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Bentone-Polyethylene Thickened Greases

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요 약. 벤톤-폴리에틸렌 및 벤톤-폴리프로필렌을 적당한 온도에서 광유에 분산시키므로써 점토-고분자를 농조제로 사용한 그리이스를 만들었으며, 내마모성, 내수성, 산화안정성, 혼화안정성 및 적점등의 그리이스의 물성을 측정하였다. 그리이스의 성질중 내수성과 같이, 좋지 못한 성질이 간혹 나왔으나 이들 그리이스의 성상을, 이 실험에서 만든 점토-금속비누 그리이스의 성상과 비교 검토할 때 특수목적에 쓸 수 있음을 알았다.

ABSTRACT. Clay-polymer thickened greases were made by dispersing bentone-polyethylene and bentone-atactic polypropylene into mineral oil at an adequate temperature, and the physical properties such as wear and water washout characteristics, oxidation and shear stabilities, and dropping point of the greases were tested. Even if the greases failed to meet some properties, it was found that those greases can be used for some special purposes, by observing and comparing the properties with those of clay-metallic soap thickened greases that were made in this experiment.

INTRODUCTION

Clays such as bentonite and kaoline, treated with organophilic amine compounds, are widely used as grease thickeners for their large swelling property in liquids[1~3]. The greases thus made, are characterized by high dropping point, good retention to metals, and high water-resistance, but they require the *anti*-corrosive property to protect bearing metals.

While some polymers have value as gelling agents for mineral oils, many polymers, when dispersed in such oils, simply form viscous fluids, and might not have given a true grease body. Viscosity relations of oil solutions of commonly used polymers were studied by Wright and Crouse[4]. Morgan and Lowe[5] tried to produce inelastic and plastic products suitable for lubricating greases using polymer such as phenol-formaldehyde resin as a gelling agent. In general, polymers containing ethylene linkage are known to give useful grease products. Polymers of fluorocarbon of ethylene linkage were studied by Lewis[6] to produce lubricating greases. The inertness of these materials toward oxidizing substances and corrosive chemicals makes them of interest for specialized uses.

In general, clay thickened greases are sensitive to the conventional metallic soap greases and care must be taken in practice to avoid such mixtures of clay and metallic soap. Metallic soap thickeners exert a de-gelling effect on clay thickened greases. However, it is not always true, and it gives sometimes the opposite impression. By mixing, therefore, of clay thickeners with polymer thickeners, one might obtain unexpected new grease thickeners that will compensate the disadvantages of clay thickeners.

For this reason, an attempt was made in this experiment to prepare new grease thickeners by blending the bentone as a clay thickener and polyethylene (PE) and atactic polypropylene (APP) as polymer thickeners. Some physical and mechanical properties were also measured to evaluate the new thickeners.

EXPERIMENTAL

Bentone, prepared previously[3], was mixed with PE (Han-Yang Chemicals, LDPE) and APP (commercial) in a definite ratio and the blend was dispersed in mineral oils of SAE 30 and SAE 50 at 150°C to get greases of NLGI 0-2. Bentone-calcium and bentone-lithium greases were also prepared by dispersing bentone, treated with dimethyl distearly ammonium chloride, in a mixture of methanol and toluene, and blended with conventional calcium and lithium greases. No. additives were used throughout the whole preparation processes.

Wear property of greases thus made was tested with Shell four-ball wear tester. Other properties such as water washout property, oxidation stability, shear stability, and dropping point were tested by the *ASTM D*-1264, *D*-942, *D*-217, and *D*-566 methods, respectively.

RESULTS AND DISCUSSION

It is indicated on many technical product bulletins of major oil companies that the wear scar diameter of a mineral oil, in general, lies between 0.50 to 0.60 mm under the testing conditions of 50 kg load, 1,800 rpm speed, and an hour running time. This value becomes somewhat smaller to 0.30~0.40 mm when additves such as EP additives are present in the oil, under the same testing conditions. However, the wear scar diameter becomes much larger to about 1.0 mm in the case of grasees, such as lithium greases as shown in *Table* 1, even when the additives are present. It is, therefore, expected that the wear scar diameter of bentone-polymer thickened greases would be in the range of 1.0 mm or so. As shown in the *Table*, the wear property of bentone-PE thickened greases was found to be fair compared to that of other conventional metallic soap greases. The somewhat inferrior property was considered to be arised from the corse particles of PE mixed in greases. Bentone-APP thickened grease proved this experimental fact by exhibiting better wear property, even if the values of wear scar diameter became somewhat disorderly. (Test conditions were little severe in the case of bentone-polymer greases.)

Since the water-washout property of a grease is linked to the bearing operation, higher water resistant greases are usually desired. As shown in *Table* 2, the water washout property of calcium or lithium base greases is much better than that of bentone treated greases. Bentone, when mixed with polymeric materials or metallic soaps, is considered pertaining to the original layer structure into which water might penetrate, and thus shows hydrophilic rather than hydrophobic property. For this reason, bentone-polymer thickened greases showed larger weight loss in the water washout test than metallic soap base greases. However, the water resistibility has increased as the

Table 1. Wear property of greases.

Thickener	Polymer %	Thickener %	Wear Scar Dia. mm	Note
Bentone-PE	0	15	1.017	
		17.5	1.069	
	10	15	1.052	50 kg,
		17.5	1.224	30~50°C
	20	15	1.029	30 min
		17.5	1.116	
	30	15	1.116	
		17.5	1.374	
Bentone-APP	10	20	1.202	
	20	20	1.116	50 kg
	30	20	0.913	30~50 °C
	40	20	1.061	30 min.
	50	20	0.993	
	100	17.5	1.082	
Ca		15	0.744	
Li		15	0.624	40 kg
Bentone-Ca		3~11	0.676	75±2 °C
Bentone-Li		3~11	0.552	30 min
Li		9.6	0.701	
Cl-paraffin	3.0			
Pb-naphthenate	0.4			40 kg
Li		9.6	0.671	60 min
Cl-paraffin	6.0			
Pb-naphthenate	0.4			

Table 2. Water washout test of greases.

Thickener	Polymer %	Thickener %	Weight loss %
Bentone-PE	0	12.5	3.3
		15.0	5.9
		17.5	2.9
	10	15.0	3.5
		17.5	4.4
	20	15.0	0.2
		17.5	0.1
	30	15.0	None
		17.5	None
Bentone-APP			lost all the weight
Ca		15	1.55
Li		15	2.17
Bentone-Ca		3~11	3.05
Bentone-Li		3~11	9.53

polymer content increased in the case of bentone-PE grease.

The effect of oxidation to the grease lubricancy has studied by Murphy[7]. Mahncke[8] has performed an oxidation test under a dynamic condition. A comparison between dynamic and static tests was also made[9]. However, those results are inconsistent and depend upon test conditions and instruments, and the degree of oxidation can be explained only, in general. Therefore, a simple oxidation test was carried out in this experiment to see only the degree of oxidation stability, and the results are shown in *Fig.* 1. Comparatively, a good oxidation resistance was observed for all the greases made. Better result was observed for bentone-

Table 3. Shear stability test of greases.

Thickener	Polymer %	Thickener %	Consistency			
			Unworked	60	120	10,000*
Bentone-PE	10	15.0	260	263		271
		17.5	242	246		253
	20	15.0	257	259		262
		17.5	231	235		240
	30	15.0	250	252		259
		17.5	228	230		238
Bentone-APP	10	15.0	288	292		301
		17.5	280	282		297
	20	15.0	286	290		305
	30	15.0	283	289		303
Ca		11	194	260	291	369
		13	260	316	332	397
Li		11	322	331	335	345
		13	239	257	261	282
Bentnoe-Ca		3~11	291	316	320	349
Bentone-Li		3~11	295	308	316	328

*Extrapolated value

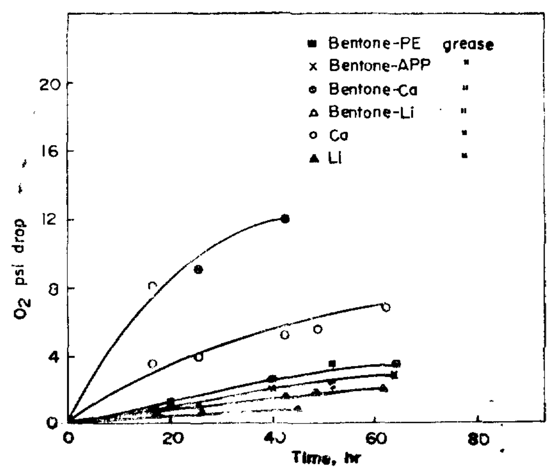

Fig. 1. Oxidation stability of greases.

PE and bentone-APP thickened greases, since the polymeric materials are considered to be more stable materials to oxidation. On the other hand, bentone is considered to give no effect or worse effect for the oxidation test. It is concluded that the effect of thickener composite

Table 4. Dropping point ranges of greases.

Thickener	Polymer %	Thickener %	Dropping Point, °C
Bentone-PE	10	15.0	112.5
	20	15.0	112.0
	30	15.0	112.0
Bentone-APP	10	15.0	Very low
	20	15.0	Very low
Bentone-Ca		1~13	110.3
		3~11	110.1
Bentone-Li		1~13	200.3
		3~11	190.2
Ca		11	100.3
		15	110.5
Li		11	190.3
		15	190.5
Bentone only		15	No dropping

on the oxidation stability is not essential but a random factor.

Shear stability of the bentone-PE thickened grease was found to be good as well as the bentone-soap thickened greases, as shown in *Table* 3. However, the shear stability of the bentone-APP thickened grease was found to be very poor. It is custom to classify the shear stability ranges as excellent, good, and poor, when the rate of change is under 5, 5~15, and 15~30%, respectively. This property is directly related to the mechanical stability of the greases.

Finally, the measured dropping points for all the greases are shown in *Table* 4. Since the bentone grease itself is considered to be a grease of no dropping point, the bentone-mixed greases are considered to be high dropping point greases. It is interesting to note that the dropping point of bentone-PE grease was nearthe melting temperature of PE itself.

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