PYROXYLIN FINISHES FOR AIRCRAFT

(MATERIAL SECTION REPORT)

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PYROXYLIN FINISHES FOR AIRCRAFT

The use of finishes which will require less time for proper application and still produce durability and protection under aircraft service conditions is highly desirable. Pyroxylin finishes have this advantage and therefore warranted an investigation into their practicability for use as protective coatings for airplanes.

Spar varnishes, aircraft enamels, and other relatively slow air-drying paint products have been employed on some of the wood and metal parts of aircraft, primarily for the purpose of protection against corrosion and deterioration. This type of material is objectionable in many cases in that it hampers production by requiring a delay of at least 24 hours between subsequent applications of the coatings. These films likewise do not resist abrasion as well as might be desired. However, any product that could be employed for such a variety of purposes will present disadvantages and the selection of the proper coating is made by weighing the advantages and disadvantages.

PURPOSE

An investigation of several commercial pyroxylin coatings to determine their suitability for use on wood and metal aircraft parts.

CONCLUSIONS

The pyroxylin finishes which show a satisfactory film after atmospheric exposure test on metal for a period of one year can be recommended for use on metal parts of aircraft provided the metal surfaces are sandblasted.

The following finishes are the brands which have been tested and are recommended for use:

I. V. E. P. Co., St. Louis, Mo.:
   - No. 2, V. E. P.—Doesit Putty.
   - No. 2, A. D.—Doesit Primer.
   - V. E. P.—Doesit Surfacer.

II. Egyptian Lacquer Co., New York City:
   - E. G. Wood Lacquer, No. 44-B.
   - E. G. Auto Primer.
   - E. G. Auto Filler.
   - E. G. Thinner, No. 2.
   - E. G. Sublime White Spray Lacquer.

III. Valentine Co., New York City:
   - Valenite Primer, No. 1037.
   - Valenite Surfacer, No. 1051.
   - Valenite Thinner, No. 1012.

IV. Beckwith-Chandler Co., Newark, N. J.:
   - Neolite Primer.
   - Neolite Surfacer.
   - Neolite Malay Brown, Color No. 110
   - Neolite Thinner.

V. Pittsburgh Plate Glass Co., Newark, N. J.:
   - Mimax Putty—ML No. 547.
   - Mimax Primer—ML No. 546.
   - Mimax Surfacer—ML No. 546.
   - Mimax Enamel, Black—ML No. 596.
   - Mimax Thinner—ML No. 533.

VI. Air Drying Auto Black Enamel. No manufacturer given.

VII. Special black baking enamel with carbon black pigment—McCook Field formula.

Various manufacturers responded to the request for samples of pyroxylin coating products by submitting materials recommended by them as primers, putties, surfacers for finishing coatings, and top finishing coats.

The information in regard to the best method of application was supplied with the samples in most cases. The samples received are as follows:

MATERIALS

The following procedures were followed in all cases in which instructions were given, in order to accomplish uniform and at least fair application. Practice panels on various articles were first prepared.
each manufacturer's products the aluminum, steel, and wood panels were simultaneously prepared by spraying. In general, the priming coat was applied to the bare sandpapered wood and sand-blasted metal panels, after which the surfaces were sprayed on. These undercoatings were then followed by three coats of the pyroxylin finishes. The deviations from this scheme of application are given in Table 1.

Three duralumin panels 3 by 9 by 0.087 inches and one tin panel were coated for the water-gasoline, gasoline-benzol, and the bend tests, respectively. These experiments consisted in partly immersing the duralumin specimens in the above media and in bending the tin specimens over a ¾-inch rod after air-drying periods of from one to five days.

Basswood panels were coated and immersed in tap water after previously weighing the specimens. The increase in weight due to water absorption in this test was taken at various intervals up to the time at which the coatings indicated complete failure.

**RESULTS**

A few remarks in regard to the application of the various products tested should be given and are as follows:

**Primers.**—Neolite primer and Egyptian primer cover well without sag. The Mimax and Valenite primers must be handled carefully to prevent sagging. With these latter two it is possible to get a full single coat without sags by spraying rather lightly and going over the panels several times by gradually building up a wet coat.

**Surfacers.**—All of the surfacers cover well without sagging. Mimax and Neolite and Doesit surfacers are ready to spray after thorough mixing. Egyptian and Valenite are heavy pastes requiring approximately two parts of thinner to one part of paste.

**Finishing coats.**—The Egyptian Lacquer and Duco produced the smoothest finishes. Mimax was very rough. Neolite and Valenite would be considered intermediate and fair in regard to smoothness of finish.

Table 1 contains data obtained on the small basswood panels which were partly immersed in water in order to determine the water absorption through the film and resistance of these coatings to this exposure.

**Bend tests.**—When the coated tin panels were bent over a ¾-inch rod after five days air drying all films cracked which contained undercoats as well as the finishing enamel. Valenite without undercoats was the only coating to withstand the bend test. The above results refer only to the pyroxylin finishes.

**Gasoline tests.**—When subjected to gasoline-immersion tests some of these finishes were considerably affected while others hardly at all. Refer to Key for Table 1. Coats Nos. 1, 2, 9, and 10 softened slightly above the gasoline after one hour exposure. After 24 hours' exposure all coats were slightly softened at the gasoline line, Nos. 1 and 2 being most affected.

In 96 hours Duco had softened considerably above the gasoline. Valenite and Egyptian Lacquer softened slightly above the surface of the gasoline, whereas, there were signs of a completion of 96 hour removal and allowed to carefully inspected.

Duco presented a rough appearance; Neolite, Egyptian Lacquer, and Valenite were practically all right; Mimax showed cracks and blisters.

A few general remarks in regard to the condition of the panels under this test which are not covered above can be made. All of the panels showed some softening at removal from the gasoline, Duco the most.

After drying in the air for 24 hours there was still a slight tackiness on all panels. This tackiness was about equal and not considered serious. The Duco panels, however, had run somewhat while soft and left a smearable appearance. All these failures were observed above the fuel level, apparently where the gasoline had crept up, evaporated, and deposited that which it had previously taken into solution from the film.

**Gasoline-benzol tests.**—All panels showed the defect of softening above the fuel level. This is apparently due to the extraction of the part of the vehicle of the enamel and its deposition where the fuel has evaporated. The effect is much more marked than with straight gasoline. Neolite under this test was much the worse, it having peeled almost entirely from the panel. Duco, Mimax, Egyptian Lacquer, and Valenite were not badly affected during this test. On the straight gasoline and the gasoline-benzol tests for 24 hours none of the panels dry back perfectly. There is a considerable amount of soft material extracted from Duco and a tackiness on Valenite and Egyptian Lacquer which remains even after months of air-drying, whereas Mimax and Neolite fail upon drying by checking and peeling.

**Water tests on Duralumin panels.**—In 72 hours these coatings were all right. Results as follows were obtained after seven days partial immersion in water.

- Panel No. 1. Duco with primer and surfacer. O. K.
- Panel No. 2. Duco alone. Very slightly pimpled.
- Panel No. 3. Neolite with primer and surfacer. O. K.
- Panel No. 4. Neolite alone. Very slightly pimpled.
- Panel No. 5. Mimax with primer and surfacer. O. K.
- Panel No. 7. Egyptian lacquer with primer and surfacer. O. K.
- Panel No. 8. Egyptian lacquer alone. Pimpled more than No. 2 and No. 4.

Nos. 1, 3, and 7 were in practically perfect condition after 14 days immersion. The remainder of the specimens showed blistering or peeling at the edges.

Table 2 shows the results which were obtained on outside exposure on wood, duralumin, and steel panels over a period of one year.

Table 3 is a condensation of results obtained on the various laboratory tests made.
Key to Table 1

No. 1. Duco, 3 coats over Doesit primer and surfacer.
No. 2. Duco, 3 coats alone.
No. 3. Neolite, 3 coats over Neolite primer and surfacer.
No. 4. Neolite, 3 coats alone.
No. 5. Mimax, 3 coats over Mimax primer and surfacer.
No. 6. Mimax, 3 coats alone.
No. 7. Egyptian, 3 coats over Egyptian primer and surfacer.
No. 8. Egyptian, 3 coats alone.
No. 9. Valenite, 3 coats over Valenite primer and surfacer.
No. 10. Valenite, 3 coats alone.

DISCUSSION OF RESULTS

Although no great experience was obtained in the application of this type of finish it was noted that there are some difficulties which can only be overcome by a familiarity gained by actually applying the finish. The products from the various manufacturers had characteristics which differed when applied. It is not recommended that these materials be applied with a paintbrush, but that they be worked on to the materials carefully by means of an air brush under methods recommended by the various manufacturers, so that such difficulties as sagging, etc., are not encountered. For example, in the case of several of the finishing coats it was apparent that they were applied by means of the brush at too great a distance from the panel inasmuch as piled panels were obtained.

It was likewise found better to build up with rapid and thin coats to the final wet coat to prevent sagging. Sagging was most pronounced with the primers.

The test which bore out atmospheric exposure on wood to a great extent was the water-immersion test on a small basswood panel. It was determined by this means that water penetrated the films readily and caused a swelling in the underlying wood with subsequently a rapid failure of the protective coating.

As a means of comparison it can be said that the best of these pyroxylin finishes do not even approach the resistance to water penetration that is shown by approved oil enamels.
sand-blasted surfaces of duralumin and steel all of the finishes except one, the Neolite, stood up well for a period of one year and in addition it can be said from appearances that the durability will extend over a considerably longer period. At the time this investigation was begun panels which were not sand-blasted were not employed inasmuch as it was only intended to determine in a preliminary way the relative durability of this type of finish against approved aircraft enamel. Sand-blasting was done on the strength of reports that it was exceedingly difficult to obtain good results with pyroxylin finishes unless great care was taken in the preparation of surfaces so as to insure the best possible bond. Information in regard to the durability of sand-blasted surfaces should.

It is to be understood that these tests were not extensive enough to furnish complete information in regard to the practicability of using these finishes for all purposes in connection with aircraft. The matter of using pyroxylin on fabric-covered surfaces such as the wings can not be definitely approved or disapproved on the strength of results of this project, but with the knowledge obtained it is believed such tests can be accelerated.

Table 3 has been included in order to facilitate readily reference to results obtained on laboratory tests.
**TABLE 2.—Outside Exposures**

<table>
<thead>
<tr>
<th>Panel No.</th>
<th>Coats were—</th>
<th>Manufacturers were—</th>
<th>Material coated</th>
<th>Time between coats</th>
<th>Results under exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Wood...</td>
<td>1 Glidden rubbing varnish</td>
<td>Glidden Co.</td>
<td>Wood</td>
<td>24 hours</td>
<td>Edge-fail</td>
</tr>
<tr>
<td></td>
<td>1 No. 2 A. D. Doesit</td>
<td>Du Pont de Nemours</td>
<td>Steel</td>
<td>1 hour</td>
<td>O. K.</td>
</tr>
<tr>
<td>1. Steel...</td>
<td>3 Duco</td>
<td>Do</td>
<td>Steel</td>
<td>1 hour</td>
<td>O. K.</td>
</tr>
<tr>
<td>1. Aluminum</td>
<td>do</td>
<td>do</td>
<td>Aluminum</td>
<td>1 hour</td>
<td>O. K.</td>
</tr>
<tr>
<td>2. Wood...</td>
<td>No. 2 A. D. Doesit Primer</td>
<td>V. E. P. Co., St. Louis</td>
<td>Wood</td>
<td>24 hours</td>
<td>Fail-edge</td>
</tr>
<tr>
<td>2. Steel...</td>
<td>No. 2 A. D. Doesit Surfacer</td>
<td>do</td>
<td>Steel</td>
<td>1 hour</td>
<td>O. K.</td>
</tr>
<tr>
<td>2. Aluminum</td>
<td>do</td>
<td>do</td>
<td>Aluminum</td>
<td>1 hour</td>
<td>O. K.</td>
</tr>
<tr>
<td>3. Wood...</td>
<td>Neolite Primer</td>
<td>Beckwith-Chandler Co.</td>
<td>Wood</td>
<td>24 hours</td>
<td>Fail badly</td>
</tr>
<tr>
<td>3. Steel...</td>
<td>Malay Brown No. 110</td>
<td>do</td>
<td>Steel</td>
<td>1 hour</td>
<td>O. K.</td>
</tr>
<tr>
<td>3. Aluminum</td>
<td>do</td>
<td>do</td>
<td>Aluminum</td>
<td>1 hour</td>
<td>O. K.</td>
</tr>
<tr>
<td>4. Wood...</td>
<td>Mimax Primer</td>
<td>Pittsburgh Plate Glass Co.</td>
<td>Wood</td>
<td>24 hours</td>
<td>Fail badly</td>
</tr>
<tr>
<td>4. Steel...</td>
<td>Mimax Surfacer</td>
<td>do</td>
<td>Steel</td>
<td>1 hour</td>
<td>O. K.</td>
</tr>
<tr>
<td>4. Aluminum</td>
<td>do</td>
<td>do</td>
<td>Aluminum</td>
<td>1 hour</td>
<td>O. K.</td>
</tr>
<tr>
<td>5. Wood...</td>
<td>Auto primer</td>
<td>Egyptian Lacquer Co.</td>
<td>Wood</td>
<td>24 hours</td>
<td>O. K.</td>
</tr>
<tr>
<td>5. Steel...</td>
<td>Auto filler</td>
<td>do</td>
<td>Steel</td>
<td>1 hour</td>
<td>O. K.</td>
</tr>
<tr>
<td>5. Aluminum</td>
<td>3 Light Beige No. 822</td>
<td>do</td>
<td>Aluminum</td>
<td>1 hour</td>
<td>O. K.</td>
</tr>
<tr>
<td>6. Wood...</td>
<td>1 Valenite Primer</td>
<td>Valentine &amp; Co.</td>
<td>Wood</td>
<td>24 hours</td>
<td>Slight failure-edge</td>
</tr>
<tr>
<td>6. Steel...</td>
<td>1 Valenite Surfacer</td>
<td>do</td>
<td>Steel</td>
<td>1 hour</td>
<td>O. K.</td>
</tr>
<tr>
<td>6. Aluminum</td>
<td>3 Enamel (black)</td>
<td>do</td>
<td>Aluminum</td>
<td>1 hour</td>
<td>O. K.</td>
</tr>
<tr>
<td>7. Wood...</td>
<td>Valspar black auto coat</td>
<td>do</td>
<td>Wood</td>
<td>24 hours</td>
<td>O. K.</td>
</tr>
<tr>
<td>7. Steel...</td>
<td>Zimmerman enamel</td>
<td>do</td>
<td>Steel</td>
<td>3 hours</td>
<td>O. K.</td>
</tr>
</tbody>
</table>

Results under exposure after exposure

- All Films on Wood Failed at this time
- Rubbing brings
- Good condition
- Same as 183
- Same as 183 for Du.
- Chalking, Rubs off
- Rather heavy
- Checked
- Badly dulled—no checks or cracks

- Results under exposure after 66 days
- Results under exposure after 110 days
- Results under exposure after 125 days
- Results under exposure after 135 days
- Results under exposure after 200 days
- Results under exposure after 266 days

- 362
### Table 3: Tests on pyroxylin enamel

<table>
<thead>
<tr>
<th>Name</th>
<th>Bend test and results on tin panels undercoats</th>
<th>Cold water on duralumin undercoats</th>
<th>Cold water on wood undercoats</th>
<th>Gasoline on duralumin undercoats with and without</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duco—Du Pont</td>
<td>Failed</td>
<td>3 days, O.K.</td>
<td>Failed, 2 days</td>
<td>1 hour, softened; 24 hours, softened; 96 hours, softened considerably above the fuel line. Does not dry completely.</td>
</tr>
<tr>
<td>Neolite—Reck-will-Chandler</td>
<td>do</td>
<td>3 days, O.K.</td>
<td>Failed, 1 day</td>
<td>1 hour, O.K.; 24 hours, O.K.; 96 hours, softened. Dries out practically O.K. Slight thickness.</td>
</tr>
<tr>
<td>Minax—Pittsburgh Plate Glass Co.</td>
<td>do</td>
<td>3 days, O.K.</td>
<td>do</td>
<td>1 hour O.K.; 24 hours, O.K.; 96 hours, softened. Checks and cracks when dried.</td>
</tr>
<tr>
<td>Egyptian—Egyptian Lacquer Co.</td>
<td>do</td>
<td>3 days, O.K.</td>
<td>21 days, O.K.</td>
<td>1 hour, O.K.; 24 hours, slight softening (more). Dries practically O.K. (Slight tackiness).</td>
</tr>
<tr>
<td>Valenite—Valentine &amp; Co.</td>
<td>O.K.</td>
<td>3 days, O.K.</td>
<td>21 days, O.K.</td>
<td>1 hour, O.K.; 24 hours, softening: 96 hours (more). Dries (same as Egyptian) practically O.K.</td>
</tr>
</tbody>
</table>

- **With** indicates the presence of an undercoat, **Without** indicates no undercoat.
- Results are based on visual inspection after specified periods.
- Gasoline tests were not employed in the evaluation of this type of enamel. Sandblasting of the metal was not done.