ENCLOSURE (B) 29

STUDIES ON SOYA BEAN PHOSPHATIDES AS ADDITIVES FOR LUBRICATING OILS

by

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ENCLOSURE (B)29

LIST OF TABLES AND ILLUSTRATIONS

Table I(B)29 Characteristics of Raw Phosphatides ..... Page 324

Table II(B)29 Kinetic Coefficients of Friction by Modified Deeley Machine ..... Page 324

Table III(B)29 Kinetic Coefficients of Friction by Modified Deeley Machine ..... Page 325

Table IV(B)29 Results of British Air Ministry Oxidation Test ..... Page 325

Table V(B)29 Results of British Air Ministry Oxidation Test ..... Page 325

Table VI(B)29 Results of British Air Ministry Oxidation Test ..... Page 326

Table VII(B)29 Results of British Air Ministry Oxidation Tests and Kinetic Coefficients of Friction ..... Page 326

ENCLOSURE (B)29

SUMMARY

The authors studied the soya bean phosphatides as lubricant additives, especially the relation between the oiliness and stability improving ability and the purity and chemical constituents of lecithin and cephalin.

The results were as follows:

1. The soya bean phosphatides were effective as oiliness agents for lubricants and the higher their acid values, the better the oiliness characteristics.

2. The soya bean phosphatides were effective as antioxidants.

3. No remarkable difference was found between lecithin and cephalin (from soya beans) as lubricant additives.

I. INTRODUCTION

It had already been reported in the literature that the phosphatides had some effect on the oxidation of animal and vegetable bodies.* Another reference** showed that the piston ring sticking in aero engines was inhibited by addition of 0.2% of phosphatides to the lubricant. The authors also recognized the effectiveness of phosphatides on the aircraft engine lubricant,***but the raw material had very complex chemical nature and it was thought necessary to study the relation between effectiveness and purity, and therefore, researches were carried on from 1943 to 1944.

II. DETAILED DESCRIPTION

A. Characteristics of Raw Phosphatides and Their Purification

1. Raw Phosphatides. The characteristics of raw phosphatides are given in Table I(B)29.

2. Separation of Lecithin and Cephalin

a. Separation of alcohol and acetone. The phosphatide prepared at Takeda Chemical Co. Ltd. was treated with alcohol and acetone as follows on the next page.

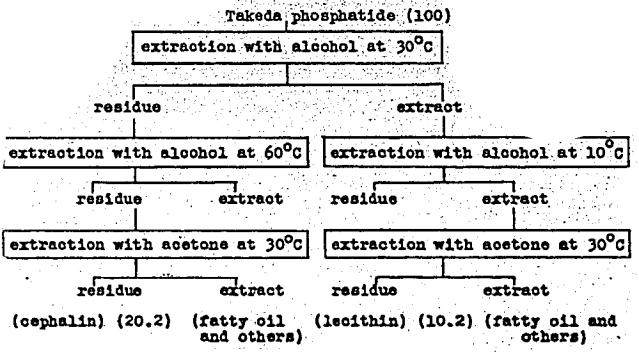
B. Results

1. Soya Bean Phosphatides as the Oiliness Agents. 1% of Takeda phosphatide was added to several oils and the low speed kinetic coefficients of friction were measured using the Dooley machine, (point contact, steel on steel). It was found that these phosphatides were very good oiliness agents. (See Table II(B)29.)

2. The Relation Between the Purity of the Phosphatides and Their Ability as Oiliness Agents. Studying the relation between the purity of the phosphatides and their ability as oiliness agents, it was found that the purer phosphatides were the poorer oiliness agents. The results are given in Table III(B)29.

*Czapeck F. Hoobeal der Pflanzen I. 773.
**U. S. Patent 2,166,286: 2,211,163: 2,212,020.
***Ser. No. 085. Enc. B-2)

ENCLOSURE (B)29

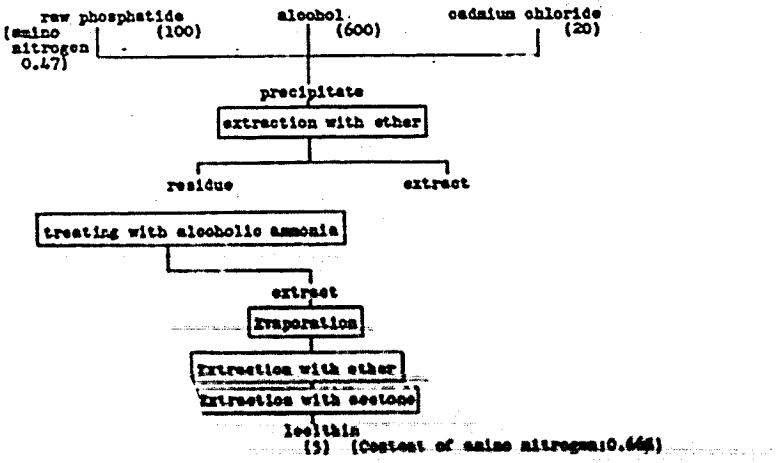


The percent content or amino nitrogen was as follows:

Raw Phosphatide	:	1.71
Lecithin	:	1.01
Cephalin	:	1.92

The separation was unsatisfactory.

b. Purification by cadmium chloride. Comparatively pure lecithin was obtained from the phosphatide prepared at Manchurian Soya Bean Co. Ltd. by cadmium chloride as follows:



From the foregoing results the oiliness of the phosphatides were concluded to depend upon the free acid contained in them.

3. Suitability of the Soya Bean Phosphatides as Antioxidants for Lubricants. The stability of lubricants was improved by means of addition of phosphatides, when using the British Air Minstry Oxidation Test. Results are given in Table IV(B)29.

4. The Relation Between the Purity of the Phosphatides and Their Value as Antioxidants. It was found that the purer the phosphatides, the greater the stability improving ability. The results are given in the Table V(B)29.

5. Effects of Combination of Phosphatides with Tricresyl Phosphate. Phosphorous compounds such as triphenyl phosphite, triphenyl phosphate, tricresyl phosphate, etc. are effective as antioxidants of lubricants. Generally speaking, the phosphites are better antioxidants than phosphates, but the former are unstable to water, so we thought that the combination of phosphates and phosphatides might be a good antioxidant. This attempt was successful in the case of mineral oil base, but it failed when the base oil was made synthetically from paraffine wax.

6. Difference of the Effects Between Lecithin and Cephalin. Two samples of phosphatides were prepared by the authors, one lecithin rich, another cephalin rich, and the difference of the effects between the two was investigated but no remarkable difference was found as shown in the Table VII(B)29. Cephalin was only slightly soluble in the oils, and we used its saturated solution. -- mixing at a temperature of 60°C-70°C. However separation did not occur at low temperature.

IV. CONCLUSION

A. The soya bean phosphatides were effective as oiliness agents and which may be attributed mainly to the free acids (organic) present.

B. The soya bean phosphatides were good antioxidants for lubricants, and the in-purification produced improved results.

C. There was no marked difference between the effectiveness of lecithin and cephalin as oiliness agents and antioxidants for lubricants.

ENCLOSURE (B)29

Table I(B)29
CHARACTERISTICS OF RAW PHOSPHATIDES

Names of samples	Acid Value	Water(%)	N(%)	P(%)	N:P
The phosphatide prepared at Manchurian Soya Bean Co.Ltd. (Purity, 40%)	77.3	14.55	0.52	1.28	0.91
Manchurian (Purity, 50%)	55.0	11.55	0.94	1.56	1.34
Manchurian (Purity, 60%)	23.3	6.66	1.00	1.76	1.25
The phosphatide prepared at Honen-seiyu Co. Ltd. (Sample C.)	81.4	15.20	0.82	2.23	0.82
Honen-seiyu (Sample E.)	127.8	8.76	1.04	2.48	0.93
Honen-seiyu(Sample EA.)	54.9	7.24	1.30	2.82	1.00
The phosphatide prepared at Takeda Chemical Co. Ltd.	53.9	8.06	1.04	2.81	0.83
The phosphatide prepared at Tokyo Institute of Industrial Research	22.5				

Table II(B)29
KINETIC COEFFICIENTS OF FRICTION BY MODIFIED DEELEY MACHINE

Names of base oils	Kinetic coef. of friciton of base oil.			Kinetic coef. of friction of phosphatide compounded oils.		
	50°C	150°C	250°C	50°C	150°C	250°C
Aero engine oil 780	0.012	0.085	0.095	0.006	0.063	0.068
Aero engine oil 7120	0.010	0.057	0.105	0.006	0.048	0.061
Turbine oil	0.010	0.098	0.116	0.008	0.090	0.086
Compressor oil	0.013	0.080	0.095	0.006	0.055	0.080

ENCLOSURE (B)29

Table III(B)29
KINETIC COEFFICIENTS OF FRICTION BY MODIFIED DEELEY MACHINE

Names of oils	Acid Values of Phosphatides	Base oil: Aeroengine oil #120			Base oil: Turbine oil		
		50°C	150°C	250°C	50°C	150°C	250°C
Base oil only		0.010	0.057	0.130	0.010	0.098	0.116
Base oil + 1% of phosphatide of purity 40%	77.3	0.008	0.051	0.068	0.008	0.071	0.072
" 55%	55.0	0.009	0.045	0.047	0.010	0.088	0.083
" 60%	23.0	0.009	0.049	0.051	0.013	0.083	0.080

Table IV(B)29
RESULTS OF BRITISH AIR MINISTRY OXIDATION TEST

Names of Base oils	Base oils only		Base oils 1% of Takeda phosphatide	
	Viscosity ratio	Carbon residue after test (%)	Viscosity ratio	Carbon residue after test (%)
Turbine oil	3.86	2.45	2.77	2.33
Aeroengine oil #80	1.50	1.72	1.29	1.27
Aeroengine oil #120	1.54	2.23	1.32	2.30
Compressor oil	2.68	2.82	2.41	2.27
Synthetic aeroengine oil #120	2.90	1.64	2.07	1.46

Table V(B)29
RESULTS OF BRITISH AIR MINISTRY OXIDATION TEST

Names of oils	Acid Values of Phosphatides	British Air Ministry Oxidation test	
		Viscosity ratio	Carbon residue in %
Aeroengine oil #120		1.54	2.23
1% of Phosphatide Purity 40%	77.3	1.35	1.65
" 55%	55.0	1.28	1.64
" 60%	23.0	1.25	1.68

ENCLOSURE (B)29

Table VI(B)29
RESULTS OF BRITISH AIR MINISTRY OXIDATION TESTS

Name of oils	Viscosity ratio	Carbon residue after test (%)
Aeroengine oil #120	1.35	2.00
Aeroengine 1% of tricresyl phosphate	1.30	1.81
Aeroengine 0.5% of tricresyl phosphate 0.5% Takeda phosphatide	1.23	1.67
Synthetic aeroengine oil #120 from paraffine wax	2.90	1.46
1% of tricresyl phosphate	2.33	1.61
0.5% of tricresyl phosphate 0.5% of Takeda phosphatide	2.19	1.64

Table VII(B)29
RESULTS OF BRITISH AIR MINISTRY OXIDATION TESTS AND KINETIC COEFFICIENTS OF FRICTION

Names of oils	British Air Ministry Oxid. test.		Kinetic coef. of friction at room temp.
	Vis. ratio	Carbon residue (%)	
Aeroengine oil #80	1.47	1.53	0.087
1% of lecithin	1.23	1.14	0.079
0.53% of cephalin	1.34	1.14	0.086
Aeroengine oil #120	1.35	2.0	0.083
1% of lecithin	1.25	1.49	0.075
0.58% of cephalin	1.25	1.52	0.075
Synthetic aeroengine oil #120	2.92	1.64	0.082
1% of lecithin	2.16	1.53	0.071
0.22% of cephalin			0.073