E. I. DU PONT DE NEMOURS & COMPANY
FABRICS AND FINISHES DEPARTMENT
CHEMICAL DIVISION

PARLIN LABORATORY

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PROJECT J-1019

SUBJECT: IMPROVED "DUCO" FURNITURE FINISHES

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INTRODUCTION

As was true with every other manufacturer of finishing materials, at the end of World War II, considerable effort was required to bring pre-war products up-to-date and to remedy quality deficiencies as they appeared. When work was initiated on this project, none of the nine different types of furniture "Duco" in our line embraced a balance of properties which equaled the best competitive topcoats appearing on the postwar market. This was particularly true for certain portions of the radio cabinet business for which no one of our formulas combined the desired resistance to cold checking, with easy processing, good clarity and a high degree of print resistance. Project J-1019, Parts I, II, and III, provided funds for work aimed at remedying this situation.

OBJECTIVE

To formulate "Duco" topcoats affording a superior compromise between durability, appearance, ease of processing, and cost.

SUMMARY AND CONCLUSIONS

In order to improve our competitive position, it appeared desirable (1) to establish a new line which would have a superior balance of properties, and (2) to reduce the number of types of furniture "Duco" offered for sale in order to simplify and keep down costs.

To attain these goals, it was necessary to develop new background information relative to what factors and ingredients govern appearance, clarity, processing, and durability. This entailed a considerable study of raw materials including a number of tailor-made resins. Based on the new formulating practice evolved, it was possible to offer compositions equal or superior to competition and to propose operating on a basis of only three lines. These were: (1) a low cost utility line, Type G; (2) a case goods line of good quality; e.g., Type F; and (3) a high quality line, Type "H" for pianos, television sets, etc. These three lines are based upon nitrocellulose, a cocoanut oil alkyd resin (RL-233), a rosin-maleic hard gum, and plasticizer, flatted where necessary with a stable flatting agent; i.e., Santocel "C". The balance between the various properties can be altered by adjusting the ratios of these various ingredients to meet the needs of specific situations. Due to the downward trend in prices of raw materials (1949),

there was so little difference between the costs of Types "F" and "G" as to eliminate the latter from consideration. This permitted offering only two lines - a good quality case goods line, Type "F", and a high quality piano line, Type "H". This is an extremely simple basis upon which to operate.

The adoption of an aerogel-like Santocel "C" in place of aluminum stearate as a flatting agent is a step of especial importance toward improving quality and reducing complaint hazards. Aluminum stearate has been shown to liberate stearic acid as the lacquer ages with resulting adverse effects upon intercoat adhesion under certain application conditions and possible serious bloom. Santocel "C" formulas are exceedingly stable and free from bloom.

It is believed that the original objectives of this study have been attained. With the background of new formulating information now available, it should be possible to handle future problems on a Sales Service basis.

ACTION TAKEN

The following release letters were issued:

1. Parlin Laboratory Release Letter No. 350, July 22, 1948, proposing Type F "Duco".

2. Parlin Laboratory Release Letter No. 365, September 1948, proposing Type G "Duco". On October 5, 1949, due to a reversal in the price trend of raw materials, Parlin Laboratory Supplementary Release Letter No. 365-A was issued proposing the withdrawal of Type G "Duco".

3. Parlin Laboratory Release Letter No. 394, April 8, 1949 and No. 394-A, October 7, 1949, proposing Type H "Duco".

PATENTS

It is not believed that Type "F" or any of the compositions developed during its formulation are patentable.

EXPERIMENTAL

The experimental work carried out under this project may be divided into two main classifications: viz, a study of the ingredients and factors influencing the physical properties of furniture lacquers and secondly, a study of the factors influencing lacquer topcoat adhesion.

A. Furniture Lacquer Formulation

Since Type "E" furniture lacquer at the start of this work appeared to combine all the desirable properties of a furniture lacquer except ease of processing and rubbed clarity, the

following basic formula of Type "E" was studied with the view to retaining its desirable characteristics and improving the properties in which it was deficient.

Type	Per Cent	Ratio
Nitrocellulose	42.4%	10.0
40% Soya Bean Oil Alkyd	6.1	1.4
45% Hydrogenated Castor Oil Alkyd	30.9	7.3
Blown Castor Oil	14.9	3.5
Raw Castor Oil	5.7	1.4
	100.0%	

The first experiments were made replacing varying amounts of the alkyd resin in Type "E" with a hard gum and noting the effect on the physical properties. The following gums were tried:

(1) Lewisol 33
(2) Krumbhaar 404
(3) Krumbhaar 444
(4) Amberol 801
(5) Amberol M-93*
(6) Amberol BS/1*
(7) Pentalyn G*
(8) Pentalyn M*
(9) Cellolyn 102
(10) Cellolyn 103
(11) Ester Gum
(12) Polypale Ester No. 1
(13) Teglac Z-152
(14) Beckacite 1111
(15) Beckacite 1119
(16) Arochem 520
(17) Arochem 523
(18) Arochem 545
(19) Damar
(20) Amberlac 898D
(21) Neville R-13*
(22) Nevidene R-1*
(23) Vinylite "C"
(24) Bakelite XR-3180*
(25) Beckacite 1118

All of the resins except those marked with an asterisk, which were incompatible, improved the processing properties and final rubbed film clarity at some sacrifice in cold crack and print resistance. The higher melting point maleic modified resins, such as Lewisol 33, Beckacite 1111, Teglac Z-152 and Krumbhaar 404 yielded the maximum improvement in clarity and ease of processing combined with a minimum loss in cold crack resistance and printing.

Replacement of the alkyd resin by 10-40% of hard resin seemed to be in the optimum range.

Of these four resins, Lewisol 33 and Beckacite 1111 were the best and, therefore, were selected for detailed studies. Other resins were evaluated in other formulations containing the preferred alkyd and plasticizer, later in this study, as will be noted further on in the body of this report.

The next ingredient scrutinized was the plasticizer. The following plasticizers were substituted for the castor oil combination in Type "E" on an equivalent plasticizing basis and also on a pound for pound basis.

(1) Raw Castor Oil
(2) Blown Castor Oil
(3) Tricresyl Phosphate
(4) Dibutyl Phthalate
(5) Dioctyl Phthalate
(6) Dibutyl Sebacate
(7) Santicizer #8
(8) Baker's P-8 Oil
(9) Paraplex G-25
(10) Arochlor 1254

Paraplex G-25 and Arochlor 1254 yielded hazy films. Of the remaining plasticizers evaluated, blown castor oil, tricresyl phosphate and dioctyl phthalate gave the best properties. Of these, blown castor oil was selected for further study.

The next ingredient studied was the alkyd resin. In this work, standard Company alkyds, "tailor-made" alkyds and competitive resins were evaluated in the Type "E" basic formula on a pound for pound basis for the total alkyd.

The standard Company alkyds evaluated were:

(1)	RL-255	55% Castor
(2)	RL-263	27% Castor
(3)	RC-212	40% Soya Bean
(4)	RL-134	40% Cottonseed
(5)	RL-272	45% Hydrogenated Castor
(6)	RL-233	50% Cocoanut
(7)	PRCP 81910	30% Linseed
(8)	PRCP 73786	35% Linseed
(9)	PRCP 73763	33.3% Linseed
(10)	PRCP 73744	40% Linseed
(11)	PRCP 68208	39.5% Glycerol Triphthalate 57.2% Ethylene Glycol Phthalate 3.3% Ethylene Glycol

None of the linseed oil alkyds offered any promise, being hard to process and exhibiting poor clarity. The shorter oil linseed alkyds also showed poor cold crack resistance.

Of the non-drying oil and semi-drying oil modified alkyds, two showed superiority over the others for ease of processing and rubbed clarity at no sacrifice in durability or cold crack resistance. They were the 50% cocoanut oil alkyd (RL-233) and the 40%

soya bean oil alkyd (RC-212). However, the latter showed blooming from the film on aging.

Based on these results, a study of "tailor-made" alkyds was undertaken in which (1) cocoanut oil and soya bean oil modified alkyds of varying oil length were prepared by the Organic Section of this laboratory with part or all of the glycerol replaced by pentaerythritol and/or glycol and also with part of the phthalic anhydride replaced by adipic acid and (2) balanced formula alkyds were prepared from pure acids ranging in chain length from C_6 (caproic) to C_{18} (stearic).

The results of the evaluation of the above alkyds are given in the table at the end of this report. In general, the following conclusions were drawn:

(1) For our purpose, the optimum oil length for a glycerol phthalate cocoanut oil modified alkyd is between 40 and 50 percent.

(2) The use of pentaerythritol in place of the glycerol in the cocoanut oil alkyd gave an equal if not slightly superior combination of properties.

(3) The use of glycol as a partial replacement for the pentaerythritol in a cocoanut oil alkyd also gave a lacquer with properties about equal to a straight glycerol cocoanut oil modified alkyd.

(4) The use of adipic acid as a partial replacement for the phthalic anhydride in either a glycerol or pentaerythritol cocoanut oil alkyd impairs processing and clarity.

(5) Balanced alkyds made from glycerol, phthalic anhydride and fatty acids varying in chain length from C_6 (caproic) to C_{18} (stearic) were used as the resin component in lacquers. The evaluation of these indicated that oils containing high percentages of myristic (C_{14}) and particularly palmitic (C_{16}) and stearic (C_{18}), bloom on aging; while below caprylic (C_8) in length; i.e., caproic, incompatibility is encountered. From these data also, it would appear that oils high in capric (C_{10}) and particularly lauric (C_{12}) are the most desirable, since the ease of processing improves with increasing chain length, with myristic being the top point, as blooming begins here.

It is interesting to note that cocoanut oil has an average composition of:

48.0%	Lauric
8.0	Caprylic
7.0	Capric
17.5	Myristic
9.0	Palmitic
2.0	Stearic
6.0	Oleic
2.5	Linoleic
100.0%	

It contains, therefore, 63% of the fatty acids found to be desirable in alkyds used in furniture lacquer, 28.5% of acids which by themselves may bloom but also which promote improved working properties and 8.5% acids of unknown effect. This perhaps explains the superior results obtained with a cocoanut oil modified alkyd.

The following competitive alkyds and plasticizing resins were examined as replacements for cocoanut oil alkyd alone and in conjunction with several hard resins.

(1) Glyptal #2477, a 45% castor oil modified alkyd.

(2) Beckasol #1323, a medium short cocoanut oil modified alkyd.

(3) BJ-15408, a phenolic modified plasticizing resin.

(4) BJ-16580, described as a "C-9" type resin which is claimed to act both as a hard and soft resin.

None of the above resins, when submitted wholly or in part for the alkyd either in our own formulas or when used in formulas supplied by their manufacturers, yielded lacquers with as desirable a combination of properties as is obtained with a 50% cocoanut oil modified alkyd (RL-233) of our own manufacture.

The most promising of the hard maleic modified rosins, Lewisol 33 and Beckacite 1111, were then re-evaluated in conjunction with RL-233.

Other hard resins not previously evaluated such as BR-9367, Beckacite 1120, Beckacite 1112, Cellolyn 104, and a soft resin, Cellolyn 95, were studied. According to the supplier, the latter is exceptionally resistant to change in color. None afforded a superior compromise between cost and properties to Lewisol #33 or Beckacite #1111.

Laboratory tests, augmented by processing, print and application tests, conducted in conjunction with representatives of the Roanoke and Chicago Field Service Laboratories, indicated that the optimum ratio of hard resin to alkyd to be 30/70 with either Lewisol 33 or Beckacite 1111. The resulting basic formula was designated as Type F Furniture "Duco".

In order to improve our profit position under the then prevailing raw material market situation, a study was made to develop a lower cost lacquer than Type "F" with a minimum sacrifice in quality from the Type "F" level, setting the lower limits of quality at the level of type II (see rating chart) but with improved color and print resistance. Using the formulating principles discussed above, it was found that this could be best accomplished by reducing the nitrocellulose content and increasing the amount of hard resin. Thirty-eight percent nitrocellulose was found to

be about the minimum without seriously impairing the processing and print resistance. Keeping the nitrocellulose at this level and increasing the amount of hard resin at the expense of the alkyd decreased final clarity, durability, print, scratch, and ultra-violet light resistance. The final compromise is represented by Type "G", the composition of which is given later in this report. This formula was finally abandoned in October 1949 because of a favorable downward trend in the prices of raw materials. Should this situation change, it could be reinstated.

To provide a lacquer for the piano trade, with improved durability over Type "F", Type "H" was set up by the Sales Service Group. Again using the formulating principles discussed previously, the hard resin content was reduced and the alkyd increased proportionately. This resulted in Type "H", the composition of which is given later in this report.

Because the initial field test with Type "F", represented by the formula J-16000-X-9410, showed this formula not to have a large factor of safety against bubbling when sprayed under adverse shop conditions, some work was done under the subject project to develop a means of determining the bubble resistance of a lacquer. A qualitative test was developed which may be described as follows:

Apply the lacquer to large flat horizontal panels with a DeVilbiss MBC gun equipped with a #704/FF cap and tip. Fluid pressure should be maintained at 15 psi and a pressure at the gun of 60 psi. Apply two coats in rapid succession and allow to dry to the dust-free stage in the spray booth with the exhaust fan on. It may be necessary to shorten this period of drying in the spray booth depending on the room temperature and air flow across the panel. By using controls consisting of one lacquer normally satisfactory in bubble resistance and one unsatisfactory, the proper drying time in the spray booth can be determined.

The results of the experimental work just described in which the various ingredients required for the formulation of a superior furniture lacquer were studied individually, indicated that in addition to nitrocellulose, such a formula should contain a hard, high melting point gum (such as a maleic modified ester gum), a non-drying oil alkyd resin, and a plasticizer. This is the composition of Type "F" in which the preferred solid ingredients are combined as follows:

Ingredient	Percent	Ratio
Nitrocellulose	42.5%	10.0
Lewisol 33	11.1	2.6
RL-233	26.0	6.1
Blown Castor Oil	20.4	4.8
	100.0%	

As already discussed, under the then prevailing market (1949) for raw materials in which gum was much cheaper than nitrocellulose or alkyd resin, a lower coat lacquer was formulated. This lacquer was somewhat inferior to Type "F" in color, printing and cold crack resistance. On the other hand, it was superior to Type II in resistance to color change and printing and equal to it in all other respects. Designated as Type "G", this lacquer has the following solids composition:

Ingredient	Percent	Ratio
Nitrocellulose	38.2%	10.0
Lewisol 33	19.8	5.2
RL-233	19.8	5.2
Blown Castor Oil	22.2	5.8
	100.0%	

To provide a piano lacquer equal or superior to "D", the ratio of the ingredients in Type "F" were adjusted by the Sales Service Group as follows:

Ingredient	Percent	Ratio
Nitrocellulose	42.5%	10.0
Lewisol 33	3.8	0.9
RL-233	33.1	7.8
Blown Castor Oil	20.6	4.8
	100.0%	

These three basic compositions compare to the nine types of lacquers formerly in our line as follows:

Type	Rubbed Clarity	Processing	Durability	4 hr. Print	Scratch Resistance	Cold Crack	Color Change	Alcohol Resistance	Water Resistance
I	6.5	6.5	9.0	5.0	8.0	9.0	6.0	5.5	7.0
II	8.0	7.5	6.0	7.0	6.0	6.0	5.5	5.5	7.0
III	8.5	8.0	7.5	4.0	7.0	7.5	7.5	5.5	7.0
A	9.0	8.0	7.0	8.0	7.0	7.0	8.0	5.5	7.5
B	8.5	8.0	6.5	6.0	6.5	6.5	5.5	5.5	7.5
C	7.5	7.0	7.0	10.0	7.0	7.0	8.0	6.0	7.5
D	8.5	7.0	9.5	7.0	8.0	9.5	8.0	5.5	7.5
E	6.5	6.5	10.0	10.0	9.0	10.0	9.5	6.0	7.5
F	8.5	8.0	8.0	9.0	7.5	8.0	8.5	5.5	7.0
G	8.0	7.5	6.5	8.0	6.5	6.5	8.5	5.5	7.0
H	8.5	8.0	9.5	8.0	8.0	9.5	8.5	5.5	7.5
WE	7.5	7.0	7.0	8.0	7.0	8.0	6.0	5.5	7.0

It is evident that an increase in clarity and ease of processing is attained by increasing the hard resin at the expense of the alkyd. This, however, impairs durability, cold crack and print resistance.

Type "F" can be formulated only at a maximum solids of 27%, with a spraying viscosity of 45-55" 7 cup due to a compatibility problem in the use of Lewisol 33. Certain lots of the latter require so much aromatic hydrocarbon to maintain stability that a satisfactory solids/viscosity relationship cannot be maintained at solids appreciably higher than 27%. If higher solids; e.g. 33-35% are required, either hot spray must be resorted to or some sacrifice in print resistance and processing accepted. Higher solids are achieved at the specified spraying viscosity by reducing the nitrocellulose content of Type "F". The following illustrates this.

Ingredient	Percent	Ratio
1/8" Nitrocellulose	11.4	10.0
Beckacite 1111	3.3	3.0
RL-233	13.1	11.8
Blown Castor Oil	2.8	2.5
Raw Castor Oil	2.8	2.5
	33.4%	

B. Adhesion of "Duco" Topcoats

In the course of an investigation of a major complaint on erratic adhesion exhibited by 16887 (an aluminum stearate 85 sheen flat Type "E" lacquer), the Plant Service Group of this Laboratory found that one batch of this lacquer varied considerably in rate of dry and in adhesion to 19380 Sealer depending on the conditions of application. Experiments conducted by the Plant Service Group of this Laboratory indicated that the conditions of application such as spraying in hot humid weather yielded films with retarded dry and impaired adhesion. Further experiments indicated that this variation in performance was probably due to a hydrolysis of the aluminum stearate, yielding free stearic acid, and that this reaction is promoted by heat, time and vehicle acidity with high acid alkyd resins definitely accelerating the hydrolysis. All these findings by the Plant Service Group were highly important and explained the deleterious effects of aluminum stearate.

Although subsequent work on the above-mentioned complaint indicated definitely that the instability of 16887 was not the source of the poor adhesion complained-of by the customer, experiments were undertaken to study this weakness of Type "E" lacquer as represented by 16887.

Four types of Furniture Clears were considered.

	E	F	O	III
Nitrocellulose	42.4%	42.4%	42.4%	31.7%
Rosin Maleate	-	11.1	-	-
Hi Acid Alkyd	37.0	-	-	48.1
Low Acid Alkyd	-	25.9	37.0	-
Plasticizer	20.6	20.6	20.6	20.2
	100.0%	100.0%	100.0%	100.0%

These clears were flatted with both aluminum stearate and Santocel "C", aged at an elevated temperature (120°F.) and sprayed under conditions of high temperature and high humidity using the batch of 16887 mentioned above as the control.

When all formulas were sprayed under conditions under which the 16887 control (i.e., 70% R.H. and 85°F. temperature) showed retarded dry, blooming and impaired adhesion, none of the Santocel "C" flatted lacquers were subnormal in these respects. In the case of the aluminum stearate flatted lacquers, impaired adhesion, retarded dry and blooming were obtained, being only slight with Type III, moderate with F and considerably worse with E and O. Additional tests indicated that F was more nearly like E and O and that III was better. However, increasing the aluminum stearate in III made III as poor in these respects as E and O.

It was suspected that the difference between III and the other types was probably due more to the fact that III contained a maleate modified rosin rather than to differences in acidity of the vehicles.

Stearic acid in an amount equal to the theoretical obtainable from a complete hydrolysis of the aluminum stearate contained in 16887 (4.4% stearic acid on the solids) was then added to the above clears. Type III again was the only lacquer not showing bad blooming, retarded dry and impaired adhesion. This indicated that Type III was more tolerant of stearic acid than the others under examination.

Experiments undertaken to determine the relative tolerance of the various types of lacquer for stearic acid yielded the following results. Minimum percent of stearic acid on the solids for:

(1) Initial Bloom: Type III - 4%
E - 2%
O - 3%
F - 2%

(2) Retarded Dry: Type III - 5%
E - 3%
O - 3%
F - 3%

(3) Impaired Adhesion: Type III - 5%
E - 3%
O - 3%
F - 4%

Since it was suspected that Type III's tolerance to stearic acid was due to its containing a maleate rosin and no alkyd resin, further experiments were undertaken to determine the effect of each of the nitrocellulose modifiers on the tolerance of a furniture lacquer to stearic acid.

Type F was modified to contain:

(1) A solvent type plasticizer, tricresyl phosphate, in place of the blown castor oil.

(2) The N/C content reduced to equal that of Type III, replacing the N/C: first, with the resins used in Type F in the same proportion as contained in F; and secondly, with only the rosin maleate component.

(3) Rosin maleate as 100% of the resin component.

Controls consisted of Types E, F, and III and also Type III with blown castor oil substituted for the plasticizer (tricresyl phosphate/blown soya bean oil) in Type III. To each of these clear lacquers, 4.4% stearic acid on the solids was added.

The only lacquers not showing bloom and impaired adhesion after an overnight dry were Type III, Type III with blown castor oil in place of tricresyl phosphate/blown soya bean oil, Type F with all the resin component consisting of a rosin maleate, Type F with the nitrocellulose content reduced and the resin component consisting of a rosin maleate. All the others showed blooming, retarded dry and impaired adhesion.

From these results it appears that the reason Type III is more tolerant of stearic acid than E, O, and F is because it does not contain any alkyd resin but instead a rosin maleate. The use of solvent type plasticizers apparently does not increase the tolerance of a lacquer for stearic acid. The type of alkyd used also does not seem to have any effect on the tolerance. Neither does the percentage of nitrocellulose, at least within the range explored.

The following typical organic acids were added to Type F on the basis of 4.4% on the solids:

(1) Stearic
(2) Lauric
(3) Linseed Oil Acids
(4) Benzoic
(5) Adipic
(6) Sebacic
(7) Phthalic
(8) Maleic
(9) Ricinoleic
(10) Carbollylic

Stearic and carbollylic modified lacquers bloomed considerably, maleic and adipic slightly, while the rest showed no bloom.

While these results did not point to an immediate solution in the development of a flatting agent which would not have the defects of aluminum stearate, they did indicate the possibility of further work along these lines to uncover a potential flatting agent of the general type of aluminum stearate (a metallic salt of a fatty acid).

Considerable additional check experiments were conducted along the lines discussed above. The results of this work confirmed the previous ones. Based on this information, Types F, G, and H were offered as a clear and flatted with Santocel "C" rather than aluminum stearate.

They also can be flatted with RV-62, a flatting agent manufactured by R.B.H. dispersions. This is supposed to be a cellulosic coated aluminum salt of a phenolic modified resin.

To sum up, aluminum stearate in flat lacquers hydrolyzes on aging, particularly in the presence of lacquer components of high acidity, and free stearic acid is released. In addition, applying the flatted lacquers under conditions of high temperature and humidity exaggerates the ill effects of free stearic acid. Some compositions are more tolerant of stearic acid in the film than others. Alkyd containing lacquers appear to have the least tolerance for free stearic acid, while those containing a high percentage of a modified resin are more tolerant.

The presence of free stearic acid in the film in quantities greater than the tolerance of the film components for stearic acid causes blooming, retardation of the dry and impaired adhesion. Incidentally, while the addition of triethanolamine to a lacquer exhibiting these undesirable properties may not be practical, such an addition prevents blooming, poor dry, and impaired adhesion. The addition of free stearic acid to a clear lacquer reproduces the results of aging the same clear flatted with aluminum stearate.

CGM/il
8/25/50

ALKYD STUDY IN FURNITURE "DUCO"

Alkyd Code	Type	% Oil	Processing	Clarity	Print	Scratch	Cold Crack	Alkyd Constants I.V.	A.N.	Visc.	Series No.	Remarks
1108-59	PE/glycol cocconut	50	6.5	7.5	-	-	10.0	69.4	22.8	1.6	2183-104	
1108-61	PE cocconut	50	8.0	8.0	-	-	10.0	69.1	49.3	4.8		
1108-64	PE/glycol cocconut	50	8.0	8.5	-	-	10.0	71.2	6.6	2.25		
1806	Type E	-	5.0	6.0	-	-	10.0	-	-	-		
1108-64	PE/glycol cocconut	50	7.5	10.0	8.5	-	10.0	71.2	6.6	2.25	2183-116	
1806	Type E	-	6.0	9.0	7.0	-	10.0					
	RL-233 (Type O)	-	7.0	9.5	7.5	-	10.0					
1108-64	PE/glycol cocconut	50	7.0	10.0	-	-	10.0	71.2	6.6	2.25	2183-120	
	Type O	-	6.5	10.0	-	-	10.0					
PRG-P-51910	Glycerol linseed	30	5.5	7.0	9.0	7.0	8.0	44.7	-	-	2183-128	
-73786	"	35	4.5	7.5	9.5	7.0	3.0	49.4	-	-		
-73763	"	33.3	4.5	7.5	9.0	7.0	4.0	49.5	-	-		
-73744	"	40.0	5.5	7.5	8.0	7.0	10.0	55.6	-	-		
68208	Glycerol/pH-E/glyc./pH, ex. glycol	-	-	-	-	-	-	60.0	-	-		Incompatible
1806	Type E	-	5.0	7.5	7.0	8.0	10.0	-	-	-		
1108-133	PE/cocconut	50.0	5.5	7.5	8.0	-	10.0	72.0	22.4	5.7	2183-152	
-137	"	55.0	6.0	7.5	8.0	-	10.0	70.8	13.7	8.7		
-141	"	60.0	6.0	7.5	7.0	-	10.0	70.2	12.8	9.0		
-64	PE/glycol/cocconut	50.0	6.0	8.0	8.0	-	10.0	71.2	6.6	2.25		
1806	Type E	-	5.0	7.0	7.0	-	10.0	-	-	-		
	Type O	-	5.0	8.0	7.0	-	10.0	-	-	-		
1108-135	Caproic C6	35.0	6.0	9.0	9.5	-	10.0	61.4	10.8	2.4	2183-148	Milky film
-139	Lauric C12	55.0	5.5	7.0	7.0	-	10.0	61.5	18.6	0.7		
-125	Stearic C18	59.0	5.5	0	7.0	-	10.0	60.3	12.7	0.5		Bad blooming
1806	Type E	-	5.0	7.0	6.5	-	10.0					
1108-151	B-COOH Adipic	-	5.0	5.0	-	6.0	10.0	-	-	-	2183-178	
1806	Type E	-	5.0	7.0	-	8.5	10.0	-	-	-		
1108-133	PE/cocconut	50.0	6.5	7.5	-	-	-	72.0	22.4	5.7	2183-162	
1108-64	PE/glycol cocconut	50.0	6.5	9.0	-	-	-	71.2	6.6	2.25		
	Type O	-	6.5	9.0	-	-	-	-	-	-		
1108-64	PE/glycol/cocconut	50.0	7.5	8.5	8.0	-	10.0	71.2	6.6	2.25	2183-192	
1108-153	Palmitic C16	58.0	7.0	0	8.5	-	10.0	62.0	12.0	13.5		Bad blooming
1108-154	Capric C10	47.8	7.5	8.5	7.5	-	10.0	61.2	17.2	7.5		
1108-155	Myristic C14	55.2	8.0	0	8.0	-	10.0	61.0	12.5	6.0		Bad blooming
1108-156	Glycerol/adipic/cocconut	46.1	5.0	6.5	7.0	-	10.0	62.0	12.5	3.9		
1108-152	Caprylic C8	43.8	8.0	8.0	8.5	-	10.0	59.5	19.6	7.5		
1108-160	PE/adipic/cocconut	46.1	5.0	6.0	7.0	-	10.0	69.5	26.4	4.7		
1108-162	Lauric C12	52.0	6.5	6.5	8.0	-	10.0	60.5	2.5	0.8		
1108-164	Stearic C18	59.3	8.0	0	7.0	-	10.0	60.3	3.8	0.5		Bad blooming
	Type O	-	7.5	9.0	8.5	-	10.0	-	-	-		
1108-166	Glycerol/cocconut	25.0	6.0	9.0	-	9.0	10.0	69.9	6.0	28.0	2183-212	
1108-168	"	40.0	7.0	9.0	-	8.5	10.0	70.3	10.8	5.3		
1108-170	"	55.0	7.0	8.5	-	7.0	10.0	70.1	10.3	1.0		
	Type O	-	8.0	9.0	-	8.5	10.0	-	-	-		
1108-166	Glycerol/cocconut	25.0	6.5	8.5	-	9.0	10.0	69.9	6.0	28.0	2183-224	
-168	"	40.0	7.5	9.0	-	8.5	10.0	70.3	10.8	5.0		
-170	"	55.0	7.5	9.0	-	7.0	10.0	70.1	10.3	1.0		
	Type O	-	7.5	9.0	-	8.5	10.0					
1108-152	Caprylic C8	43.8	7.0	8.0	-	9.0	-	59.5	19.6	7.5	2183-228	
-154	Capric C10	47.8	8.0	9.0	-	8.0	-	61.2	17.2	7.5		
-162	Lauric C12	52.0	8.0	9.0	-	8.0	-	60.5	2.5	0.8		
-155	Myristic C14	55.2	8.0	0	-	8.0	-	61.0	12.5	6.0		Bad blooming
-153	Palmitic C16	58.0	8.0	0	-	8.0	-	62.0	12.0	13.5		Bad blooming
	Type O	-	8.0	9.0	-	8.0	-	-	-	-		
1108-147	PE/glycol/cocconut	50	7.0	9.0	-	-	10.0	65.5	2.6	0.9	2183-232	
-175	"	55	6.0	9.0	-	-	10.0	70.5	9.0	2.8		
-176	"	40	6.5	9.0	-	-	10.0	69.9	8.5	10.8		
-178	"	55	7.0	9.0	-	-	10.0	69.0	7.3	0.9		
	Type O	-	7.0	9.0	-	-	10.0	-	-	-		
4629-71	Alkyd resin 3,5,5 trimethyl hexanoic acid	-	10.0	7.5	8.5	8.5	10.0	70.0	22.3	3.2	2183-240	
	Type O	-	8.0	9.0	8.5	8.0	10.0					
	1,2,5 tri-hydroxy pentane for 1/2 glycerol in RL-233		7.0	7.5	6.0	8.0	10.0	-	-	-	2183-242	
	Type O		7.0	8.0	7.0	8.5	10.0	-	-	-		
2205-13	PE/cocconut	25.0	-	-	-	-	-	72.0	-	11.6	2183-244	Incompatible
2205-4	"	40.0	8.5	8.0	6.5	8.5	10.0	73.8	-	8.5		
1108-184	"	55.0	7.5	8.5	8.0	10.0	10.0	69.6	8.7	2.0		
	Type O	-	8.5	9.0	7.0	8.5	10.0	-	-	-		
2205-17	SBO/glycerol	45.0	8.5	8.5	7.0	10.0	10.0	52.1	36.5	0.75	2183-246	
	RC-212	40.0	8.5	8.5	7.0	10.0	10.0	-	-	-		
	RL-233	50.0	8.5	8.5	7.0	8.5	10.0	-	-	-		
2201-21	SBO/glycerol	25.0	7.0	8.5	9.5	-	10.0	69.0	9.2	31.0	2183-248	
-19	"	40.0	8.0	9.0	8.0	-	10.0	70.8	10.2	7.5		
-17	"	55.0	8.0	9.0	7.5	-	10.0	52.1	36.5	0.75		
-15	"	55.0	8.0	8.5	7.0	-	10.0	70.0	9.7	1.35		
	RC-212	40.0	8.0	9.0	7.5	-	10.0	-	-	-		
	RL-233	50.0	8.0	9.0	7.0	-	10.0	-	-	-		
2205-23	PE/glycol/SBO	55.0	7.0	8.0	7.5	8.5	10.0	70.15	12.7	1.2	2183-252	
-25	"	40.0	7.5	9.0	8.0	8.5	6.0	70.5	10.5	6.0		
-29/31	"	25.0	7.5	9.0	8.5	8.0	3.0	68.45	11.0	10.8		
	RC-212	40.0	7.5	9.0	8.0	8.5	10.0	-	-	-		
	RL-233	50.0	7.5	9.0	7.5	8.0	10.0	-	-	-		
1108-181	Hydrogenated cottonseed oil	-	-	-	-	-	-	-	-	-	2183-230	Incompatible

CGM:DMZ
8/7/47

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