5. Circulate!

1-1
2-6

St. Louis Research Report No. 1730

January 22, 1957

FINAL REPORT

ON

APPLICATION WORK ON PRESENT PLASTICIZERS

- -

Job No. 2-02-750.01-3129-III

Monsanto Chemical Company
Organic Chemicals Division
St. Louis Research Department

Work done by:

J. R. Darby
W. G. Allen
E. E. Cowell
N. W. Touchette
L. R. Wangler
J. A. Cannon

Prepared by:

J. A. Cannon

0690764

HARTOLDMON0005199

D I S T R I B U T I O N

1. File
2. J. R. Darby
3. J. H. Lum - F. B. Zienty - File
4. Duplicate File
5. ~~Circulate: Assoc. and Assist. Research Directors~~ Central File
6. J. A. Cannon
7. W. B. Hicks
8. H. I. Armstrong
9. H. W. Mohrman - Springfield
10. F. J. Locke - Springfield
11. Extra
12. Extra
13. Extra

This report contains confidential information which is the property of the Monsanto Chemical Company and which shall be disclosed only to duly authorized persons. The recipient is held accountable for the filing and safe custody of the report which must be returned on demand.

HARTOLDMON0005200

TABLE OF CONTENTS

		Page No.
I.	INTRODUCTION	1
II.	SUMMARY	1
III.	CONCLUSIONS	1, 2
IV.	RECOMMENDATIONS	3
V.	PATENT STATUS	3
VI.	REFERENCES	3
VII.	EXPERIMENTAL WORK	
	A. Quality Control	3
	1. Santicizer 160	4
	2. Santicizer 141	4
	B. Compatibility of Carbide and Carbon's Monomer MG-1	4
	C. Volatility of Santicizer 213 and Santicizer 214	5
	D. Effect of Mixing Incompatible Plasticizers of Opposite Polarity	5
	E. Intensive Evaluation of Experimental Product 6004	
	1. Properties evaluation	5
	2. Compatibility	6
	3. Tensile Properties	6
	4. Migration	6, 7
	5. Soapy Water Extraction	7
	6. Dry Blending and Extrusion	8
	7. Heat and Light Stability	8
	F. Odor Masking of Aroclor 1232 in PVAc Adhesives	8
	G. Migration of Aroclor 1262 and HB-40	9, 10
	H. Volatility of Chlorinated DDB vs. DDB	10, 11
	I. Work Covered in Other Reports	11, 12
VIII.	DISCUSSION	12, 13
IX.	EXPERIMENTAL PROCEDURES	13
X.	APPENDIX	13

HARTOLDMON0005201

LIST OF TABLES AND FIGURES

		Page No.
Figure 1	Tensile Properties of E.P. 6004	(Appendix)
Table I	Loop and Window Compatibility of MG-1	4
Table II	Per Se Volatility of S-213 and S-214	5
Table III	Properties of Opalon 300 Plasticized with E.P. 6004	(Appendix)
Table IV	Migration of E.P. 6004	6
Table V	Migration of E.P. 6004 to Linde Silica	7
Table VI	Soapy Water Extraction of E.P. 6004	7
Table VII	Dry Blending and Extrusion of E.P. 6004	8
Table VIII	Migration of Aroclor 1262 and HB-40	9
Table IX	General Motors Lacquer Test for Aroclor 1262 and HB-40	10
Table X	Volatility of Chlorinated DDB vs. DDB	10
Table XI	Per Se Volatility of Chlorinated DDB vs. DDB	11
Table XII	Volatility and Mill Loss of Stabilized Chlorinated DDB vs. DDB	11

HARTOLDMON0005202

I. INTRODUCTION

Successful participation in the competitive plasticizer market depends not only upon maintenance of production of current products and the introduction of new plasticizers but also upon the adaptation of present products to various applications. The burden of proof for product performance in any given application rests with the producer. It is basic, then, that present products and by-products be evaluated both generally, in order to observe properties which might be advantageous, and particularly to see if requirements are met for specific applications.

The objectives of this job number, therefore, are the evaluation of plasticizers for quality control, intensive evaluation of new plasticizers which have shown promising properties during screening, direct comparison of Monsanto plasticizers with specific competitive products and the evaluation of Monsanto products and by-products in respect to performance in new applications.

II. SUMMARY

This job number covers a number of problems rather than a closely knit major program.

Santicizer 141 and Santicizer 160 processes modifications were checked for quality of products in regards to heat and light stability. A polymerizable plasticizer, Monomer MG-1 (Carbide and Carbon), was checked for compatibility. The volatility (per se) of Santicizer 213 and Santicizer 214 were determined. Incompatible plasticizers of opposite polarity were mixed to determine possible synergistic compatibilizing effects. Blends of dodecylbenzene with di-2-ethylhexyl phthalate, di-isodecyl phthalate and Santicizer 141 were evaluated as possible primary plasticizers. Odor masking of Aroclor 1232 in polyvinyl acetate adhesives and migration of Aroclor 1262 and HB-40 were studied. Work was initiated on the retention of physical properties during aging of electrical formulations. The volatility of chlorinated dodecylbenzene was compared with that of dodecylbenzene.

III. CONCLUSIONS

The following conclusions are drawn from the details of the evaluations on the various problems.

A. Quality Control

1. Santicizer 160

Charcoal refined Santicizer 160 (butybenzyl phthalate) is completely equivalent in light stability and very slightly superior in heat stability to regular production S-160.

HARTOLDMON0005203

The triethylamine process yielded S-160 with heat and light stabilities equivalent to control S-160.

2. Santicizer 141

Santicizer 141 made by the reverse addition method of preparation of the intermediate sodium phenate is comparable to regular S-141.

Santicizer 141 washed only with hot water instead of lye water to reduce emulsion formation has satisfactory heat stability.

B. Monomer MG-1 is incompatible as a plasticizer for PVC. Polymerization by the addition of two percent of benzoyl peroxide results in compatible, brittle systems of poor heat stability.

C. The 24 hour per se volatility test indicates that the percent plasticizer lost from Santicizer 213 and Santicizer 214 is only slightly lower than the percent of dodecyl benzene originally present.

D. Although compatibility was not achieved by mixing benzyl stearate with each of several more polar esters, no conclusions can be made here as to the general possibilities of this procedure.

E. Experimental Product 6004 (one part dodecylbenzene and three parts Santicizer 141) is compatible with PVC to give formulations with flexibilizing efficiency equivalent to DOP. Volatility and water sensitivity are higher for E.P. 6004 than for DOP. Heat and light stability are fairly comparable with DOP. The tendencies of E.P. 6004 to migrate to furniture lacquer, nitrocellulose sheeting and styrene wall tile are serious deterrents to applications in which there might be possibilities of contacts with these surfaces.

F. Pollak and Swartz's masking agents No. 1004 (camphor odor) and No. 1066 (fruity odor) are effective in neutralizing the odor of Aroclor 1232 in polyvinyl acetate adhesives.

G. A compound containing a monomeric plasticizer (DOP) with 20 parts HB-40 or Aroclor 1262 will not mar or soften nitrocellulose film and will probably pass the General Motors Lacquer test.

H. Chlorinated dodecylbenzene has higher boiling range and lower per se volatility than dodecylbenzene, but the volatility of chlorinated DDB in plasticizer PVC is higher than that of DDB.

HARTOLDMON0005204

IV. RECOMMENDATIONS

This type of application research should be continued so that new and varied applications may be found for Monsanto products through the extensive knowledge obtained on plasticizer properties. General information is essential in keeping abreast with competitors in filling requirements of the industry.

V. PATENT STATUS

The nature of the work covered by this report is that of further investigation of materials previously considered and it is felt that patentable features have been or are being evaluated by those concerned with the original inventions, if any. No disclosures were filed from the Applications Group as a result of the work covered by this report.

VI. REFERENCES

Final reports on Job No. 2-02-750.01-3129, Part I, "The Intensive Evaluation of Santicizer 214 and Experimental Product 6002" by J. A. Cannon and Part II, "The Evaluation of Isophthalates as Plasticizers for Polyvinyl Chloride" by N. W. Touchette are the other reports written for this job in 1956.

The Final Report on Job No. 2-02-750.01-2896, Part II, "Application Work on Present Plasticizers", by P. R. Graham and Final Report, Job No. 2-02-750.01-2616, Part V by J. A. Cannon contain references to all prior reports written concerning application of present plasticizers.

VII. EXPERIMENTAL WORK

The work covered by this job number consists of various problems rather than one specific type. Therefore, the details are recorded here in individual sections for each particular problem.

A. Quality Control

The continuous scrutiny of economic performance and product quality of production items results in process modifications from time to time. Plasticizers produced after altering the method of preparation must be evaluated for performance, at least in the areas which might be affected most.

HARTOLDMON0005205

1. Santicizer 160

Heat and light stability tests on Santicizer 160 prepared with two different process modifications were equivalent to standard production S-160. The one preparation utilized charcoal refining as compared to permanganation and the other process involved the use of the triethylamine salt of butyl acid phthalate.

2. Santicizer 141

Samples of Santicizer 141 (reverse phenate preparation method) and S-141 (hot water wash instead of lye water) were formulated at 50 PHR in Opalon 300 unstabilized, and stabilized with the lead system (POS-C, DS-207) and with the epoxy system (G-60, Mark XI and Mark XX). Both S-141 samples were tested for heat stability and found to be satisfactory.

Light stability of S-141 (reverse phenate method) was found to be equivalent to control S-141.

B. Compatibility of Carbide and Carbon's Monomer MG-1

Screening evaluation of Monomer MG-1 indicated limited compatibility in replacing DOP. To check the compatibility in plastisols the following formulations were prepared with Opalon 410 and plasticizer concentration of 80 PHR. Monomer MG-1 is a polymerizable plasticizer and in the formulations indicated two percent benzoyl peroxide was added as catalyst, based on the weight of MG-1.

TABLE I

Loop and Window Exposure Compatibility of MG-1

Plasticizer, 80 PHR	Loop Test	Window Exposure
MG-1	Incompatible	Incompatible-1 week
MG-1 + Catalyst	Brittle-no loop	Decomposed in mold
MG-1/DOP (3:1)	Incompatible	Slight exudation-3 weeks
MG-1/DOP (3:1)+Catalyst	Brittle-no loop	Decomposed in mold
MG-1/DOP (1:1)	Compatible	Slight exudation-3 weeks
MG-1/DOP (1:1)+Catalyst	Compatible	No exudation-3 months
MG-1/DOP (1:3)	Compatible	Slight exudation-3 weeks
MG-1/DOP (1:3)+Catalyst	Compatible	No exudation-3 months
DOP	Compatible	Very slightly tacky-3 months

The exudant resinified on the surface of the incompatible formulations after continued exposure in the window.

HARTOLDMON0005206

C. Volatility of Santicizer 213 and Santicizer 214

Santicizer 213 and Santicizer 214 were subjected to the per se volatility test.

TABLE II

Per Se Volatility of S-213 and S-214

Time (hours)	% Plasticizer Lost S-213	S-214
2	4.3	2.1
4	8.2	4.1
24	23	11

D. Effect of Mixing Incompatible Plasticizers of Opposite Polarity

In an effort to obtain a compatible plasticizer system by mixing two incompatible materials of opposite polarity, five samples (50:50 mixtures by weight) were prepared using the non-polar benzyl stearate, an incompatible plasticizer, with several polar esters ranging from incompatible, through compounds of limited compatibility, to compounds of borderline compatibility.

The plasticizer mixtures were:

1. Benzyl stearate with diethylene glycol bis(o-benzyl glycolate)

2. Benzyl stearate with diethylene glycol bis(butyl phthalyl glycolate)

3. Benzyl stearate with diethylene glycol di(butyl succinyl glycolate)

4. Benzyl stearate with ethylene glycol bis(butyl phthalyl glycolate)

5. Benzyl stearate with 2,6-di-isopropyl phenol

All five were incompatible. Nos. 1 and 4 showed slight exudation almost immediately. Number 5 would not completely fuse on the roll mill.

HARTOLDMON0005207

E. Intensive Evaluation of Experimental Product 6004

1. Properties Evaluation

The properties of Opalon 300 plasticized with E.P. 6004 at 20%, 30%, 40% and 50% plasticizer concentrations are compared with DOP in Table III in the Appendix.

2. Compatibility

Compatibility testing of E.P. 6004 consisted of loop test and window exposure on 20%, 30%, 40% and 50% unstabilized formulations and on 40% formulations stabilized with the lead system (POS-C, DS-207), the epoxy system (G-62, Mark XI and Mark XX), Staycin I and dibutyl tin dilaurate. No exudation was observed for any of the formulations in the loop test for one week in the case of the unstabilized and two weeks for those stabilized. The unstabilized samples did not exude during the four months of window exposure. Of the stabilized formulations, E.P. 6004 stabilized with dibutyl tin dilaurate exuded in one week, whereas the others have given no indication of incompatibility for four months.

3. Tensile Properties

Tensile strength, 100% modulus and elongation were determined for 20%, 30%, 40% and 50% E.P. 6004 formulations in comparison with DOP. The results are displayed in Figure 1 in the Appendix.

4. Migration

Experimental Product 6004 was tested for tendencies to migrate to polystyrene wall tile, nitrocellulose film and nitrocellulose furniture lacquer. E.P. 6004 and DOP were formulated at 40% plasticizer concentration and placed in contact with the various surfaces. The results of the testing are recorded below.

TABLE IV

Migration Tests on E.P. 6004

Duration of Test	Polystyrene, 50°C.		Nitrocellulose Lacquer, 50°C.		Nitrocellulose Film, 50°C.	
	E.P.6004	DOP	E.P.6004	DOP	E.P.6004	DOP
1 week	B-4	B-3	C-4	B-3	C-4	A-3
2 weeks	B-4	B-3	C-4	B-3	C-4	A-3
3 weeks	B-4	B-3	C-4	B-3	C-4	A-3
4 weeks	B-4	B-3	C-4	B-3	C-1	A-3

HARTOLDMON0005208

The alphabetical and numerical ratings above are interpreted as follows:

0	None	A	Marking (surface marred but not sticky)
1	Very slight		
2	Slight	B	Softening (surface marred and sticky)
3	Moderate		
4	Severe	C	Lifting (surface removed from panel)

E.P. 6004 was compared to DOP at various plasticizer concentrations with respect to migration to Linde Silica. The results of this testing are recorded below.

TABLE V

Linde Silica Test

		% Loss After 1 day	% Loss After 3 days	% Loss After 7 days
E.P. 6004	20%	0	0	0.06
	30%	0.50	0.70	1.3
	40%	2.5	4.5	7.3
	50%	4.5	9.6	16
DOP	20%	0.50	0.16	0.27
	30%	0.47	1.0	1.8
	40%	1.2	2.7	5.0
	50%	2.0	4.7	9.0

5. Soapy Water Extraction

The formulations listed in the Linde Silica Test were tested for extraction by 1% Ivory Soap solution at 50°C. for 24 hours. The results are listed below:

TABLE VI

Soapy Water Extraction

		% Plasticizer Lost
E.P. 6004	20%	2.3
	30%	7.1
	40%	13
	50%	22
DOP	20%	1.1
	30%	1.4
	40%	1.3
	50%	1.2

0690774

HARTOLDMON0005209

6. Dry Blending and Extrusion

The dry blending and extrusion characteristics of E.P. 6004 were compared with DOP. Formulations of 50 PHR of each plasticizer were tested as shown in the following table:

TABLE VII

Dry Blending and Extrusion of E.P. 6004

	1	2	3	4
Opalon 300 FM	100	100		
Opalon 300			100	100
E.P. 6004	50		50	
DOP		50		50
POS-C	3	3	3	3
DS-207	0.5	0.5	0.5	0.5
Time to dry blend (min.)	25	45	45	120
Temp. at dryness	75°C.	75°C.	75°C.	75°C.
Extrusion rate (g./min.)	14.1	16.4	15.2	17.9

7. Heat and Light Stability

E.P. 6004 and DOP were evaluated for heat and light stability in formulations stabilized with the lead system (POS-C, DS-207) and the epoxy system (O-60, Mark M and Mark PL). Heat degradation occurred slightly earlier for E.P. 6004 than for DOP in the lead system and much earlier in the epoxy system (i.e., 60 minutes vs. 180 minutes at 170°C.).

Exposure in the Fadeometer caused degradation of E.P. 6004 and DOP after 200 hours in the lead system and not until 2300 hours with the epoxy system.

F. Odor Masking of Aroclor 1232 in Polyvinyl Acetate Adhesives

Odor masking agents used were:

LeFevre Chemical Co.	No. 14-2
LeFevre Chemical Co.	No. 15-5
Coumarin	
Pollak and Swartz	No. 1004
Pollak and Swartz	No. 1066

Films containing 0.005% and less masking agent (based on resin content) were aged for 40 hours at 150°F. After these aging conditions the films still retained the odor of the masking agent.

HARTOLDMON0005210

G. Migration of Aroclor 1262 and HB-40

Migration of Aroclor 1262 and HB-40 to nitrocellulose film was tested using the following formulations.

	1	2	3	4	5	6	7	8	9
Opalon 300	100	100	100	100	100	100	100	100	100
DOP	68	35	---	32	35	27	33	63	55
G-53	---	35	75	32	35	27	33	---	---
G-52	6	6	6	6	6	6	6	6	6
Aroclor 1262	---	---	---	---	10	---	20	20	---
HB-40	---	---	---	10	---	20	---	---	20
Ferro 1825	3	3	3	3	3	3	3	3	3
Atomite	25	25	25	25	25	25	25	25	25
Shore "A" Hardness	72	73.5	77	73	73	73	72	72	70

Films 1 in. x 1 in. were placed on nitrocellulose sheets under one psi pressure at room temperature and at 50°C. The results are listed below:

TABLE VIII

Migration to Nitrocellulose Films at Room Temperature

Formulation	1 week	2 weeks	3 weeks	4 weeks	5 weeks	10 weeks
1	0	0	0	0	0	0
2	2A	2A	2A	2A	2A	2A
3	2A	2A	3A	3A	3A	3A
4	0	0	1A-	1A-	1A-	1A
5	0	0	0	0	0	0
6	1A-	1A-	1A-	1A-	1A	1A
7	0	0	1A-	1A	1A	1A
8	0	0	0	0	0	0
9	0	0	0	0	0	0
			50°C. n/c Films			
1	2A	2A	2A	3A	3A	3A
2	1B-	1B-	2B	2B	2B	3B
3	1B-	1B-	3B	3B	3B	4B
4	4A	4A	2B	2B	2B	3B
5	3A	3A	3A	1B	1B	2B
6	3A	3A	1B-	2B	2B	2B
7	3A	4A	1B-	2B	2B	2B
8	0	0	0	0	0	0
9	0	0	0	0	0	0

HARTOLDMON0005211

Rating Code:

0	No Change	A	Marking
1	Very slight	B	Softening
2	Slight	C	Lifting
3	Moderate		
4	Severe		

The General Motors test for migration to automobile lacquer was also run for the above formulations.

TABLE IX

General Motors Lacquer Test

Formulation	Remarks
1	Extreme softening
2	Extreme softening
3	Lifting
4	Extreme softening
5	Lifting
6	Softening
7	Lifting
8	Indentation - very slight softening
9	Indentation - very slight softening

H. Comparison of the Volatility of Dodecylbenzene (DDB) and Chlorinated Dodecylbenzene

Chlorinated DDB and DDB were formulated to equal hardness as 1:2 mixtures with DOP. Specimens of each were subjected to charcoal volatility and circulating air volatility tests.

TABLE X

Volatility of Chlorinated DDB and DDB

	Chlorinated DDB-DOP (1:2)	DDB-DOP (1:2)
Percent Plasticizer	40	42.5
Volatility: (% Plast.Lost)		
Charcoal Method	25.8	18.7
Circulating Air Method	41.5	33.6
Shore "A" Hardness:		
Before Volatility	82	82
After Charcoal Volatility	83	83
After Circulating Air Volatility	89	87

HARTOLDMON0005212

The per se volatilities were determined for chlorinated DDB and DDB and for 1:2 mixtures with DOP.

TABLE XI

Per Se Volatility of Chlorinated DDB and DDB

Time (hours)	Cl. DDB	% Plasticizer Lost		
		DDB	Cl. DDB-DOP	DDB-DOP
2	5.5	9.5	2.4	6.9
4	9.4	22.2	4.0	11.2
24	51.7	85.8	13.8	28.1

Chlorinated DDB and DDB were formulated in 1:2 mixtures with DOP (33-1/3 percent plasticizer) in epoxy stabilized formulations. The milling loss was determined and the stabilized samples were tested for volatility.

TABLE XII

Volatility and Mill Loss of Stabilized Chlorinated DDB and DDB

	Chlorinated DDB-DOP (1:2)	DDB-DOP (1:2)
Percent Plasticizer	33-1/3	33-1/2
Milling Loss:		
Percent of Secondary Plasticizer	27	49
Percent Total Plasticizer	9	16
Volatility: (% Plast. Lost)		
Charcoal Method	22.2	18.8
Circulating Air Method	38.8	33.1
Shore "A" Hardness:		
Before Volatility	87	88
After Charcoal Volatility	92	93
After Circ. Air Volatility	92	93

I. Work Covered in Other Reports

The intensive evaluation of Santicizer 213 and Experimental Product 6002 has been reported in Final Report No. 2-02-750.01-3129, Part I by J. A. Cannon.

HARTOLDMON0005213

Testing of electrical formulations for the retention of physical properties during heat aging was initiated under this job number and continued under Job No. 2-02-750.01-3254 and will be covered in reports for that job number. This work includes:

1. Stabilizing DIDP with Bisphenol A and TCP
2. Stabilization of Santicizer 300
3. Retention of physical properties upon heat aging of secondary plasticizers, Kendex 0869X, Socony XT-1045A, Halowax 4004 and Aroclors 1248, 1254 and 5460.

VIII. DISCUSSION

In replacing ONB (o-nitro biphenyl) in polyvinyl acetate adhesives with the Aroclors a serious objection, that of odor, developed. The approach taken was that of using commercial masking agents to neutralize or replace the disagreeable odor. Success was achieved by the use of the Pollak and Swartz agents.

Incompatible plasticizers fall into two general categories, the polar and the non-polar. The objective of one segment of the work under this job number was to see if mixing polar and non-polar incompatible plasticizers would result in compatibility. The work initiated for benzyl stearate and several glycolates although unsuccessful has been continued to include other systems under an exploratory job number.

Quality control evaluations are necessitated by the requirements for consistent performance characteristics of production items. Thus, as processes are changed due to shifting raw material sources and/or modification of manufacturing techniques, the products resulting from such changes must be evaluated for effects upon the ultimate end uses. During the period covered by this report, the modifications of Santicizer 160 and Santicizer 141 processes yielded products comparable to their predecessors.

Monomer MG-1 (Carbide and Carbon's polymerizable plasticizer, dipropylene glycol dimethacrylate) is proposed by Carbide and Carbon Chemical Co. to make it possible to obtain harder formulations than have previously been attainable through plastisol techniques. Their literature claims performance comparable to DOP when used as partial or full replacement for DOP. Compatibility studies showed MG-1 to be incompatible as a replacement for DOP. When catalyzed by 2% benzoyl peroxide, compatible formulations are obtained.

HARTOLDMON0005214

The program of blending dodecylbenzene with primary plasticizers was continued to include Santicizer 214 and E.P. 6002 (Final Report No. 2-02-750.01-3129, Part I) and Experimental Product 6004 (one part dodecylbenzene and three parts Santicizer 141). The intensive evaluation given these products included properties evaluations on plasticized PVC at various concentrations, compatibility studies, evaluations of tensile properties, migration, soapy water extraction, dry blending and extrusion and evaluation of heat and light stability.

During the screening of chlorinated dodecylbenzene a volatility higher than that of dodecylbenzene was obtained. The boiling range of chlorinated DDB is higher than for DDB. Per se volatility was determined for both compounds and showed chlorinated DDB to be lower in volatility than DDB. Since all tests indicated lower per se volatility and higher volatility from the plasticized sheet for chlorinated DDB other tests were proposed to help explain the cross-over. Volatility tests were run on stabilized chlorinated DDB and DDB with results comparable to those on unstabilized formulations; chlorinated DDB still showed higher volatility than DDB. The determination of plasticizer lost during milling showed that about three times more DDB was lost than chlorinated DDB. This higher mill loss could result in apparently higher volatility for chlorinated DDB because of errors in calculating the volatile loss of DDB. Further work to explain this cross-over was abandoned due to the unattractive volatility and economic factors of chlorinated DDB.

IX. EXPERIMENTAL PROCEDURES

All test methods used in this work are contained in the test method manual entitled, "Standard Test Methods of the Organic Division, Plasticizer Applications Laboratory". This manual is kept up to date with revisions as old tests are improved or new ones developed.

X. APPENDIX

The original notes for the work covered by this report may be found on notebook pages:

79104, 79114, 80620, 80623, 80628, 80631, 80637, 80638, 80639, 80641, 80646, 80648, 83364, 83365, 83367, 83368, 83369, 83370

J. A. Cannon

J. R. Darby

md
5-21-57

HARTOLDMON0005215

TABLE I

PROPERTIES OF PLASTICIZED OPALON 300

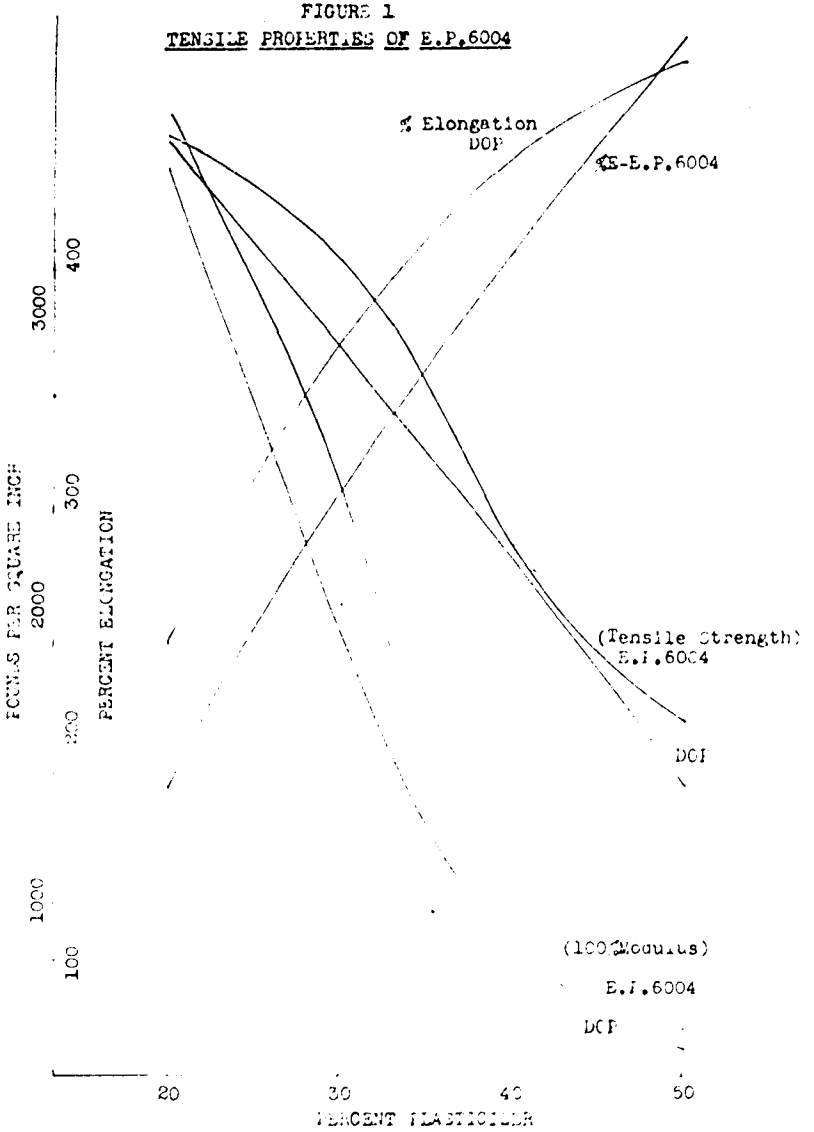
Plasticiser 40% unless specified		Milling results			Molded sheet			T_f°C.	Volatility % Plast. lost	Hardness		Heat Stability		Water Absorption		Kerosene extraction % Plast. lost
		Fuming	Odor	Color	Transparency	Odor	Color			Before Vol.	After Vol.	Color after 30 mins. at 325° F.	Rating	% Soluble matter lost	% Absorption	
E.P.6004 (DDI- S-160 1:3)	20%	mod.	mod.	lt. amber	sl. cloudy	mod.	yellow	17	6.7	100	100			0.04	0.95	4.2
E.P.6004	30%	mod.	mod.	lt. amber	sl. cloudy	mod.	yellow	-15	16	88	96			0.33	1.6	10
E.P.6004	40%	mod.	mod.	lt. amber	sl. cloudy	mod.	yellow	-38	21	72	83			0.64	2.5	22
E.P.6004	50%	mod. to heavy	mod.	lt. amber	sl. cloudy	mod.	yellow	-52	17	66	73			0.50	2.6	32
DOP	20%	mod.	mod.	char	sl. cloudy	mod.	yellow	11	4.8	92	94			---	0.89	2.5
DOP	30%	mod.	mod.	yellow	sl. cloudy	mod.	yellow	-19	5.4	86	86			---	1.0	8.0
DOP	40%	mod.	mod.	nil	sl. cloudy	mod.	yellow	-39	5.7	74	76			0.01	1.0	46
DOP	50%	mod.	mod.	nil	sl. cloudy	mod.	yellow	-53	4.6	64	57			0.05	1.6	80

0690781

HARTOLDMON0005216

FIGURE 1

TENSILE PROPERTIES OF E.P.6004



0690782

HARTOLDMON0005217