ASIATRIB 2002International Conference
JEJU ISLAND, KOREA

Advantages and Applications of Synthetic Greases

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The numbers of synthetic greases have been developed with synthetic oils because of their excellent performance factors including thermal/oxidation stability, low-temperature fluidity and plastic compatibility. Long life under high-temperature condition and excellent low-temperature fluidity are required to serve as grease for bearings of engine room electrical component. As many plastics are used in place of metals for the purpose of weight saving, synthetic hydrocarbon grease is in use to avoid adverse effect on plastics. Other various special synthetic greases are also in use depending on specific requirements like conductivity and vacuum condition.

Keywords: grease, synthetic, ester, PAO, ether, PFPE

1. Ester Greases

The composition and typical properties data of major synthetic greases products we developed were shown in Table 1. Among various esters, polyol ester has excellent thermal stability. Ester oil can provide various molecular structures depending on the combinations of alcohol and fatty acid. In respect of lubricity, alkyl group of long and straight chain structure provides better lubricity than that of short and branched chain structure. Resulting from ester's characteristics, ester grease is usable in a wide range of temperature from low to high. Grease A in Table 1 is ester grease thickened with lithium soap. Grease A can be used in a wide temperature range from −50 to 150°C. It enjoys wide applications including bearings of various electric motors, consumer electronics and car electric equipment. One of the essential properties required from small sealed bearings is low noise. Recent study has determined that ester grease thickened with urea provides longer life than other synthetic urea grease. Grease B is excellent in heat resistance, made it possible to develop grease with extremely long life. Some of ester oils have good biodegradability. This Grease A has obtained Eco labeling certification as biodegradable grease.

2. Synthetic Hydrocarbon (PAO) Greases

PAO fluid, unlike ester oil, does not have a polar group inside its molecule, thus having little tendency to give adverse effect on other organic ingredients. Grease C in Table 1 is lithium soap thickened grease containing additives for plastic lubrication. Grease C is widely used for AV, OA and FA appliances like video players and printers, as well as actuators of car door mirrors and switches. PAO grease is usable in a wide range of temperature from low to high, like ester grease. Grease D thickened with di-urea is put into practical use as small sealed bearing grease, whose applications include electrical motors, consumer electronics and car electrical accessories. With special manufacturing method allows Grease D to overcome the unfavorable bearing noise profile of diurea.

3. Phenyl ether Grease

Polyphenyl ether oil excels in thermal and oxidation stability, while also is known to have weak points such as low viscosity index, high pour point and very high cost. Alkyldiphenyl ether (ADE) is not as excellent as polyphenyl ether in thermal and oxidation stability but provides better properties in other aspects, thus being widely used as base oil for grease. ADE grease is characterized by excellent thermal and oxidation stability. Diurea thickened type is mainly used for applications where long life under high temperature condition is required. In iron and steel mills, this grease is used for sealed bearings operating at high temperature conditions of continuous casting machine, realizing maintenance-free operation for about one year at each mill. Grease E based on ADE is used in increasing number of bearings for alternators and other various electrical accessories.

4. Perfluoroalkylpolyether (PFPE) Grease

Fluorine lubricant is distinguished from other lubricants by high-temperature property. PFPE grease under long use at high temperature will only result in oil decrease, free from chemical changes such as oxidation, polymerization or molecular chain rupture. This means no sludge formation. PFPE grease has been used for heat roller bearings of copying machine, overhead conveyer trolley, single facer bearings of corrugating machine and electromagnetic clutches of ECVT. Grease F in Table 1 is the first grease successfully replaced oil as lubricant for single facer roll bearings of corrugating machine. Inside of these rolls pass steam for pressing, and the roll surface temperature reaches 200 to 250°C.

5. Current Carrying Field Grease

Grease can be used in current carrying field. Conductive grease is so designed as to conduct electricity more smoothly, while contact point grease is designed basically as electrical insulator. Regular grease is insulator and oil film providing effective lubrication is insulated. Conductive grease is designed to give insulating property to the oil film. Grease G is our typical conductive grease and shows resistance of $10^3 \sim 10^4\ \Omega \cdot$ cm. In contact points of relatively large amount of current as seen with car actuators, electric arc is often observed at making and breaking a circuit. Open and close the contact point repeatedly by sliding the test strip to and fro, allowing on/off of the load (electric bulb). Grease H is thickened with special lithium complex soap, and has been used in contact points of car actuators.

6. Space Grease

Most of the lubricants used in space environment are solid lubricant and lubricating oil. Commercial satellites and LEO

[low-earth-orbit] satellites are launched, grease lubrication has come under review for the purpose of cost savings. In space, low vapor pressure property is absolutely essential. That is why fluorine grease made from PFPE and PTFE have been dominant. Cyclopentane fluid is also called MAC by the initials of its chemical structure. Tris(2—octyldodecyl)Cyclopentane of synthetic hydrocarbon. Grease I is our proprietary product made from Cyclopentane fluid. Our user evaluation test confirmed good friction/wear characteristics in comparison with fluorine grease.

7. Conclusion

In this paper authors have discussed advantages and application of grease made from synthetic oils. What is necessary now is to develop greases and put into practical use grease products with more focus on price and performance, as well as biodegradability, recycle and other global environment protection issues. For users of synthetic grease, it is important to know the properties including advantages and disadvantages of the grease.

Table 1 Compositions and typical properties of Synthetic Greases

	Test condition	Test method	Grease A	Grease B	Grease C	Grease D	Grease E	Grease F	Grease G	Grease H	Grease I
Thickener	—	—	Lithium soap	Diurea	Lithium soap	Diurea	Diurea	PTFE	Carbon black	Special lithium complex soap	Lithium soap
Base Oil	—	—	Synthetic Ester	Synthetic Ester	PAO	PAO	Synthetic Ester	PFAE	Synthetic Ester	PAO	Cyclo pentan
Worked penetration	25	ASTM D 217	250	267	300	220	300	280	215	280	227
Dropping point,	—	ASTM D 566	190	260<	205	260<	230	—	245	235	209
Copper strip corrosion	100 , 24h	ASTM D 4048	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Evaporation loss, mass%	99, 22h	ASTM D 972	0.30	—	0.20	0.21	—	—	0.25	0.23	—
Oil separation, mass%	100 , 24h	FTMS 791C-321 Mod.	1.2	—	4.2	0.4	1.0	6.1 (200)	2.6	1.4	1.1
Oxidation stability, kpa	99, 100h	ASTM D 942	25	—	15	10	—	—	29	—	—
Water washout, mass%	38, 1h	ASTM D 1264	1.3	—	3.5	1.2	—	1.1	—	—	—
Low-temperature torque N-cm Starting	-40	ASTM D 1487-63	11	105 (-30)	7.9	40	—	33 (-20)	9.0 (-30)	38 (-30)	16
Running,			2.8	99 (-30)	4.3	7.8	—	17 (-20)	2.9 (-30)	12 (-30)	8.6
Corrosion preventive properties	52, 48h	ASTM D 1743-73	#1	#1	#1	#1	#1	#1	#1	#1	#1