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NEW NON－POE LUBE OIL WITH LOW VISCOSITY FOR REFRIGERATORS

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ABSTRACT

The authors have successfully developed a new ETHER type lube oil with low viscosity(10[cSt]/40[℃]) and excellent R134a miscibility, "RE-5210", for refrigerators.

RE-5210 has very good chemical stability when tested with water contamination (1000 [ppm]/175[℃]/14[days]) and air contamination (100[torr]/175[℃]/14[days]). RE-5210 also has very good PET compatibility.

Lubricity of RE-5210 in the 4 ball and FALEX tests is almost the same as that of POE (VG22). Compressor tests with RE-5210 are in progress.

INTRODUCTION

R12 refrigerant which was used in automotive air conditioners and refrigerators has high ODP. Consequently the use of R12 refrigerant was abolished at the end of 1995.

POE/R134a systems have been developed for refrigerators in the place of mineral oils/ R12 systems. However it is widely known that POE oils have corrosion problems due to their tendency to absorb water and form acids by decomposition. Further more, the viscosity of POE oils adopted in R134a systems must be higher in order to compensate for their poor lubricity and to maintain compressor durability.

Compressor manufacturers have been seeking non-POE oils with lower viscosity to get better compressor reliability and to save energy since POE/R134a systems for refrigerators were developed.

The authors have successfully developed a new ETHER type lube oil with low viscosity (10[cSt]/40[℃]), "RE-5210" , for refrigerators which meets these demands.

RESULTS AND DISCUSSION

1. STABILITY OF RE-5210

1.1 THERMAL STABILITY

Thermal stability of RE-5210 was measured by DSC (Differential ScanningCalorimeter). Theresults are shown in FIGURE 1 and TABLE 1.

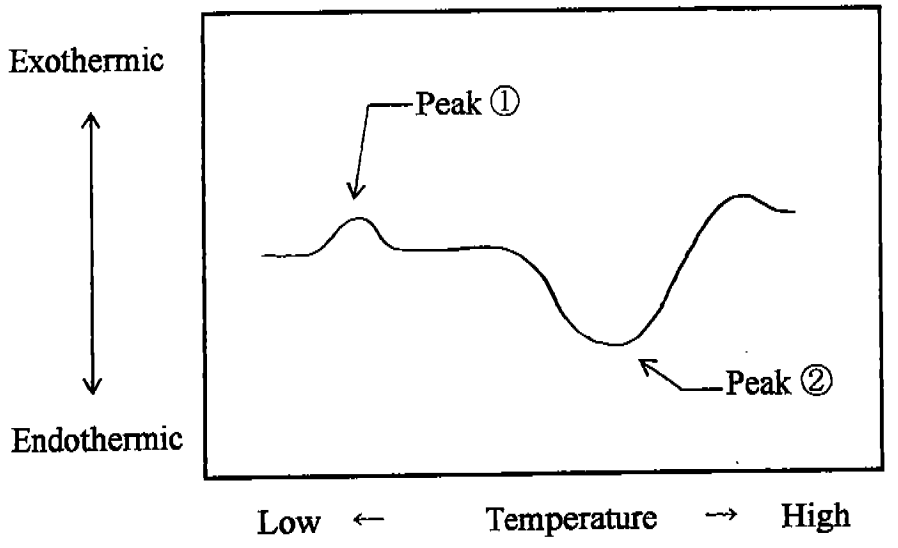


Fig.1 DSC CHART

CONDITIONS/
Cell:Sus
Sampling:Uder air
Temperature:
20 ℃ → 10 ℃ /min
→ 500 ℃

TABLE 1 THERMAL DECOMPOSITION AND OXIDATION TEMPERATURE OF RE-5210

	Oxidation(Peak ①)	Thermal Decop.(Peak ②)
RE-5210(VG10)	247℃	429℃
POE(VG22)	230℃	455℃
SUNISO 4GS	194℃	489℃

Oxidation temperature of RE-5210 is higher than those of POE(VG22) and SUNISO 4GS. The thermal decomposition temperature of RE-5210 is only slightly lower than that of POE(VG22).

1.2 CHEMICAL STABILITY OF RE-5210/SEALED TUBE TEST

Sealed tube tests with RE-5210 were carried out. The results are shown in TABLE 2.

TABLE 2 SEALED TUBE TESTS OF RE-5210(VG10)

TEST CONDITION		RE-5210	POE(VG22)	SUN.-3GS
175 ℃ × 14 days Oil/R134a=1/1(wt) Cat./Cu/Al 『 H2O=1000[ppm] Air=0.05torr 』 **SUNISO3GS: R12 was used.	Appearance of oils Deposit in oils	No Change No	Deep Yellow Partially	Deep Yellow Partially
	Viscosity : before test after test	9．92 9．44	22．10 20．12	30．64 27．12
	TAN[mgKOH/g]	0．02	0．56	0．13
	Fe/Cu/Al Fe Cu Al	No Change No Change No Change	Deep Brown Black No Luster	Deep Brown Black No Luster
175 ℃ × 14 days Oil/R134a=1/1(w) Cat./Cu/Al 『 H2O=50[ppm] ↓ Air=100torr 』 **SUNISO3GS: R12 was used.	Appearance of oils Deposit in oils	No Change No	Brown Partially	Deep Yellow Partially
	Viscosity : before test after test	9．92 9．53	22．10 20．41	30．64 27．48
	TAN[mgKOH/g]	0．02	0．20	0．35
	Fe/Cu/Al Fe Cu Al	No Change No Change No Change	Deep Brown Black No Luster	Deep Brown Black No Luster

RE-5210 demonstrates very good chemical stability when contaminated with water and air in sealed tube tests.

2. PET COMPATIBILITY

In general, low viscosity oils have demonstrated poor PET compatibility. PET compatibility of RE-5210 was examined by sealed tube tests. Results are shown in TABLE 3.

TABLE 3 PET COMPATIBILITY / 140 ℃ × 14days

	RE-5210(VG10)	POE(VG22)
PET Piece(Dumbbell)*		
Appearance	No Change	No Change
Molecular weight	20,800(Mn) 44,550(Mw)	20,450(Mn) 43,550(Mw)
Yield Strength	95[%]	97[%]
Tensil Strength	88[%]	89[%]
Elongation	66[%]	77[%]
Elasticity	100[%]	100[%]
PET Dissolved in Oils		
Molecular weight	ca.600(Trimer)	ca.600(Trimer)
Amount in Oils	182[ppm]	157[ppm]
PET Dissolved/PET	0.18[wt%]	0.16[wt%]

*Original PET film : 25,000(Mn)/54,500(Mw)

PET compatibility of RE-5210 is almost the same as that of POE(VG22).

3. LUBRICITY

Lubricity of RE-5210 was examined by FALEX and 4 ball tests under refrigerant. Results are shown in TABLE 4.

TABLE 4 LUBRICITY OF RE-5210(VG10)

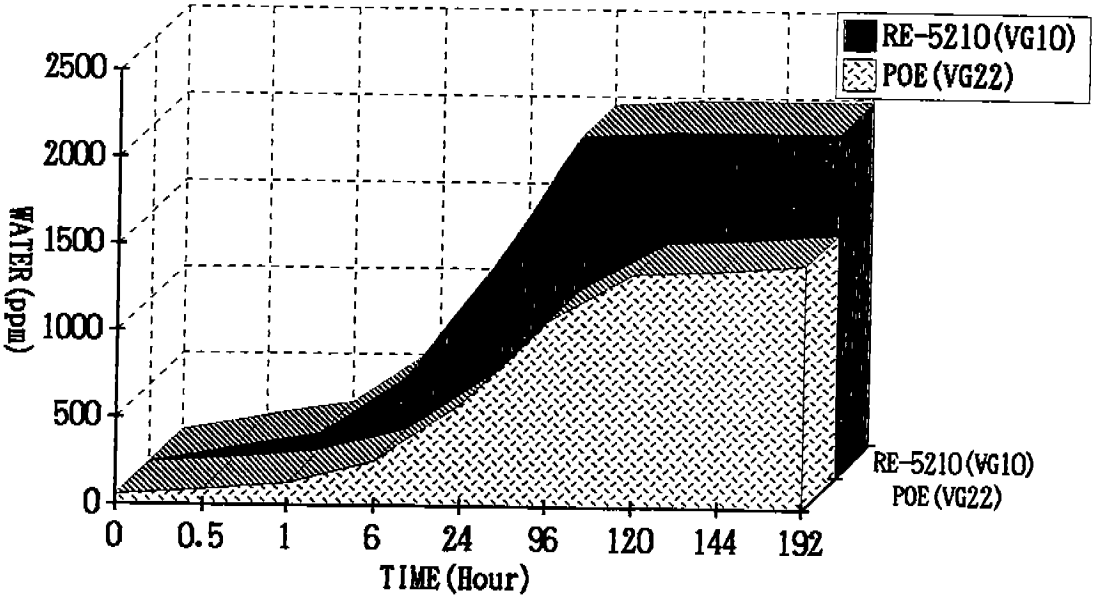
TEST CONDITIONS	RE-5210(VG10)	POE(VG22)
FALEX (No Refrigerant) Temp:room temp. 290 ± 10[rpm]	6 9 0 [lbf]	9 3 0 [lbf]
4 Ball TEST Temp.:60 ~ 75 ℃ 981[N] × 2[hours] × [500rpm] R134a:0.3 ~ 0.6[MPa] (R134a was saturated in a chamber of test machine)	Wear	
	N=1/2 1.5/1.6 [mg]	N=1/2 1.4/1.2[mg]
	Friction Coefficient[μ]	
	N=1/2 0.10/0.10	N=1/2 0.05/0.07

Lubricity of RE-5210(VG10) is almost the same as that of POE(VG22).

4. WATER ABSORPTION CURVE

Water absorption curve is shown below.

FIG. 2 WATER ABSORPTION CURVE



The speed of water absorption of RE-5210 is a little higher than that of POE.

5. TYPICAL PROPERTIES

Typical properties are shown in TABLE 5.

TABLE 5 TYPICAL PROPERTIES OF RE-5210

VISCOSITY	[cSt] (@40 ℃)	9．913
	[cSt](@100 ℃)	2．186
VISCOSITY INDEX		0＞
SPECIFIC GRAVITY [15 ℃ , g/cm ^{3}]		0．9384
FLASH POINT [℃]		162
TAN [mgKOH/g]		0．01
ELECTRIC RESISTIVITY [Ω ·cm]		2．0×10^{13}
MISCIBILITY(R134a)	H-CST[℃]	100↑
	L-CST[℃]	−36

CONCLUSION

(1) A new non-POE(ether) lube oil with low viscosity(10[cSt/]40[℃]) "RE-5210" has been successfully developed for refrigerators.

(2) RE-5210(VG10) has very good chemical stability against water(1000[ppm]) and air(100toor) contamination. After 175[℃] × 14[days] sealed tube tests with those contaminations, RE-5210 didn't produce acids.

(3) RE-5210(VG10) has the same PET compatibility as that of POE(VG22).

(4) Lubricity of RE-5210(VG10) is almost the same as that of POE(VG22).