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MEMORANDUM REPORT NO. M-439

"STRESS CRACKING" OF FURNITURE FINISHES

INTRODUCTION:

There have been a number of complaints recently on the cracking air-dry of Type H "Duco" furniture finishes resulting from a reformulation to use soya bean oil plasticizer instead of the castor oil which was in short supply. This work was undertaken to investigate the relationship between this field experience and certain physical property tests to determine the major factors which influence this cracking.

SUMMARY AND CONCLUSIONS:

1. Air dried soya bean oil modified furniture finishes appear to have an exaggerated tendency to crack when subjected to thermal or mechanical shock. This is attributed to unrelieved film stresses and therefore the term "Stress Cracking" is proposed to describe the resulting phenomena.

2. This cracking tendency may be greatly reduced by short period heat aging. The reason for this is not clearly understood, but apparently some incompatability of nitrocellulose and plasticizer is corrected by heating. The use of the term "annealing" for this process is proposed.

3. Preliminary data indicates that "Stress Cracking" tendency may best be measured by a graph of the maximum film build which will pass a one cycle cold box test vs. the age of the film when tested. A tentative test method is attached to in this report.

4. The conventional "cold crack" test measures the cracking tendency of an annealed finish when subjected to alternate hot and cold cycles. A form of fatigue failure is measured by the number of cycles necessary to cause failure. These preliminary data indicate that "stress crack" resistance may be more significant than conventional cold crack resistance in predicting the field performance of a furniture finish.

5. Previous workers have found that the "Mullen" cold distensibility tests give a satisfactory correlation with field experience on the "cold crack" resistance of annealed finishes. The current difficulties do not invalidate this correlation.

6. Preliminary data indicate that the "Stress Cracking" resistance of both the castor oil and soya bean oil products may be improved by "annealing", but the annealed soya formula remains inferior to the air dried castor oil formula.

7. The experimental work described below is only of a "high spot" nature. It is not intended to serve as an evaluation of any test method, but was done to develop leads which might point to the methods worth evaluating.

EXPERIMENTAL:

Test A. Distensibilities were determined on copper panels as described by R. W. LaBerge in Research Report #1142 and TD-512B-51 except that the 14200 "Duco" was applied by spraying rather than by the pour down method. The topcoat was applied directly to the copper. Panels to be baked were flashed one hour at room temperature, then placed in the Haas oven for 1-1/2 hours at 130°F and 35% RH. Other panels were kept at room temperatures. After aging, the panels were placed in the Mullen Tester at -20°F. for 1-1/2 hours before the test was conducted. Most of the panels cracked before the test was run. These account for the blank places on the data sheet. The age given on the data sheet is the time between spraying and placing in the Mullen Tester.

Test B. Cold tests and mechanical flexing tests were run on mahogany panels. Large 15 x 24 inch panels were prepared with one formula on each half. The panels were stained with VS-4489, wash coated with 1366 "Butacite" sealer, and filled with 27-5017 filler. Half of the panel was then sealed with 2 mils of the soya bean oil type of 19380 sealer while the other half was sealed with the castor oil formula. Topcoat films of varying thicknesses of the two 14200 "Duco" formulae were then built up on top of their respective sealers. The build given on the data sheet refers to the topcoat build. Neither the sealer nor the topcoat was sanded. The topcoat was applied in double passes with 15 minute flash periods between each pair of passes.

The panels were cut into 2 x 12" pieces for testing. Duplicate cold test panels were run in each case. The panels were aged for the period of time specified on the date sheet, then subjected to a one cycle cold test. Sixteen hours at -12°F was used for the 46 and 112 hour old panels while six hours at -19°F was used for the 16 hour old panels (The -12°F cold box was not available). The panels were then brought to room temperature. All cracking occurred with 1-1/2 hour after removal from cold box.

Test C. Preliminary work had shown that cracking of the type observed in the field could be produced by bending a 2 x 12" panel over the corner of the laboratory bench without using any refrigeration equipment. This procedure was followed on a

set of panels identical to the panels subjected to cold crack tests. In general the results of this flexing were in fair agreement with the cold crack tests. It is apparently a crude test which can be used to determine gross differences in cracking resistance.

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CRACKING RESISTANCE OF SYSTEM
19380 SEALER 14200 TOPCOAT

Age	Topcoat Build	Soya Oil System Air-Dried			Soya Oil System Baked			Castor Oil System Air-Dried			Castor Oil System Baked		
		Test A - Cold Distensibility	Test B - Cold Box	Test C - Mechanical Flexing	Test A - Cold Distensibility	Test B - Cold Box	Test C - Mechanical Flexing	Test A - Cold Distensibility	Test B - Cold Box	Test C - Mechanical Flexing	Test A - Cold Distensibility	Test B - Cold Box	Test C - Mechanical Flexing
16hrs	2.6 ± .2	-	C	NC	.0670	C	NC	.0692	1-NC 1-C	NC	.0688	C	NC
	5.5 ± .2	-	C	NC	-	C	NC	.0786	NC	NC	.0682	C	NC
	7.7 ± .2	-	C	NC	-	C	NC	.0697	NC	NC	-	C	NC
	10.2 ± .2	-	C	NC	-	C	NC	-	NC	NC	-	C	NC
46hrs	2.4 ± .1	-	C	C	.0687	C	NC	.0644	NC	NC	.0699	NC	NC
	5.4 ± .1	-	C	C	-	C	NC	-	NC	NC	.0728	NC	NC
	7.4 ± .1	-	C	C	-	C	NC	-	C	NC	-	NC	NC
	10.0 ± .1	-	C	C	-	C	C	-	C	NC	-	NC	NC
137 hrs	2.1 ± .2	.0640	C	C	.0590	C	C	.0669	NC	NC	.0668	NC	NC
	4.2 ± .2	-	C	C	-	C	C	-	C	C	.0660	NC	NC
	6.2 ± .2	-	C	C	-	C	C	-	C	NC	-	1-NC 1-C	NC
	7.5 ± .2	-	C	C	-	C	C	-	C	C	-	1-NC 1-C	C

Explanation:

C = cracked
NC = no cracks
AGE = exact age of cold distensibility panels and approximate age of other panels
Duplicate wooden panels run for cold crack. All duplicates agreed except in the three cases noted.
Range of 95% reliability of distensions is approximately ± .003 inches.