Cross Reference: C-1

Punch Card Index

CC: R. G. Brown, Lab.
R. E. Pike, Lab.

Marshall Laboratory
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MEMORANDUM REPORT NO. 381

"GRAIN CRACK" RESISTANCE OF WOOD FURNITURE FINISHES

Purpose:

A study of the comparative resistance of various types of wood furniture finishes to the film failure known as "grain cracking" has been completed.

Procedure:

Systems set up for study and evaluation were as follows:

Substrate:	8"x24", 5 ply walnut veneer, with grain as uniform as was available.
Wash Coat:	19380 reduced with 36407 1:1.
Filler:	27-5003 air dried overnight
Sealer:	19380 1.0 ± 0.2 mil.
Topcoat:	Representative "Duco" and "Dulux" wood furniture types, and also two competitive finishes.

A control topcoat and a comparison topcoat were included on each panel. Panels were processed with an estimated three-fourths of a mil being removed. This left the films which were to undergo the test at between 2.1 and 2.8 mils.

These panels next were cut in half, with each resulting set containing both the control and the comparison topcoat. One set, 4 days after application of the topcoat, was subjected to cycles of variable humidity consisting of 24 hours at 38% relative humidity and 24 hours at 95% relative humidity, temperature being held constant at 80°F for the entire cycle. The other set was exposed to the air in the laboratory for comparison at the completion of the test. All panels were examined at the end of each cycle and rated on their relative "grain crack" resistance. The test was discontinued at the end of ten cycles because of the

demand for the variable humidity room.

Results:

Test results are listed in Table I, attached. Failure appeared first in the sealer coat, having occurred on every panel by the end of the first complete cycle. Topcoat failure had begun to occur by the end of the sixth cycle. Since the edges of these panels were not sealed in, cracking appeared first in the topcoats at the edges of the panels and then later throughout the entire film. In the ratings in the attached table, edge cracks were disregarded, it being felt that those cracks in the general film itself represented a truer comparison. The degree of cracking varied considerably with grain variations in the veneer, including those of the same piece of veneer on the same panel under the same finish.

The following observations are apparent after a careful consideration of the results in Table I:

1. Under the heading "Cycle of Break Through Topcoat", the differences in the readings for the control and the comparison finishes are not great enough to be clearly significant. Under the heading, "Rating on Relative Degree of Cracking", these differences are even less pronounced and therefore, less significant than in the first column mentioned.

2. On some of the panels, such as panel 3, fairly wide differences in the ratings given on both sections of veneer, a and b, in both columns and for the same finish emphasize the importance of wood variations on both the cycle of failure and the degree of failure. The similar fairly wide variation of the Type "H" 27% solids control finish from panel to panel is additional evidence of this fact. In addition, the method of cutting the veneer originally, before it is glued to the panel, appears to affect the resistance to failure. On some of the panels listed, although not all of them, the a and b sections represent "open-book" veneer, i.e. their faces were adjacent portions of wood in the original uncut log. These might be expected to have the same effect on cracking, although that has not been found to be the case in every instance. Some methods of cutting the veneer apparently press the fibres of the wood on one side more tightly together than before, either by the pressure or by the heat of cutting, or both. Then, whenever such a face is placed upward on a panel, that portion of the veneer causes less cracking than a similar "unpressed" portion.

3. Finishes which are formulated for a higher degree of flexibility do not show clearly significant differences. Panels 4 and 5, for example, were sealed with 19380 Sealer and 1366

Penetrating Primer, respectively, and yet on both panels, failure occurred in the Sealer in the first cycle. Panels 4 and 5 also were topcoated with a modified Type "H" lacquer formulated for a high degree of flexibility, and representing a major change in formulation in this direction, and yet the improvement in cracking resistance over the regular lacquer types is, in general, not a marked one. Type "H", itself, which is considered one of the more flexible lacquers, at least with respect to cold crack resistance, does not show a favorable comparison in this test.

The general impression from the results, then, is that the test, as presently constituted, is not sufficiently refined to give clearly significant differences. Further possibilities to be considered in improving the test might be:

1. Consideration of a more uniform surface than wood itself, such as Masonite, for the comparisons.

2. Use of a greater difference in humidity, such as from 20% to 95% relative humidity.

3. Sealing in of the edges of the panels tested to prevent the early appearance of edge cracks.

4. Aging of the panels for a period of time sufficient to insure solvent escape before running the test.

5. Determination of the effect of film thickness, although this is probably not as critical as in "cold crack" tests.

6. Running the test on a statistical basis because of the large number of variables involved, similar to the approach used in the "cold crack" test.

7. Consideration of the effect of relative permeability of the films to water vapor, a factor which may possibly be quite significant. An approach such as sealing off the back of a finished panel with some material as nearly moistureproof as possible, such as Cellophane, and then sealing off the same finish of another panel in a similar manner and comparing under conditions of variable humidity, might be useful.

8. Comparison of various sealer types alone, since sealers appear to be the weakest point of the system under this test, to ascertain their possible effect on topcoat failure.

Conclusions:

It is concluded that, inasmuch as wood furniture is subject

to numerous cycles of varying humidity during a period of even a year, none of our finishes has a high degree of resistance to "grain cracking". Further, it is concluded that, pending refinement of the test, establishing definite comparative ratings for our types of topcoats should not be attempted.

MARSHALL LABORATORY

J. R. Powers
J. R. POWERS

JRP:hfm
8/31/51-T
8/30/51-R

ATTACH:

TABLE I

"DUCO" AND COMPETITIVE LACQUERS [1]

Panel	Build in Mils Before Processing	Topcoat	Type	Cycle of Break Through Topcoat [2] a	Cycle of Break Through Topcoat b	Rating on Relative Degree of Cracking [8] a	Rating on Relative Degree of Cracking [8] b
1	3.3	14290	"H," Flat, 27% TS	9	10 [3]	9.0	9.5
	3.0	14200	"H," Clear, 27% TS	6	10,OK [3]	9.0	9.5
2	3.5	14500	"H," Clear, 32% TS	6	10,OK	9.0	9.5
	3.3	14200		7	10,OK	8.0	9.5
3	3.3	14201	"H," Clear, 21% TS	6	10,OK	6.0	10.0
	3.2	14200		6	10,OK	6.0	10.0
4	3.0	[4] P-14200-R-81638	"H," Clear, Special, 27% TS	10,OK	10	10.0	9.0
	3.1	14200		10	9	9.5	8.5
5	2.8	[5] P-14200-R-81638	(over 1366 Penetrating Primer)	9	10,OK	6.0	10.0
	2.9	14200		9	10,OK	6.0	10.0
6	3.3	16900	"WE", Clear, 27% TS	10,OK	10,OK	10.0	10.0
	3.2	14200		9.0	10	7.0	10.0
7	3.3	J-16700-A-9717	"D," Clear, 27% TS	10,OK	10,OK	10.0	9.0
	3.1	14200		9	6	8.0	6.0
8	3.3	1759	"A," Clear, 27% TS	10,OK	10,OK	9.5	10.0
	3.0	14200		9	10,OK	9.5	10.0
9	3.1	14000	"F," Clear, 27% TS	7	10	7.5	9
	2.9	14200		8	9	7.5	7
10	3.5	Competitive	Schaeffer Semi-Flat, 21% TS	10,OK	10,OK	10	10
	3.2	14290		6	7	7	8

Panel	Build in Mils Before Processing	Topcoat	Type	Cycle of Break Through Topcoat a	Cycle of Break Through Topcoat b	Rating on Relative Degree of Cracking [8] a	Rating on Relative Degree of Cracking [8] b
11	3.3	Competitive	Lindeman, Flat, 27% TS	6	10	8.0	9.0
	3.3	14290		6	9	6.0	8.0
			"DULUX" FINISHES [6]				
12	3.0	J-RK-X-10528	"A," Clear, 42% TS, Oven-dry	6	7	7.0	9.0
	3.0	RK-5760	"A," Clear, 42% TS, Oven-dry	6	7	7.0	9.0
13	3.0	J-RK-X-10528	Air-dry	7	6	9.5	6.0
	3.0	RK-5760	Air-dry	7	7	9.5	6.0
14	3.6	RF-5700	"A," Flat, 42% TS, Oven-dry	9	6	10.0	7.0
	3.5	RK-5760	Oven-dry	9	6	10.0	7.0
15	3.5	RF-5700	Air-dry	10,OK	7	10.0	7.0
	3.2	RK-5760	Air-dry	10,OK	7	10.0	6.0
16	3.1 [7]	P-RK-R-81629	Special, Clear 38% TS Oven-dry	6	7	6.0	9.0
	3.1	RK-5760	Oven-dry	6	10	9.0	9.0
17	3.1	P-RK-R-81629	Air-dry	10,OK	7	9.5	6.0
	3.1	RK-5760	Air-dry	10,OK	6	9.5	6.0

Note 1: All lacquers were air dried for 48 hrs. before processing and running the test.
Note 2: Headings a and b represent different pieces of veneer which were glued edge to edge to form the panel surface.
Note 3: All cycles marked OK indicate that at that cycle no failure through the topcoat itself had occurred.
Note 4: P-14200-R-81638 is 14200 with 100% of the plasticizer replaced with DOP to give greater flexibility.
Note 5: On panel #5, 1366 Penetrating Primer was the Sealer, on all others 19380 Sealer was used.
Note 6: Oven-dry "Dulux" Finishes were baked 1½ hrs. @ 130°F., air-dry finishes were dried at room temperature for 48 hrs. before processing.

Note 7: P-RK-R-81629 is RK-4707, Synthetic Baking Finish, reduced to 38% TS.
Note 8: The ratings in this column represent relative degree of cracking in the topcoat at the end of the test as follows:

10.0	No cracks in topcoat at end of test.
9.0	Cracks over approximately 30% of the wood pores.
8.0	Cracks over approximately 60% of the wood pores.
7.0	Cracks over 90-100% of the wood pores.
6.0	Cracks over all pores as well as generally between pores.

JRP:aig
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