#940 THE INSTITUTE OF PAPER CHEMISTRY
(Waterproof Shipping Containers)
Reports

PROJECT REPORT FORM

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PROJECT NO. 940
COOPERATOR Institute
REPORT NO. 9
DATE June 28, 1944 (Typed 7/5/44)
NOTE BOOK 401
PAGE 97 TO 98
SIGNED Ralph E. Harpt
Ralph E. Harpt

PARAFFIN STIFFENING

The problem of using paraffin mixtures as a stiffening as well as a waterproofing agent for beer boxes has been considered. Modification of mixtures to produce required stiffness without sacrifice to undesirable increased brittleness has been undertaken.

Samples of 3-ply laminated solid fiber board 0.1 by 5 by 5.5 inches were impregnated by submergence in various paraffin mixtures at 200-210° F. for 5 minutes. These were then drained, wiped dry, and allowed to cool. The per cent retention by the board is the amount retained times 100, divided by the weight of untreated board. Only a single sample of each was made for comparative brittleness tests.

Sample 1. Blank - untreated stock

Sample 2. 135-137° F. paraffin-retention = 16.91 g. = 55.6%

Sample 3. 50% 135-137° F. paraffin
50% Muroz-V (Newport Industries, Inc.).
Retention = 12.73 g. = 42.0%

Sample 4. 50% 135-137° F. paraffin
50% Penros (Newport Industries, Inc.)
Retention 15.34 g. = 50.4%

Sample 5. 50% 135-137° F. paraffin
25% Muroz-V
25% Tenex
Retention = 10.06 g. = 32.9%

Sample 6. 50% 135-137° F. paraffin

25% Penros

25% Tenex

Retention = 12.89 g. ≡ 41.1%

Sample 7. 50% 135-137° F. paraffin

50% Tenex

Retention = 12.47 g. ≡ 41.0%

Sample 8. 50% 135-137° F. paraffin

25% Nandene (Newport Industries, Inc.)

25% Tenex

Retention=17.24 g. ≡ 55.8%

Sample 9. 50% 135-137° F. paraffin

25% Nalene (Newport Industries, Inc.)

25% Tenex

Retention = 15.22 g. ≡ 50.0%

Sample 10. 80% 135-137° F. paraffin

20% Nandene

Retention = 13.33 g. ≡ 43.1%

Sample 11. 80% 135-137° F. paraffin

20% Nalene

Retention = 12.13 g. ≡ 39.6%

reh/lhh

M E M O R A N D U M

April 27, 1944
File: 940

FROM: Code Office
TO: Dr. Kress, cc. Mr. Johnson
SUBJECT: Sample submitted April 24, 1944.

Institute File No.	Code No.	Dry Bursting Strength ("Jumbo" Mullen) points Test 1	Test 2	Av.	Wet Bursting Strength (after 24-hour immersion) ("Jumbo" Mullen) points Test 1	Test 2	Av.
113169	Board Sample--						
	Sample 1				400	425	413
	Sample 2				200	205	203
	Sample 3				250	305	278
	Sample 4				91	90	91
	Sample 5*	345	345	345			

* The dry Mullen sample was conditioned for 24-1/2 hours at 50% R.H., 73° F.

Note: Varying degrees of voluntary ply separation were noted in the wet board samples. The degree of voluntary ply separation was as follows:

No. 1	slightly less than 1/4 inch
No. 2	1/2 inch
No. 3	1/4 inch
No. 4	1/2 inch to 1-1/2 inches.

HW

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PROJECT NO. 940
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DATE April 24, 1944 (Typed 4/26/44)
NOTE BOOK 401
PAGE 91 TO 97
SIGNED C. E. Johnson
C. E. Johnson

PLASTICIZING OF (1-1) TENEX-WAX

A series of experiments was conducted to find a plasticizing agent for 1-1 Tenex-wax. The (1-1) mixture appears to be too brittle when used for impregnation of solid fiber boxes and, for this reason, the boxes fail at the score line.

The following mixtures were prepared and after melting were applied to surface of glassine paper for flexibility tests.

Sample	Composition
1.	50% Tenex, 50% paraffin wax
2.	45% Tenex, 45% paraffin wax, 10% Arochlor 1254 (Monsanto)
3.	45% Tenex, 45% paraffin wax, 10% Kronisol (Ohio Apex, Inc.)
4.	45% Tenex, 45% paraffin wax, 10% Pine oil
5.	45% Tenex, 45% paraffin wax, 10% castor oil
6.	45% Tenex, 45% paraffin wax, 10% chlorinated paraffin (Hercules Powder Company)
7.	45% Tenex, 45% paraffin wax, 10% Dow plasticizer No. 7
8.	45% Tenex, 45% paraffin wax, 10% Monsanto Santicizer B-16
9.	45% Tenex, 45% paraffin wax, 10% carnation oil
10.	45% Tenex, 45% paraffin wax, 10% Dow Plasticizer No. 5
11.	45% Tenex, 45% paraffin wax, 10% crude tall oil (Gulf States Paper Corporation)
12.	45% Tenex, 45% paraffin wax, 10% benzyl benzoate
13.	45% Tenex, 45% paraffin wax, 10% Corpolin (The Aktivin Corporation)
14.	45% Tenex, 45% paraffin wax, 10% boiled linseed oil
15.	45% Tenex, 45% paraffin wax, 10% pure tung oil (Bogalusa Tung Oil Company)

The above samples which were applied as films to glassine were examined for flexibility at 70° F. and - 18° F.

Sample	Results at 70° F.	Sample	Results at - 18° F.
3, 4, 5, 6, 8, 9, 10, 11, 12, 14, 15	Pliable	1-15	Brittle
2	Pliable-brittle		
1, 7, 13	Brittle		

The softness or flexibility of the various mixtures in beakers was also determined by testing them with the fingernail at 70° F., -18° F., and 40° F.

Sample	Results at 70° F.
12	Softest. Could be dented readily with the fingernail.
8, 3, 14	Next softest. Quite pliable.
15, 9	Third softest.
11, 6, 5, 10, 4	Fourth softest.
7,2	Fifth softest. Quite hard.
13, 1	Hardest, could scarcely be dented with fingernail.

Sample	Results at -18° F.
1, 3, 8, 9, 12, 14, and 15	All samples were brittle.

Sample	Results at 40° F.
1	Brittle.
9	Somewhat soft.
12	Slightly softer than Sample 9

The melting point of some of the more promising mixtures was determined by dipping a thermometer in the material about 20° F. above the melting point, removing the thermometer, rotating the thermometer, and noting the temperature at which material would no longer flow on the thermometer bulb.

Sample	Melt Point, °F.	Sample	Melt Point, °F.
1	121	12	118
3	121	14	120
8	119	15	121
9	118		

The previous tests have indicated that of the various materials tested benzyl benzoate is the best plasticizer for Tenex-wax and that carnation oil is quite effective. Carnation oil is very considerably cheaper than benzyl benzoate.

Solid fiber board samples were cut from a box so that a commercial score line which had not been bent was present in the machine direction of each sample. The board represented .088-inch solid fiber board manufactured by the John Strange Paper Company and consisted of two outer plies of .016-inch weatherproof liner and two inner plies of .028-inch chipboard. The plies had been laminated with starch urea weatherproof glue.

The above samples which were about 4-1/2 by 7 inches in size and with the score line in the middle and in the 4-1/2-inch direction, were then impregnated for 10 minutes in various mixtures at 200°-220° F. Five samples were treated in each mixture.

The following treatments were given the samples with solid retention as indicated based on the final weight of the samples.

Sample		Original Wt., g.	Final Wt., g.	Solids Retained g.	Solids Retained %
1	50% Tenex 50% Wax	33.3	49.2	15.9	32.3
2	45% Tenex 45% Wax 10% Benzyl benzoate	33.9	50.7	16.8	33.1
3	45% Tenex 45% Wax 10% Carnation oil	33.0	49.3	16.3	33.1
4	Blank. Not treated			--	--

Four of each of the above samples were allowed to cool to room temperature for about 1/2-hour and were then bent about 90° in each direction at the score line to simulate conditions under which the boxes are sealed.

The samples were then submerged in water at 70-75° F. for 24 hours after which they were tested for water pickup, wet Mullen at the score line, and wet tensile strength. The wet Mullen test represents averages of two tests and the wet tensile test represents averages of four tests which were made on 2- by 7-inch strips with the score line in the 2-inch direction. The tensile strips failed at the score line.

The results of these tests are given in the following table:

TESTS ON SAMPLES SUBMERGED IN WATER 24 HOURS

Sample	Water Pickup g.	Water Pickup %	Mullen Points	Tensile lb.
1	7.8	16.5	413	126
2	15.8	32.5	203	44
3	10.2	21.6	278	60
4	20.3	61.5	91	25.5

The untreated board was also tested dry at the score line with results as follows:

Sample	Mullen, Points	Tensile, lb.
5	345	213

CONCLUSIONS

The addition of 10% plasticizer such as carnation oil and benzyl benzoate to 1-1 Tenex-wax weakened the score line of board which was tested for tensile and Mullen after 24-hour water submergence.

It was noted in bending the dry samples that the plies loosened in all cases. This may be caused by poor adhesive or cheap furnish.

cej/lhh

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REPORT NO. 7 - April 10, 1944
DATE Typed April 11, 1944
NOTE BOOK 401
PAGE 89 TO 91
SIGNED C. E. Johnson

The following boxes have been treated for five minutes in 1-1 Tenex-wax at 210-220° F. and were shipped today to the companies indicated.

1. 50 boxes, solid fiber, chip filler, no asphalt in laminating adhesive. Atlas Boxmakers, Incorporated, 2555 West Diversey Avenue, Chicago, Illinois. Tenex-wax retention equals 22.1% based on the final weight.

2. Three knockdown solid fiber, all southern kraft beer boxes. Gaylord Container Corporation, Saint Louis, Missouri. Tenex-wax retention equals 15.6% based on the final weight.

cej/lhh

6 a

PROJECT REPORT FORM

PROJECT NO. 940

COOPERATOR Institute

REPORT NO. 6

DATE March 21, 1944 (Typed 3/22)

NOTE BOOK 401

PAGE 82-84 and 87-88

SIGNED William M. Sirek
William M. Sirek

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REDWOOD BOARD TREATMENT IN 1-1 TENEX-WAX

Redwood boards were treated in a 1-1 Tenex-wax mixture in order to see what effect it had on making the boards more water resistant. Some redwood boards were cut about 12 inches by 9 inches. An 8-inch space was marked off with the length of each board and a 6-inch space with the width of each board. This was done to be able to determine the amount of expansion of the board after treatment in Tenex-wax and then soaked in water.

The boards were treated as follows:

1. The board was dipped for 5 minutes in a 1-1 Tenex-wax mixture at 210° F. and dried in an oven at 102° C. for 17 minutes. The weight gained was 26.8 grams. The board was put back in an oven for an additional two hours and at the end of this time the gained weight had dropped to 20.2 grams. The original weight of the board was 394.1 grams. One inch was sawed off the end of the board to see how far Tenex-wax had gone into the wood. Very little impregnation was found.

2. This board was dipped in Tenex-wax at 210° F. for 15 minutes and dried in an oven at 102° C. for two hours.

3. Put this sample in an oven at 105° C. and dried it for 3-1/2 hours at the end of which time it weighed 387 grams. The original weight was 400.1 grams. It was then dipped in 1-1 Tenex-wax at 210° F. for 15 minutes and dried in an oven at 105° C. for 8 minutes.

4. This sample was left without any dip in Tenex-wax. The chart shows the amount of weight gained but these figures actually do not represent the total amount of wax picked up as moisture was being cooked out of the boards while they were being dipped.

	Original Weight	After Dip and Drying	Gained Weight	Gained %
1.	394.1	414.3	20.2	5.13
2.	369.9	386.6	16.7	4.51
3.	400.1	417.7	30.7	7.67
4.	370.9	Not Treated	00.0	0.00

For the first 24 hours the boards were submerged in a tray of water about 2 inches deep. These boards were then mounted on a frame so that each board was about 1 inch above the other in a 30 gallon tank of water. The surface of the water being about 8 inches above the top board and about 18 inches above the bottom board. The boards were weighed at different intervals and each board was dried with a dry cloth before weighing. The chart shows these results.

	Before Submerged	After 1/2 hr.	Gain %	After 4 hr.	Gain %	After 24 hr.	Gain %	After 245 hr.	Gain %
1.	368.2	390.0	5.9	409.9	11.3	470.2	27.7	591.5	60.6
2.	386.6	387.8	.31	340.5	.95	400.9	3.64	490.8	26.7
3.	417.7	419.1	.34	421.6	.93	433.5	3.73	523.8	25.3
4.	370.9	401.9	8.4	427.9	15.4	450.7	21.52	562.2	51.8

The boards were in the frame in the following order: (4) was on top; (3) was second; (1) was third and (2) was at the bottom.

The increases in length of the 8-inch and 6-inch spaces were as follows:

	8-in. space After 24 hr.	6-in. space 24 hr.	8-in. space 245 hr.	6-in. space 245 hr.
1.	1/64 in.	2/64	1/64	13/64
2.	1/64	3/64	1/64	11/64
3.	0	0	0	12/64
4.	1/64	6/64	1/64	11/64

The boards were then put back in the frame in a tank of water for further treatment. This time, however, the order was reversed so that the top one at first was at the bottom.

wms/lhh

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NOTE BOOK 401
PAGE 81 TO
SIGNED William M. Sirek
William M. Sirek

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GAYLORD BEER BOXES

The Gaylord set up beer boxes made of southern kraft were dipped in a 1-1 Tenex-wax mixture in order to make the bottoms more resistant to the water condensation from beer bottles. Each of the boxes, size 11-1/2 by 10 by 17 inches, were dipped to a depth of two inches as follows:

1. Had drilled 12 (3/8-inch diameter) holes in the bottom for drainage.
Dipped in Tenex-wax at 200° F. for 10 minutes.
Weight of the box increased, because of dipping, 126 grams.
Original weight of box was 1497 grams.

2. Had drilled six holes in the bottom for drainage.
Dipped in Tenex-wax at 230° F. for three minutes.
The weight increased 96 grams because of the dip.
The original weight was 1511 grams.

3. Had 16 holes (3/8 inch diameter) drilled in the bottom.
Dipped in Tenex-wax at 175° F. for five minutes.
The weight increased 107 grams because of the dip.
The original weight was 1497 grams.

None of the boxes were wiped after treatment but were allowed to drain for several minutes.

These boxes were then enclosed in a container on March 7, 1944 and shipped via express to the Gaylord Container Corporation, Saint Louis, Missouri.

wms/lhh

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DATE March 1, 1944
NOTE BOOK 401
PAGE 78 TO 80
SIGNED C. E. Johnson
C. E. Johnson

Samples for Forest Products Laboratory

The Forest Products Laboratory, Madison, Wisconsin submitted various shell containers to us for tenex-wax treatment. Mr. Chidester described these samples as follows in his letter of Feb. 22 to Dr. Kress:

1. 15 M-130 containers. These containers consisted of chipboard inner tube and asphalt paper lined top and bottom slip covers.
2. 3 chipboard tubes
3. 3 rectangular containers for 20 mm. shells. Outside dimensions were 2-1/4" x 5-1/2" x 2-1/2". Each container consisted of 5 separate pieces. The containers were lined on outside with kraft paper, otherwise they were made completely of chipboard.

All of the above samples were treated in 1-1 tenex-wax mixture at 220° F. The excess material was removed by wiping. All samples were taken apart before treatment. The treated samples were shipped to Mr. Chidester on Feb. 29 by express collect. The following retention data were obtained:

1. Treated the 15 M-130 containers by submergence for 2 minutes and determined tenex-wax pick up for 3 complete units.

	Top	Bottom	Tube
Treated weight - g	232.6	386.4	418.4
Untreated weight - g	215.3	359.4	359.4
Tenex + wax - g	17.3	27.0	59.0
Treated weight - g	233.1	380.2	425.2
Untreated weight - g	218.8	353.9	359.3
Tenex + wax - g	14.3	26.3	65.9
Treated weight - g	231.2	383.1	419.7
Untreated weight - g	217.9	357.2	356.1
Texex + wax - g	13.3	25.9	63.6
Ave. tenex + wax - g	15.0	26.4	62.8

Ave. tenex + wax per container = 104.2 g.

2. Two of the chipboard tubes were treated for 2 minutes and the third was treated for 5 minutes.

	2 Minute Treatment	5 Minute Treatment
Treated weight - g	425.9	470.2
Untreated weight - g	353.1	350.8
Tenex + wax - g	72.8	119.4

3. The retention data for the individual parts of the 20 mm. shell containers which were treated for 1 minute were as follows:

		a	b	c	Ave.
Part #1	Treated weight - g	106.6	110.3	104.7	
	Untreated weight - g	72.4	72.9	72.2	
	Tenex + wax - g	34.2	37.4	32.5	34.7
Part #2	Treated weight - g	10.4	10.2	10.2	
	Untreated weight - g	6.9	7.1	6.9	
	Tenex + wax - g	3.5	3.1	3.3	3.3
Part #3	Treated weight - g	38.3	37.2	38.3	
	Untreated weight - g	25.5	25.3	25.3	
	Tenex + wax - g	12.8	11.9	13.0	12.6
Part #4	Treated weight - g	30.8	30.3	30.8	
	Untreated weight - g	22.3	21.4	21.2	
	Tenex + wax - g	8.5	8.9	9.6	9.0
Part #5	Treated weight - g	174.2	172.4	173.9	
	Untreated weight - g	144.2	144.3	143.9	
	Tenex + wax - g	30.0	28.1	30.0	29.4

Average-tenex + wax for complete unit = 89.0 g

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NOTE BOOK 401
PAGE 74 TO 77
SIGNED C. E. Johnson
C. E. Johnson

SAMPLES FOR FOREST PRODUCTS LABORATORY

We have treated and submitted the following samples to the Forest Products Laboratory, Madison, Wisconsin.

A. 0.100-inch fiberboard of at least 600-pound dry mullen treated with 14% Tenex-wax melt at 210° F. for 5 minutes. The samples retained about 16% Tenex plus wax and are to be tested for cleated box structures by the Forest Products Laboratory. Both untreated and treated samples were submitted.

B. Ammunition containers (105 mm., M 129) which were submitted by the Forest Products Laboratory for waterproofing treatment at the Institute. These containers consisted of an inner chipboard, spirally wound tube with an asphalt outer liner; outer tubes with metal ends to serve as top and bottom which fit over the inner tube. The outer tubes were also fiberboard with an asphalt outer liner. Eight complete tubes were treated in 1-1 Tenex-wax-wax mixture at 230° F. for one minute by submerging the individual parts in the hot melt.

The Tenex-wax retention was as follows:

	Original Tube, g.	Tenex + Wax/Tube, g.
Inside Tube	403.9	41.6
Top Tube	214.6	15.8
Bottom Tube	352.5	29.9
Total Unit	971.0	87.3

Two untreated tubes were also returned for comparison purposes.

C. Ordinary 2-inch diameter chipboard tubes were also submitted, one of which was treated in 1-1 Tenex-wax mixture at 230° F. for 30 seconds and the other was untreated. The Tenex-wax treated tube weighed 88.16 grams before treatment and 125.0 grams after treatment.

A single Riehle compression test was made on the treated and untreated dry tubes which were four inches long.

	Untreated	Treated
Riehle Compression	144	338

cej/lhh

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PROJECT NO. 940
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NOTE BOOK 332 and 401
PAGE 160 - 66 - 70
SIGNED R. E. Williams
R. E. Williams

Treatment of starch laminated solid fiber boxboard with 85:15 Tenex-wax at 240° F. for various lengths of time was tried and the products tested.

New adhesive samples have been tested on Tenex-wax treated box-board.

TENEX-WAX 85:15 TREATMENTS

Wisconsin Container Corporation starch laminated solid fiber box-board was cut to 8 inch by 9 inch pieces. Two pieces were treated in a molten mixture of 85% Tenex resin and 15% paraffin wax at 240° F., for each of four different times. The excess Tenex-wax was wiped from each surface by using a cloth. One set of samples was then submerged in water for 24 hours, with dry and wet weights and calipers and wet Mullen strength being measured. The other set was stored at 120° F. for 16 days, with original and final weights being measured and the Mullen strength determined after 22 hours conditioning at 50% R.H. and 73° F. The data and results are summarized in the following table:

BOXBOARD TREATMENTS AND RESULTS

	Time Dipped in 85:15 Tenex-wax Melt, Min.				
	2	5	10	20	
Retention of 85:15 mix, %	6.3	10.1	14.6	20.1	
Submergence test - 24 hr.					
a. Water absorbed, %	37.0	39.2	36.0	32.1	
b. Caliper rise, %	25.3	26.5	22.4	23.6	
c. Mullen strength, av. lb./in.^{2}	240	245	290	425	
d. Ply separation	Considerable	Almost Complete	Very Slight	Slight	
Oven test - 16 days 120° F.					Blank
a. Loss in weight, % (Reg.	3.11	2.62	1.93	0.0	5.46
(Wtpf.	3.51	2.07	1.12	0.0	5.80
b. Mullen strength, av., lb./in.^{2} (Reg.	515	323	510	445	505
(Wtpf.	683	800+	680	678	760

Note: All percentages listed in the above table are calculated on the moist or soaked basis.

ADHESIVE TESTS

Further tests of Arabol 62-51-03 (made by Arabol Manufacturing Company, Cicero, Illinois) checked the good results of previous tests of this material. Asphalted fiber VIS boxes submitted by Dr. George Sears were successfully glued and soaked several days in water without failure of flap adhesive. One asphalted VIS box, with one end glued and dried, was submitted to Dr. Sears.

Williamson No. 100 Labeling Adhesive for Waxed Paper (made by Williamson Adhesives, Inc., Chicago, Illinois) was applied to Tenex-wax treated board. After 19 days at room conditions, it remains tacky and semiplastic, but does give a fair bonding. This sample has been submerged to determine the water resistance of the adhesive.

DISCUSSION

The following conclusions are based on the work reported above:

1. Relatively long dipping times (10 minutes or more) were required to obtain good results from treating solid fiber boxboard in 85:15 Tenex-wax melt at 240° F.

2. Water submergence tests showed best resistance from 20 minute treated boxboard, which retained good strength and lamination bonding after 24 hour soaking .

3. Storage at 120° F. for 16 days had little effect on treated boxboard.

4. Arabol 62-51-03 adhesive gave entirely satisfactory results on asphalted fiber VIS cartons.

rew/lhh

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PROJECT NO. 940
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NOTE BOOK 332
PAGE 154 TO 159
SIGNED C. E. Johnson
C. E. Johnson

ADHESIVE TESTS

A new waterproof glue sample Arabol 62-51-03 was received from the Arabol Manufacturing Company and was tested on a Tenex-wax treated box. The flaps of the box were sealed with this glue and the box was filled with 24 No. 2 cans. The box was weighted with 4 other full cartons and was allowed to stand for three days in order to set the glue. After this period of time, the carton was examined and it was noted that the flaps were bonded well. The carton was then placed in water for 24 hours and was again examined. The flaps were bound which indicated that the glue was water resistant. This box was then subjected to the standard Army drop test and the following data were secured:

6 drops - can cut
7 drops - 6-inch can cut
8 drops - complete failure of horizontal side score line.

The box was firm and retained its shape during this test.

A duplicate sealing test has been made on this glue and will be reported on at a later date.

Two samples of adhesive were received from Trumbull Asphalt Company, 5440 West 67th Street, Chicago, Illinois. These samples are identified as follows:

1. Trumbull semiliquid waterproof sealer
2. Trumbull liquid waterproof sealer.

Strips of Tenex-wax treated boxboard were glued together with each of the above samples and it was noted that the semiliquid waterproof sealer gave poor bonding and the liquid waterproof sealer gave fair bonding.

In order to determine the value of the liquid waterproof sealer as an adhesive, a Tenex-wax treated box was sealed with this material. The box was allowed to condition for 3 days after which it was examined. None of the flaps showed any degree of bonding although the adhesive had dried out.

EFFECT OF INCREASING THE TENEX CONTENT OF THE TENEX-WAX MIXTURE FOR WEATHERPROOF BOXES

Two types of boxboards (A) regular starch glued board, and (B) .016 inch - .023 inch - .025 inch - .023 inch - .016 inch weatherproof board ("C" board of trials made at Wisconsin Container Corporation on 4-19-43) were treated in various mixtures of Tenex and wax.

The samples were submerged in the molten Tenex-wax mixture for varying lengths of time in order to obtain approximately the same amount of Tenex-wax retention for each set of samples. The following table gives the description of the various treatments and the amount of Tenex-wax retained by the samples:

Sample	Tenex Wax Proportion	Temperature of Mixture Degrees F.	Time of Treatment Min.	Tenex-wax Retained %
1-A	1:1	230	3	21.2
1-B	1:1	230	3	13.3
2-A	2:1	230	5	23.5
2-B	2:1	230	5	12.8
3-A	3:1	250	5	20.6
3-B	3:1	250	15	15.4
4-A	5.7:1	260	12	24.7
4-B	5.7:1	260	15	13.9

The above samples were submerged in water for 24 hours and gain in weight, increase in caliper, and the Mullen were determined. These results are given in the following table:

Sample	Gain in Weight %	Increase in Caliper %	Mullen Points per pound High	Low	Average
A-Blank	87.6	35.9	124	104	115
1-A	51.2	31.7	445	250	328
2-A	34.7	21.5	515	330	429
3-A	40.9	21.6	555	275	378
4-A	20.5	13.4	650	535	596
B-Blank	84.5	45.5	390	310	345
1-B	63.3	43.1	800	375	614
2-B	52.0	37.9	800+	480	710+
3-B	40.6	33.3	800+	430	713+
4-B	27.2	21.9	800+	800+	800+

It was noted that the stiffness of the water-soaked board samples increased with increasing Tenex content. The large variation in Mullen for the same sample can be accounted for by the fact that the samples were small and in some cases water penetrated between the plies of the samples.

We have placed small pieces of each of the above treated boards in an oven at 120° F. and these samples will be tested for Mullen after a week or two storage under these conditions. This test will give some indication as to whether prolonged heating of a board which contains Tenex will cause deterioration of the board due to the acidity of the Tenex.

These results indicate quite conclusively that the higher the Tenex content in the Tenex-wax mixture, the better the weatherproofing results are. From the standpoint of application of the Tenex-wax mixture to the board, it may not be possible to increase the Tenex content too much because longer impregnation times are required for the higher Tenex mixtures.

cej/lhh

PROJECT REPORT FORM

PROJECT NO. 940
COOPERATOR Institute
REPORT NO. 3
DATE May 20, 1943
NOTE BOOK 332
PAGE 136 TO 137
SIGNED C. E. Johnson
C. E. Johnson

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Samples of the .090 inch and .100 inch solid kraft fiber board were received from the Southern Kraft Corporation, Georgetown, South Carolina. These samples were 12 inches by 18 inches in size. The solid kraft board samples were treated in one to one wax tenex mixture at about 210° F. for varying lengths of time. The samples were passed through the hot rolls of the Institute laminating machine immediately after they were removed from the impregnating mixture. The surface of the board was free of wax tenex mixture after one passage through the rolls except at the extreme edges.

The following tables give the retention data and physical tests on these samples after 24-hour water submergence:

TABLE I

Sample	Treating time-min.	Increase in board weight by treatment	Dry Caliper in.
1	0.5	4.1%	.109
2	10.0	10.8%	.109
3	0.5	3.75%	.092
4	--	0.0%	.092
5	--	0.0%	.110

TABLE II

Sample	Water Pickup-%	Caliper in.	Mullen Points	Riehle - lb. In	Across	Beach Puncture Units
1	91.6	.168	516	69	58	138
2	73.0	.159	549	101	76	174
3	90.1	.143	372	72	55	134
4	103.5	.144	319	69	42	115
5	106.1	.169	397	63	53	130

The samples and results of our tests were submitted to Mr. Davis of the Southern Kraft Corporation, Georgetown, South Carolina.

cej/lhh

PROJECT REPORT FORM

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R. E. Williams

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Major attention has been focused on a search for a waterproof glue for sealing weatherproof fiber boxes, and a number of different materials have been tried for this purpose. Other work has been concerned with continued tests of containers for "Graphol", a penetrating lubricant containing graphite, tests of sulfur impregnated fiber board, cold tests of solid fiber boards, and with tests of the resistance of Vinsol and castor oil to gasoline and similar materials. These subjects will be reviewed in detail in the following report.

A. Waterproof Glue for Sealing Weatherproof Fiber Cartons

The method of testing materials in this investigation was a simple trial of brushing the sample on the surface of two flat weatherproof solid fiber board samples, pressing the two coated surfaces together, drying, and testing for bond before and after water immersion. Before the summary of these trials and results, the description of the various boxboards which were used will be given.

Boxboards were from the following types:

1. Tenex-wax (50:50) treated boards
   a) Wisconsin Container Corporation's 750 dry, 500 wet test (48 hour) solid weatherproof fiberboard, made from four 0.025 inch plies laminated with starch plus 10% urea.
   b) Wisconsin Container Corporation's regular starch laminated solid fiber board samples 1,2,3.

2. Regular commercial boards - not Institute treated.
   a) Same board as in 1-a (weatherproof solid fiber board).
   b) Wisconsin Container Corporation's regular silicate

laminated solid fiber board.

c) Bird and Son, Inc. regular solid fiber board.

3. Staybelite - wax (75:25) treated boards - same board as in 1-a but different treatment.

4. Tenex-wax-asphalt (46.5: 46.5: 7.0) treated corrugated fiber carton.

NOTE: All the boxboards above involve no new treatments except 1-b. This series represents a new method of dipping boards in Tenex-wax (50:50) melt and removing excess surface coating by passing through hot rolls. Very good results were obtained by this method; boards were passed through steam heated iron rolls (215° F. surface temperature) four times and all surface excess was removed uniformly. Three similar boxboards were treated thus; one retained 9.1% solids on the final weight basis, the other two, 5.4% and 5.5%. This difference was due to a lower density of the first sample. Five sheets 7 x 12 inches each were sent to Mr. Merrigold of Wisconsin Container Corporation, and another five, to Paisley Products, Inc., Chicago, Illinois, attention of Mr. Earl C. Lenz, from this first sample.

The glue tests are summarized in the following table:

Description of Adhesive	Concentration used*	Type of Board (code above)	Time Pressed min.	Strength of Bond Dry	Strength of Bond Wet(48 hrs.)
Milk Casein dissolved with 15% conc. ammonia	20%	1-a	2-5	Good	Good
		2-a	2-5	Good	
		3	5-1440	Good	Good
Egg Albumin	40%	1-a	5	Poor	-
		2-a	5	Poor	-
		3	5	Poor	-
Cooper's Glue	20%	1-a	5	Fair	-
		2-a	5	Poor	-
		3	5	Good	-
Sodium Silicate	as rec'd.	1-a	5	Good	-
		2-a	5	Poor	-
		3	5	Good	-
Thin Boiling Starch (Stein Hall Co. "Superfilm")	20%	1-a	5	Poor	-
		2-a	5	Poor	-
		3	5	Good	-
Milk Casein dissolved with 15% conc. Ammonia	17%	4	5	Fair	Poor-Fair
Urea-formaldehyde "Urac 132", by American Cyanimid, plus 2% Ammonium chloride	89% (as rec'd.)	1-b-1	2	Good	Good
Urea-formaldehyde "Perkins 100"	as rec'd.	1-b-1	2	Good	Poor

* Wet bond tests after only 24 hour soaking.

Description of Adhesive	Concentration used*	Type of Board (code above)	Time Pressed min.	Strength of Bond Dry	Strength of Bond Wet (48 hrs.)
Urea-formaldehyde "Perkins 100" plus 2% ammonium chloride	96% (as rec'd)	1-b-1	2	Fair-Good	Good
		2-c	2	Good	Good
Waterproof glue "FSCC", Findley Glue Co., Milwaukee	as rec'd.	1-b-1	2	Good	Poor
Milk Casein dissolved with 15% conc. ammonia	17%	1-b-1	2	Fair	Poor
Same as above	13%	1-b-1	2	Fair-Poor	Poor
Milk Casein dissolved with 5% caustic soda	17%	1-b-1	2	Poor	-
Milk Casein dissolved with 15% conc. ammonia, plus carbon tetrachloride	14.2% Casein 16.7% CCl_4	1-b-1	2880	Good	Poor
Rosin size paste	65%	1-b-1	2880	Poor	-
Rosin size paste plus carbon tetrachloride	56.2% Rosin 13.3% CCl_4	1-b	2880	Poor	-
Gum Rosin dissolved with 25% conc. ammonia	50%	1-b-1	2880	Poor	-

* Wet bond tests after only 24 hour soaking.

Description of Adhesive	Concentration used*	Type of Board (code above)	Time Pressed min.	Strength of Bond Dry	Strength of Bond Wet(48 hrs.)
Urea-formaldehyde, "Perkins 100", plus 2% ammonium chloride	90.3%(as rec'd.)	1-b-1	60	Poor-Good	Good
Urea-formaldehyde, "Perkins 100", plus 2% ammonium chloride plus carbon tetrachloride	75.7%(as rec'd) 8.2%(CCl_4)	1-b-1	60	Good	Good
Milk Casein dissolved with 15% conc. ammonia	18%	1-b-1	instant	Good	Good
		1-b-1	5	Good	Poor
		1-b-1	1440	Good	Poor
Same as above	18%	1-b-2	instant	Poor	-
		1-b-2	5	Poor	-
		1-b-2	1440	Poor	-
Same as above	18%	2-b	instant	Good	Poor
		2-b	5	Good	Good
		2-b	1440	Good	Good
Mikah 3250 adhesive, by National Adhesives	85%(as rec'd)	1-a	5	Poor	-
		2-a	5	Good	Poor*
Waterproof Adhesive by National Aniline	85%(as rec'd)	1-a	5	Fair	
		2-a	5	Good	Good*
Glu-Weld c-255 by Findley Glue	90%(as rec'd)	1-a	5	Poor	-
		2-a	5	Good	Good*

* Wet bond tests after only 24 hour soaking.

Description of Adhesive	Concentration used	Type of Board (code above)	Time Pressed min.	Strength of Bond Dry	Strength of Bond Wet(48 Hrs.)
Urea-formaldehyde "Perkins 100" plus 0.2% ammonium chloride	99% (as rec'd)	1-a	5	Good	Good*
Same plus carbon tetrachloride in addition	94% (as rec'd) 5% (CCl_4)	1-a	5	Good	Good*
Same plus more carbon tetrachloride	89% (as rec'd) 10% (CCl_4)	1-a	5	Good	Good*
Same plus more carbon tetrachloride	79% (as rec'd) 20% (CCl_4)	1-a	5	Good	Good*

* Wet bond tests after only 24 hours soaking.

As shown in the table above, casein and urea-formaldehyde solutions gave the best results of all adhesives tested. Casein solutions were effective bonding agents in all cases except one, namely on the Tenex-wax treated board of slightly higher density but lower retention of coating. Other Tenex-wax treated boards and untreated boards were glued satisfactorily with casein solutions, however. The urea-formaldehyde adhesives were consistently good (with only one exception, and in rechecks of that, similar tests showed good results) provided that ammonium chloride was added. The recommended amount of ammonium chloride (2% of the glue weight) was found to be high; one-tenth of that amount (0.2% of the glue weight) was found effective in setting the glue in almost the same time. This subject is covered in greater detail below.

Urea-formaldehyde glue ("Perkins 100") was tested for time required to set, i.e. to "dry", or "harden", in various mixtures with ammonium chloride and carbon tetrachloride. The various mixtures were tested by placing 1/8 inch thick films on pad paper and noting the time for the glue to harden. A table of the composition, setting time, and water solubility of the mixtures is given below.

Urea-formaldehyde Glue Mixture Tests

Composition of Mixture, %				Setting Time Min.	Water Solubility (after set)
Glue	Ammonium Chloride	Water	Carbon Tetrachloride		
100	-	-	-	not set in 2 days	soluble (not set)
94	2	4	-	30	insoluble
78	2	4	16	15	insoluble
99.0	0.2	0.8	-	85	insoluble
96.1	0.8	3.1	-	50	insoluble
90.9	1.8	7.3	-	50	insoluble
99.0	0.2	0.8	-	60	insoluble
94.3	0.2	0.8	4.7	60	insoluble
90.1	0.2	0.7	9.0	70	insoluble
82.5	0.2	0.7	16.6	70	insoluble

Casein adhesive films were tested for water solubility as follows:

a) 15% ammonium hydroxide - 20% casein solution

b) 5% sodium hydroxide - 20% casein solution

The above mixtures were spread into thin films on glass and allowed to air-dry for 10 days. The dry films, about 1 inch square, were placed in 100cc. of water at 25° C. in separate beakers and shaken intermittently by hand The time required for the solution of each was noted.

Results: Time for solution

a) 24-1/2 minutes

b) 13-1/2 minutes

B. Graphol Container Tests

Graphol container tests were continued from the earlier chipboard - Vinsol - castor oil preparations. The results of various drying and storage procedures are reviewed in the following table:

Table of Graphol Container Tests

No.	Type	Drying
1	Chipboard - S.W.L. - Vinsol - castor oil	instant
2	Same as 1 plus greaseproof	instant
3	Same as 1 plus hexone	2 weeks at 120° F.
4	Same as 3 plus greaseproof	2 weeks at 120° F.

(cont'd) Graphol Storage

1	5 days at 80° F., 2 days at 120° F.	-	complete failure
2	7 days at 80° F., 24 days at 120° F.	-	no failure
3	1 day at 80° F.	-	no failure
4	1 day at 80° F.	-	no failure

These tests are being continued.

C. Tests of Sulfur Impregnated Fiber Board.

A sample of sulfur-fiber sheet, 0.030 inch thick, was received from Mr. Heard, Ontonagon Paper Co., Ontonagon, Michigan. Tests were made to determine water, kerosene, and oil resistance as follows:

1. Water Immersion Test

   2 samples 6 x 6 inches, placed in water for 26 hours; weighed to determine water absorption in 4 and 26 hours.

2. Water, Kerosene, and No. 40 Oil Penetration

   2 samples 4 x 4 inches were sealed to glass cylinders by

means of a castor oil - Vinsol - mixture.

The test materials water, kerosene, and No. 40 oil were then added in two cylinders each (kerosene also to a separate set which was coated on the test side with Vinsol-castor oil). The results are summarized in the following table:

Results of Impregnated Sulfur Board Tests

Test Liquid	Test 1	Test 2	Average
water	no visible leak, but 12.5% loss in 3 weeks		
#40 oil	5 days	5 days	5 days
kerosene	45 minutes	45 minutes	45 minutes
kerosene on coated sheet	6 days	5 days	5-1/2 days

Also, acidity and corrosion tests of oil which was in contact with the sulfur impregnated paper for 19 days were carried out, along with similar tests of oil in contact with Vinsol - castor oil mixture and free powdered sulfur. The methods used were from Griffin, "Technical Methods of Analyses", 2nd edition pp. 334-5 McGraw Hill, New York (1927). The results are tabulated below.

Acidity and Corrosion Tests of Treated Oil

Mixture:	150 cc. No. 300 Texas Oil Plus	Mineral Acid*	Total Acid*	Copper Corrosion
1	40 g. sulfur impregnated paper	0.0011	0.0072	strongly corrosive
2	20 g. (2:1) Vinsol-No.4 Castor Oil	0.0037	0.0068	not corrosive
3	--- (Blank) ---	0.0011	0.0034	not corrosive
4	20 g. powdered sulfur	0.0018	0.0038	strongly corrosive

* Figures are in percent H_2SO_4 on oil weight.

D. Cold tests of Solid Fiber Boards

A series of cold storage tests of solid fiber box board was concluded. These tests were made on Wisconsin Container Corporation's 750 dry, 500 wet test weatherproof 0.100 inch board, glued with urea treated (10%) starch, Institute treated and untreated.

The results were:

1. Tenex-wax coated board stored 5 days at 22-32° below zero Centigrade was slightly more brittle than originally, but strong.
2. Tenex-wax coated board stored 12 days at 22-32° below zero Centigrade was also slightly more brittle than originally but strong.
3. Tenex-wax coated board stored 38 days at 22-32° below zero Centigrade and untreated board stored 19 days at 22-32° below Centigrade were tested for cold Mullen strength:

Mullen strength - treated board cold - 755 lb./sq.in. (av.)
untreated board cold- 673 lb./sq.in. (av.)

From the above test results, Institute treated solid fiber boards are concluded to retain very good strength on cold storage (to 32° below zero C.)

E. Tests of Resistance of Vinsol and Castor Oil to Gasoline, etc.

Test tube experiments were conducted to determine the effects of gasoline, petroleum ether, and benzene on Vinsol, castor oil, and Vinsol-castor oil mixtures.

The results, as determined after 24 hours and checked after 21 days, were as follows:

Effects of Petroleum Products on Vinsol, Castor Oil

Petroleum Product:	Gasoline*	Petroleum ether	Benzin
Effect on Vinsol	no discernable effect	slightly colored	slightly colored
Effect on No. 4 castor oil	no discernable effect	no effect	no effect
Effect on Fused (2:1) Vinsol-No. 4 castor oil	no discernable effect	no effect	no effect

* The gasoline was colored a light red when obtained and slight color changes would not be discernable.

From this, castor oil and 2:1 Vinsol-castor oil mixture are indicated to be unaffected by these light petroleum fractions.

Note: Further waterproof glue tests were made in Project 946 (John Strange Paper Co.) and will be reported therein.

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PROJECT REPORT FORM

PROJECT NO. 940
COOPERATOR Institute
REPORT NO. One
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NOTE BOOK 332
PAGE 75 TO 84
SIGNED R. E. Williams
R. E. Williams

The development of improved paper containers was made the object of this project. Work has been continued along lines established under Project 1000, of treating solid fiber boxboards with molten wax-resin mixtures, of incorporating sulfur in kraft sheets, and of treating chipboard for greaseproofness by the use of castor oil-Vinsol mixtures.

I. Boxboard Treatments

A. Wax-Tenex Resin Dip Followed by Oven Storage.

Wisconsin Container Corporation's 750 dry, 500 wet test solid fiber weatherproof board (made from four 0.025-inch plies laminated with 10% urea treated starch) was treated in 50:50 paraffin wax-Tenex resin. Eight 9 by 12-inch samples were dipped 5 seconds each in a molten bath of this mixture at 90-100° C. After dipping, each sample was drained to one corner, allowed to cool, and added to a common stack. This stack of 8 boards was clamped between rigid faces with the undetermined pressure of two "C" clamps, and heated in a 148° F. oven for 23 hours. The resulting samples were uniform, free of excess coating on the surface, and only slightly darker in color than before heating. The sheets were tested for Mullen (bursting) strength before and after 48 hours of water soaking, along with untreated samples. The results are given in the following table.

TEST DATA ON OVEN-CONDITIONED BOXBOARD
TREATED WITH 50:50 WAX-TENEX

Description of Sample	Wax-Tenex Retention, %	Wet Mullen (48-hr. soaked) lb./sq.in.	Water Absorption, % per 48 hr.
Treated, including edges	17.8	487	33.9
Treated, edges trimmed	16.4	492	36.2
Untreated	0	255	51.8

The average dry Mullen of untreated board was 638 lb./sq.in.

B. Wax-Staybelite Dip

The same Wisconsin Container Corporation board that was described in A was given a different treatment also. This involved the use of a 75:25 Staybelite rosin-paraffin wax melt for the dipping bath, and a treatment similar to that of A with the exception of time of dipping (1 minute dips were made in place of 5 second dips as before). The bath temperature was again 90-100° C. No oven treatment was given these boards (6 samples were treated) but two were soaked 48 hours in water, as before. The data on wax-resin retention, water absorption, caliper, and Mullen strength are given in the following table.

TEST DATA ON 75:25 STAYBELITE-WAX TREATED BOXBOARD

Description of Sample	Wax-Rosin Retention, %	Mullen Strength lb./sq.in.	Water Absorption, % per 48 hr.	Caliper, inch
Treated, dry	6.9	671	—	0.100
Treated, soaked 48 hr.	7.1	407(wet)	57.5	0.140(wet)

Also, three pieces of 50:50 Tenex-paraffin treated board from A were placed in a cold chamber at -32° C. One of these pieces was removed January 9, 1943, after 5 days in the chamber, and was found to retain excellent strength and bending properties, but to have slightly weaker bonding of the four plies. Other samples will be examined after longer tests.

Small samples of the stock boxboard were also treated in 67:33 and 75:25 Tenex-wax melts to determine qualitatively the effects of varying Tenex content. Progressively higher viscosities were encountered at the higher Tenex contents at constant temperature (approximately 100° C.), and slightly heavier coatings resulted. However, no difference in the brittleness, color, abrasion resistance, etc., was noticeable in comparing with 50:50 Tenex-wax treated board.

II. Incorporation of Sulfur in Kraft Sheets

A. Impregnation of Kraft Sheets with Molten Sulfur.

Kraft handsheets of varying weight (from 20 to 240 lb. basis weight, approximately) were prepared. Samples of each weight were dipped in molten sulfur at 140° C. The following table gives pertinent data.

SULFUR-IMPREGNATION OF KRAFT HANDSHEETS

Kraft Sheet* Basis Weight	Sulfur Penetration Time, Sec.	Total Sulfur Dip Time, min.	Sulfur in Sheet, %	Caliper, inch
29.3	2	1	67.7	0.004
41.8	2	1	64.8	0.006
55.8	2	1	69.1	0.009
83.8	3	1	65.7	0.012
112.5	5	2	70.1	0.014
132.5	5	2	61.7	0.016
191.0	20	2	62.7	0.025
254.0	30	2	60.8	0.031
336.0	40	2	58.5	0.040

*Basis weight = lb./24" x 36" x 500.

Some of the sulfur-dipped samples and some corresponding untreated kraft handsheets were tested for Mullen bursting strength, both dry and wet (soaked over 48 hours in water), with the following results:

MULLEN STRENGTH OF KRAFT-SULFUR HANDSHEETS

Kraft Sheet Basis Weight*	Untreated Strength Dry, lb./sq.in.	Untreated Strength Wet 48 hr. lb./sq.in.	Sulfur Treated Strength, Wet 48 hr. lb./sq.in.
132.5	94	—	40
254.0	150	19	78

*Basis weight = lb./24" x 36" x 500.

Other kraft-sulfur combinations were produced by mixing sulfur in pulp suspensions and forming the mixture to a pad on a sheet mold. After steam drying, the sheets were pressed at 110 lb./sq.in. for 5 minutes at a 140° C. temperature. In each case, sulfur flowed out of the sheets. Various data for the samples, all of which had the same weight of kraft fiber (fiber equivalent to sheet of 132.5 lb./24" x 36" x 500 basis weight), but a range of sulfur weights are given in the following table.

DATA ON KRAFT-SULFUR HANDSHEETS

Sulfur-Fiber Ratio in Mold	Per cent Sulfur in Sheet Unpressed %	Pressed %	Final Weight lb./24X36X500	Caliper, inch	Mullen Strength Wet 48 hr. lb./sq.in.
6:1	83.0	72.0	499	0.028	49
5:1	79.2	70.9	481	0.027	44
4:1	75.5	69.4	459	0.025	39
3:1	66.5	66.9	422	0.024	38

The Mullen strength (bursting strength) of the 48-hour soaked samples in the above table can be compared to the 94-pound dry blank test on the same fiber weight sheet, and 40 lb. 48-hour soaked impregnated sulfur-kraft sheet test.

III. Chipboard Treatments with Castor Oil-Vinsol Mixtures.

Two types of treated chipboard cylinders were prepared in attempts to develop a greaseproof container for "Graphol," a penetrating lubricant containing graphite. Both types had cylinders of convolutely wound chipboard, six plies laminated with Clarion extract. One of these had an additional inner ply, also bound with Clarion extract, of Thilmany Pulp and Paper Company's greaseproof paper. A sample of each type was sealed and inside coated with 2:1 Vinsol-No. 4 pale castor oil hot melt, and another of each type, with methyl isobutyl ketone-Vinsol-No. 4 pale castor oil mixture. The preparation data are given in the following table:

CHIPBOARD CONTAINERS FOR "GRAPHOL"

1. Six-ply chipboard can; added 32.5% S.W.L., dry basis to laminate; sealed bottom and coated inside with 2:1 Vinsol-No. 4 pale oil mixture at 160° C. (paper can heated to 120° C.). The weight gain was 15.4% over the previous weight.

2. Six-ply chipboard and one ply Thilmany greaseproof; added 27.5% S.W.L., dry basis, to laminate; sealed bottom and coated inside with 2:1 Vinsol-No. 4 pale castor oil mixture at 100° C. The weight gain was 19.8% over the previous weight.

3. Six-ply chipboard; added 32.7% S.W.L., dry basis, to laminate; sealed bottom and coated inside with a mixture of 99 g. of 2:1 Vinsol-No. 4 pale castor oil and 33 cc. of hexone (methyl isobutyl ketone) at 70° C. The weight gain was 12.4% over the previous weight before drying.

4. Six-ply chipboard and one ply Thilmany greaseproof; added 27.7% S.W.L., dry basis, to laminate; sealed bottom and coated inside with a mixture of 99 g. of 2:1 Vinsol-No. 4 pale castor oil and 33 cc. of hexone (methyl isobutyl ketone) at 70° C. The weight gain was 9.7% over the previous weight before drying.

The No. 1 and 2 samples were placed under a "Graphol" storage test at room temperature at 8:00 a.m., January 11, 1943. No sign of failure was evident after several hours; the tests will continue. The No. 3 and 4 samples did not lose the coating agent thinner, hexone, as rapidly as expected, and are now in a 120° F. oven for drying to a solvent-free condition before testing.

DISCUSSION

The tests of boxboard treatments showed greater evidence of practicability inasmuch as oven conditioning following dipping of boards in a hot melt gave good results; also inasmuch as the resin-wax ratio increases had little effect; inasmuch as Staybelite resin was substituted for Tenex resin in the treatments with fair results; and inasmuch as cold storage was not significantly harmful to treated board.

The "Graphol" containers of Vinsol-castor oil-treated chipboard have withstood several hours' test, with longer periods of test to be reported on at a later date.