity		W/m·K	0.17	0.20	0.19	0.17	0.19
Use temperature range		°C	–30 to +250		–50 to +200		
Volatile content		200°C×24h %	≤1.0	0.3	0.1*1	0.1*1	0.1
Low-molecular-weight silicone content		ΣD3-D10 ppm	≤100				

*1 Measured at 150 °C×24 h.

(Not specified values)

For dielectric & sealing applications (High vacuum seals)

HIVAC-G

HIVAC-G features a base oil of specially refined silicone fluid, compounded with silica powder. This oil compound has excellent heat resistance, oxidative stability and chemical stability. Through an intensive refining process, volatile content has been reduced to very low levels, thereby making it possible to attain high vacuums of 10^{-6} Torr. HIVAC-G forms exceptionally tight seals on gaskets and sliding mechanisms, and is widely used as a sealing compound for high vacuum devices.

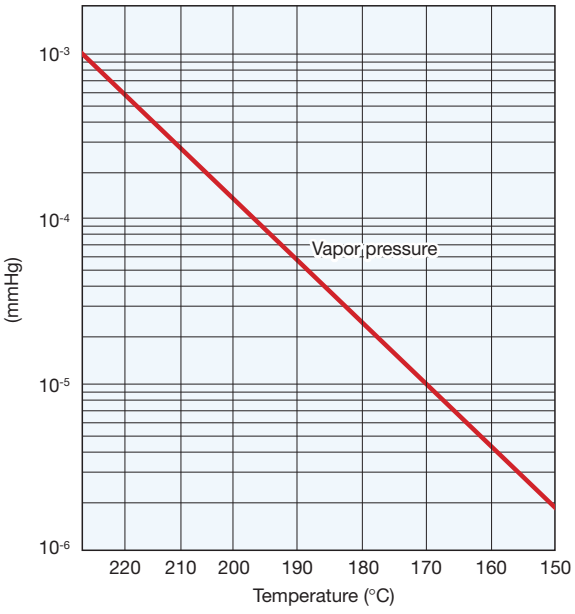
Typical properties

Parameter			HIVAC-G
Appearance			White grease
Specific gravity		25°C	1.03
JIS K2220 Test method	Penetration	25°C/worked	209
	Oil separation	200°C×24h %	0.1
	Copper strip corrosion	Room temp./24h	Pass
Dielectric breakdown strength		0.1mm kV	4
Volume resistivity		TΩ·m	900
Permittivity		60Hz	2.82
Dissipation factor		60Hz	2.2×10^{-4}
Use temperature range		°C	–50 to +200
Volatile content		200°C×24h %	0.1
Low-molecular-weight silicone content		ΣD3-D10 ppm	≤100

(Not specified values)

Sealing of high vacuum devices

Vapor pressure curve of HIVAC-G



For dielectric & sealing applications (Special purpose)

■KS-650N KS-651 KS-65A KS-623 KS-622 KS-63G

These oil compounds have superior electrical properties and water repellency, and are chemically inert. They are ideal for use as insulating and sealing materials for electric and electronic equipment.
KS-650N and KS-651 will not cause swelling of silicone rubber.
KS-65A and KS-623 are ideal for sealing valves, cocks and packing in common chemistry equipment.
KS-622 is specially formulated to prevent corrosion of copper, and is ideal for terminal protection for copper wiring.
KS-63G can be applied to insulators to help prevent flashover which can be caused by salt damage.

Protecting insulators from salt damage
(application example for KS-63G)

Typical properties

Parameter			KS-650N	KS-651	KS-65A	KS-623	KS-622	KS-63G
Appearance			Creamy white translucent grease	Pale yellow to yellow grease	White grease	White grease	Creamy white grease	Green grease
Specific gravity		25°C	0.98	1.02	1.04	1.03	1.03	1.06
JIS K2220 Test method	Penetration	25°C/worked	263	258	221	211	268	209
	Oil separation	%	0.7(105°C×24h)	2.0(150°C×24h)	1.1(200°C×24h)	1.9(200°C×24h)	2.74(150°C×24h)	0.8(150°C×24h)
Silicone rubber swelling (Weight change/volume change)		105°C×500h %	+0.5/+1.1	+0.6/+1.3	—	—	—	—
Dielectric breakdown strength		0.1mm kV	—	—	3.7	1.5<	—	11*1
Volume resistivity		TΩ·m	208	1.3	2,600	1<	—	2,300
Permittivity		60Hz	2.48	2.6	—	—	—	2.82
Dissipation factor		60Hz	3.3×10^{-4}	4.7×10^{-4}	—	—	—	—
Use temperature range		°C	−10 to +100	−50 to +170	−50 to +200		−50 to +160	−50 to +200
Volatile content		%	0.5(105°C×24h)	0.1(150°C×24h)	0.1(200°C×24h)	0.2(200°C×24h)	0.44(150°C×24h)	0.1(150°C×24h)
Low-molecular-weight silicone content		ΣD_3-D_{10} ppm	≤100					

※1: 0.25mm

(Not specified values)

Electrically conductive

■KS-660 KS-660B

These oil compounds feature a base oil of silicone fluid compounded with carbon. They have excellent conductivity, heat resistance, and thermo-oxidative stability. KS-660 is for conductive sealing applications, while KS-660B is ideal for use as a conductive lubricant.

Typical properties

Parameter			KS-660	KS-660B
Appearance			Black grease	
Specific gravity		25°C	1.04	1.00
JIS K2220 Test method	Penetration	25°C/worked	247	301
	Drop point	°C	200+	200+
	Oil separation	%	8.0(200°C×24h)	3.9(150°C×24h)
	Copper strip corrosion	Room temp.×24h	Pass	
Volume resistivity		Ω·m	0.83	11
Thermal conductivity		W/m·K	0.38	0.38
Aluminum strip corrosion		Room temp.×24h	Pass	
Use temperature range		°C	−50 to +200	−50 to +150
Volatile content		%	0.2(200°C×24h)	0.1(150°C×24h)
Low-molecular-weight silicone content		ΣD_3-D_{10} ppm	≤100	

(Not specified values)

For optical applications

Optseal Optseal-L

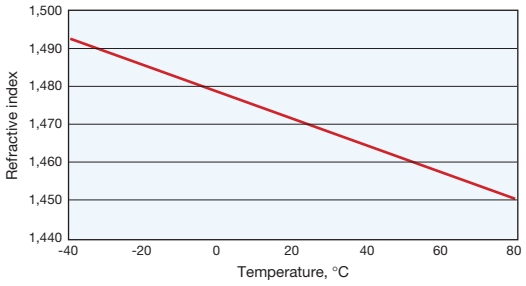
These oil compounds have high transparency, close to that of quartz glass. A 10 mm layer of Optseal allows over 90% of visible light (400-700 nm) to pass through. These compounds are thus ideal for use as a filler to protect the junction points of optical fiber and optoelectronics devices. Optseal is a non-flow compound, while Optseal-L is somewhat soft and slightly flowable.

Typical properties

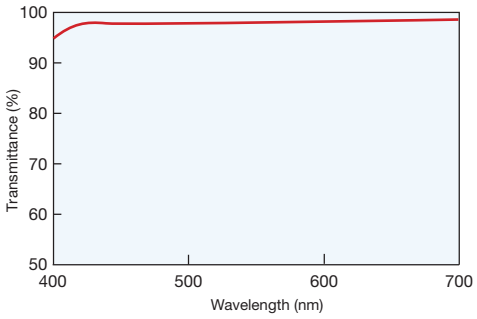
Parameter				Optseal	Optseal-L
Appearance				High transparency grease	High transparency grease
Specific gravity		25°C		1.1	1.1
JIS K2220 Test method	Penetration	25°C/worked		300	400
	Oil separation	200°C×24h	%	≤0.01	—
Refractive index (n^{25}_{D})				1.4690	1.4690
Use temperature range			°C	–40 to +200	–40 to +200
Volatile content		200°C×24h	%	1.1	1.1
Low-molecular-weight silicone content		ΣD_3-D_{10}	ppm	≤100	

(Not specified values)

Optseal: Temperature vs. Refractive index



Visible light transmittance (Grease thickness: 10 mm)



Filling junction points of optical equipment

Reference data

Various silicone fluids and their swelling of synthetic rubbers

Test of swelling tendencies of base oils on synthetic rubbers

(70°C, 120°C×240h)

Rubber type	Test item	KS-64 (base oil)		650N (base oil)		G-40 (base oil)		G-30 (base oil)		FG-720 (base oil)	
		70°C	120°C	70°C	120°C	70°C	120°C	70°C	120°C	70°C	120°C
IIR	Weight change (%)	–1.8	–3.7	–1.5	–2.1	–1.8	–2.8	–2.0	–3.6	–0.2	–0.9
	Volume change (%)	–3.1	–6.3	–2.4	–3.5	–3.0	–4.9	–3.3	–6.2	–0.4	–1.6
CR	Weight change (%)	–11.8	–12.1	–13.1	–14.1	–11.0	–11.6	–12.1	–12.4	–10.3	–11.1
	Volume change (%)	–18.5	–19.7	–20.1	–22.1	–17.4	–18.9	–19.0	–1.4	–16.1	–18.1
NR	Weight change (%)	–3.0	–4.2	–2.3	–5.0	–0.6	–3.0	–3.0	–4.6	–1.4	–2.0
	Volume change (%)	–5.1	–9.4	–3.5	–9.4	–1.4	–7.3	–5.1	–10.1	–2.2	–5.3
NBR	Weight change (%)	–5.4	–9.6	–6.3	–10.8	–6.1	–10.0	–5.8	–9.8	–4.9	–8.6
	Volume change (%)	–6.5	–12.9	–7.7	–13.9	–7.3	–13.0	–7.1	–13.2	–6.1	–11.6
EPDM	Weight change (%)	–17.6	–17.9	–14.7	–15.8	–17.7	–17.9	–18.1	–18.4	–11.3	–14.3
	Volume change (%)	–19.5	–20.5	–15.8	–17.4	–19.5	–20.4	–20.2	–21.1	–12.1	–16.3
Silicone	Weight change (%)	+32.0	+31.2	–0.2	–0.4	+7.2	+7.7	+33.2	+33.4	–0.6	–1.5
	Volume change (%)	+38.9	+38.5	+0.3	+0.2	+8.3	+9.4	+39.2	+39.8	–0.5	–1.2

Note: The data in the table above are the values observed in severe tests in which strips of rubber were immersed in the base oils, and do not represent results obtained with greases. The table should be taken as a guide with respect to compatibility with the materials shown. The same tests conducted with the actual greases tend to yield absolute values which are lower.

Safety data

Toxicity test results for silicone greases & oil compounds

Item / Product name	Skin irritation (human)*1	LD50: Oral (rat) (unit: g/kg)
HIVAC-G	Negative	5<
KS-64	Negative	5<
G-30M	Negative	5<
G-40M	Negative	5<

*1 Tested by the Japanese Society for Cutaneous Health.

As the table at left shows, most silicone greases and oil compounds are highly safe. (See below for information on oral toxicity standards.) However, Shin-Etsu's special grades may differ in terms of safety, so please contact us for inquiries about products other than those shown at left.

Oral toxicity standards

●Acute toxicity test

Generally, an animal subject is exposed to a large quantity of a substance to determine the lethal dose.
This is normally expressed as LD50 (Lethal Dose, 50%). See the table below for information on degrees of toxicity.

●Categories of strength of toxicity

Degree of toxicity	LD50: Oral (rat) (unit: g/kg)
Extremely toxic	<0.001
Strongly toxic	0.001～0.05
Moderately toxic	0.05～0.5
Mildly toxic	0.5～5
Minimally toxic	5～15
Nearly non-toxic	15<

Source: Hodge, H.G. and Sterner, J.H.
: American Industrial Hygiene Association Quarterly, 10:4, 93, 1943

Precautions Related to Handling, Safety and Hygiene

Handling & storage

1. After prolonged storage, oil may have separated, but it does not mean there is a problem with product. Stir the product well before using.
2. Before applying the product to the intended area, clean and dry the area thoroughly.
3. Do not mix these products with other oils or greases.
4. After opening product containers, take care to keep dirt and other contaminants out of containers.
5. If product is left over after use, close containers tightly and be sure to store in a cool, dark place.

Safety & hygiene

1. Wear gloves and other protective gear when using these products.
2. If product gets on the hands or other exposed skin, wipe off with a dry cloth and then wash thoroughly with soap and water. In case of eye contact, immediately flush eyes with plenty of running water, and consult a physician if necessary. Contact lens wearers must be careful to avoid contact between product and their contact lenses. If it comes into contact with the lens, the contact lens may become stuck to the eye.
3. Be sure there is adequate ventilation when handling these products at the time of heating in particular. Avoid handling in a poorly ventilated area causing inhalation of vapors.If you feel ill after breathing the vapors, move immediately to an area with fresh air.
4. Keep out of the reach of children.
5. If product gets on the floor, it will become slippery. After wiping product up with a cloth, spread sand or other absorbent material, then wipe again to remove product completely.
6. Fluorosilicone greases (FG-720 series), G-420 are essentially harmless when used normally. However, if heated to temperatures above 150 °C, trace amounts of toxic gas will be released. When using these products in high temperature conditions, be sure there is adequate ventilation.
7. Be sure to read the Material Safety Data Sheets (MSDS) for these products before use. MSDS are available from the Shin-Etsu Sales Department.

Packaging

		Tube	Polyethylene bottle	Syringe	Plastic container	Metal can	Pail can
Greases	G-30F	100g				1kg	18kg
	G-30L	100g				1kg	18kg
	G-30M	100g				1kg	18kg
	G-30H	100g				1kg	18kg
	G-40L	100g				1kg	20kg
	G-40M	100g				1kg	20kg
	G-40H	100g				1kg	20kg
	G-420					1kg	20kg
	G-501	80g				1kg	16kg
	FG-720		100g			1kg	20kg
	FG-721		100g			1kg	20kg
	FG-722		100g			1kg	20kg
	G-302					1kg	18kg
	G-503					1kg	16kg
	G-411		100g			1kg	20kg
	G-330		100g			1kg	15kg
	G-331		100g			1kg	20kg
	G-332		100g			1kg	20kg
	G-333					1kg	20kg
	G-334					1kg	20kg
	G-340		100g			1kg	18kg
	G-341		100g			1kg	18kg
	G-342					1kg	18kg
	G-631					1kg	18kg
	G-632					1kg	18kg
	G-633					1kg	18kg
Oil compound	KS-609	200g			1kg		20kg
	KS-613					1kg	20kg
	G-747	200g			1kg		20kg
	G-775		100g	90g, 1kg			
	G-776		100g		1kg		
	G-777		200g	90g	1kg		
	G-765	200g		90g	1kg		
	G-750			90g	1kg		
	G-751		100g	150g	1kg		
	X-23-7762		100g		1kg		
	X-23-7783D		100g		1kg		
	X-23-7868-2D		100g		1kg		
	X-23-7921-5			60g	1kg		
	KS-63W					1kg	20kg
	KS-64	100g				1kg	20kg
	KS-64F	100g				1kg	20kg
	KS-62F					1kg	20kg
	KS-62M					1kg	20kg
	HIVAC-G	100g	50g			1kg	20kg
	KS-650N	100g				1kg	16kg
	KS-651		100g			1kg	18kg
	KS-65A					1kg	20kg
	KS-623					1kg	20kg
	KS-622					1kg	15kg
	KS-660					1kg	15kg
	KS-660B					1kg	18kg
	KS-63G					1kg	20kg
	Optseal			50g			
	Optseal-L			50g			

※1 DC(S): Designated Combustible (Synthetic resin)

Shin-Etsu

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The Development and Manufacture of Shin-Etsu Silicones are based on the following registered international quality and environmental management standards.

Gunma Complex	ISO 9001 (JCQA-0004)	ISO 14001 (JCQA-E-0002)
Naoetsu Plant	ISO 9001 (JCQA-0018)	ISO 14001 (JCQA-E-0064)
Takefu Plant	ISO 9001 (JQA-0479)	ISO 14001 (JQA-EM0298)

JAB CM009

http://www.silicone.jp/