EXPOSURE TESTS OF SURFACE-TREATED SAWN COCONUT TIMBER

R.N. Palomar[1], P. Jensen [2] and V.K. Sulc[2]

ABSTRACT

An investigation was made to determine the relative performance of three readily available inorganic chemicals containing either copper or chromium when applied singly or in combination to sawn coconut timber surfaces. The treating solutions, consisting of chromic acid (H_2CrO_4) sodium chromate (Na_2CrO_4) and copper sulphate ($CuSO_4$), were applied by trush to wood surfaces with one coating at the rate of approximately 155 grams per square meter. The specimens were exposed outdoors on racks inclined at 450 angle and facing south.

Results after 3 years of test showed that treatments with mixture of H_2CrO_4 and $CuSO_4$ or combination of Na_2CrO_4 and CO_4 performed better than single application of either H_2Cr_4 or Na_2CrO_4. The former treatments still showed uniform and pleasing appearance after the exposure period.

INTRODUCTION

Current trends to incorporate natural beauty in the design of modern buildings have lead to great interest in the use of natural finishes of wood to show its fine texture and grain. The natural effect may be achieved by permitting the wood to weather fully without protection, by treating the surface with water-repellent preservatives or by applying natural varnishes.

Untreated sawn coconut timber, particularly the soft portion, would weather very easily when used in exterior walls resulting to unsightly dark gray appearance. This is mainly attributed to the accumulation of fungal spores and mycelium on the surface of the wood during exposure to the weather. In addition, weathered wood acquires a surface roughness characterized by a degradation and loosening of surface fibres.

Several approaches have been used in attempting to develop acceptable natural finishes of wood. The application of preservatives or natural varnishes into the wood undoubtedly produces attractive natural finishes. But these clear finishes could not effectively protect the exposed wood alone from weathering for a considerable number of years due to Dhoto-oxidation process or ultra-violet irradiation from the sun. Photo-oxidation causes deterioration of the wood surface whereby the coating loses its adhesion. (Black and Mraz, 1974).

As a result of this problem, trials on clear finishes of wood at the Forest Research Institute, New Zealand (Preston, 1977) showed that acid-copperchromate and ammoniacal-copper-chromate are the best pre-treatments although sodium dichromate, ammonium chromate and various other copper and chromiumcontaining solutions also showed promising results.

On the other hand, Black and Mraz (1974) reported that the performance of natural finishes on wood exposed outdoors was vastly improved by treatment of wood surfaces with inorganic chemicals. The treatments that effectively protect the wood surface from photo-degradation include ammonium chromate, ammonium copper-chromate, ammonium copper-chromearsenate, cupriethylene diamine, copper molybdate and copper ferricyanide.

[1] Chief, Timber Utilization Division, PCA-Zamboanga Research Centre, P.O. Box. 356, Zarnboanga City, Philippines.
[2] Consultants, UNDP/FAO Coconut Research and Development Project, Philippines.

Likewise, Feist and Ellis (1977) found out that the use of chromic acid was effective in improving the weathering resistance of wood as well as increasing the durability of varnishes and paints applied over the treated wood.

Treatment of wood surfaces with aqueous solutions of inorganic salts containing copper and chromium was explored as a low-cost exterior natural finish (Feist and Ellis, 1977 and Black and Mraz, 1974). The benefits derived from using these chemicals include among others the following: (a) impart resistance of wood to degradation caused by natural weathering or ultra-violet irradiation from the sun, (b) increase water repellency in wood, (c) provide a degree of fungal resistance to the wood surface, (d) improve durability of finishes on wood, and (e) serve adequately as natural exterior finishes.

This study examined the effectiveness of three readily available inorganic chemicals containing either copper or chromium applied singly or in combination to sawn coconut timber surfaces for retention of original colour and protection from degradation/fungal infection exposed outdoors for a period of three years.

MATERIAL AND METHODS

The specimens used in this study were composed of high and medium density sawn coconut lumber. Forty five pieces of each density group, measuring 25 mm thick x 100 mm wide and 850 mm long, were air-dried to equilibrium moisture content (17% M.C.). After drying, each material was machined to form smooth surface with final thickness and width of 21 mm and 87 mm, respectively.

The treating solutions were applied by brush to the wood surfaces with only one coating at the rate of approximately 155 grams per square meter. The specimens were then air-dried and conditioned for one week at room temperature to allow the treating solutions to diffuse and fix effectively into the surface fibres. However, no effort was made to determine the depth of penetration of any of the treatments.

The study was composed of nine (9) treatments replicated five times. Each treated specimen was mounted on a test rack, 90 centimeters high, and exposed outdoor at 450 angle and facing south of the PCA-ZRC graveyard.

The composition of the treating solutions for the treatments used in the study is presented in Table 1.

The specimens were evaluated after three years of outdoor exposure for retention of original colour and protection of wood surfaces from degradation and fungal infection. Assessment was made based on the percentage ratings presenteld as, follows:

Table 1: Composition of the Treating Solutions

Treatment No.	COMPONENTS (grams)					Molar[1]	Elemental[2] Ratio Solid(%)
	Chromic Acid (H_2CrO_4)	Sodium Chromate ($Na_2CrO_4.4H_2O$)	Copper Sulphate ($CuSO_4.5H_2O$)	Ammonium Hydroxide (NH_4OH) 30%	Water (H_2O)		
1.	9.6	-	-	-	90.4	-	5
2.	4.8	-	-	-	95.2	-	2.5
3.	5.1	-	10.8	-	84.1	1:1	5

4.	5.1	-	10.8	22.0	62.1	1:1	5
5.	-	22.5	-	-	77.5	-	5
6.	-	10.1	10.8	22.0	57.1	1:1	5
7.	-	11.2	-	-	88.8	-	2.5
8.	-	10.1	10.8	-	79.1	1:1	5
9.	Control						

1/ Molar ration of copper : chromium.
2/ Combined weights of copper and chromium.

Retention of original colourlappearance

1. No significant change in appearance/colour 100
2. Slight deviation from the original cleanliness and colour but appearance still-remains uniform and pleasing 75
3. Moderate change in appearance and need for refinishing 50
4. Marked deviation from the original appearance with displeasing colour 25

Protection of wood surface from degradation/fungal infection

1. No significant weathering of wood surface 100
2. Slight softening of the surface fibers and brittle when probed resulting to a-fiberglass, cork-like nature of wood surface 75
3. Moderate softening of surface fibres to about 1/4 of an inch 50
4. Deep softening with slight erosion of the surface fibres 25

The Duncan's Multiple Range Test was used to compare the mean performance efficiencies of the different surface treatments.

RESULTS AND DISCUSSION

One of the recognized causes of wood deterioration when used as exterior siding and weather-boards for building is weathering due to the absorption of ultra-violet energy from the sun. The protection of wood surfaces from ultra-violet light by impregnating the wood with effective chemical is a technique which could hold great promise as a durable natural finish.

Three inorganic chemicals containing copper and chromium were applied singly or in combination by brushing to coconut wood surfaces and their performance was evaluated after 3 years of outdoor exposure. The result of assessment after this duration is presented in Table 2. The mean performance rating of the individual treatment is shown in Figure l for both high and medium density timber.

The evaluation of the dif ferent treatments as a natural exterior finishing system involved primarily two factors, namely; retention of colour/appearance and resistance to degradation/fungal infection.

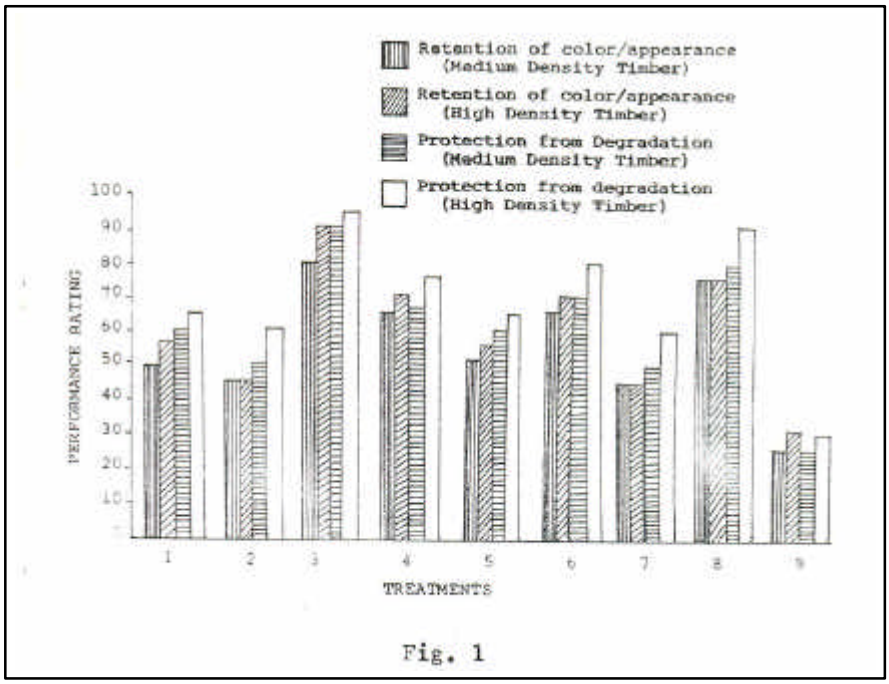

Fig. 1

Table 2: Result of Final Assessment of Brush-coated Chemicals Containing Copper and Chromium Applied to Sawn Coconut Timber Specimens After 36 months of Outdor Exposure[1]

Treatment	Elemental Solid 2/ (%)	Retention of colour/ Appearance 3/		Protection from Degradation 3/	
		Medium Density	High Density	Medium Density	High Density
1. H_2Cr_4	5	50^{bc}	55^{bc}	60^{bc}	65^{bc}
2. H_2CrO_4	2.5	45^{c}	45^{c}	50^{c}	60^{c}
3. $H_2CrO_4 + CuSO_4$	5	80^{a}	90^{a}	90^{a}	95^{a}
4. $H_2CrO_4 + CuSO_4 + NH_4OH$	5	65^{ab}	70^{ab}	65^{abc}	75^{abc}
5. Na_2CrO_4	5	50^{bc}	55^{bc}	60^{bc}	65^{bc}
6. $Na_2CrO_4 + CuSO_4 + NH_4OH$	5	65^{ab}	70^{ab}	70^{bc}	80^{bc}
7. Na_2CrO_4	2.5	45^{c}	45^{c}	50^{c}	60^{c}
8. $Na_2CrO_4 + CuSO_4$	5	75^{a}	75^{a}	80^{ab}	90^{ab}
9. Control	-	25^{d}	30^{d}	25^{d}	30^{d}

Retention of Colour/Appearance

The appearance, colour and colour retention of the specimens were markedly dependent on the treatments employed. Prior to exposure the specimens treated with chemicals containing copper and chromium (T_3 and T_8) were generally of greenish-brown in colour while the addition of NH_4OH (T_4 and T_6) were initially very unattractive which showed blackish-brown colour due to precipitated salts on the surface of the wood. Likewise, the ones treated with chemicals containing only chromium (T_I, T_2, T_5 and T_7) showed light to dark brown colour.

In the early stages of weathering T_4 and T_6 improved in colour uniformity and appearance while T_1, T_2, T_5 and T_7 slowly became less attractive as degradation proceeded. On the other hand, T3 and T_8 still produced attractive and uniform greenish-brown colour.

The effect of various surface treatments on the appearance of sawn coconut lumber exposed outdoor is illustrated in Figures 2 and 3.

After 36 months of exposure to natural weather conditions, the promising treatments appeared to be a mixture of H_2CrO_4 + $CuSO_4$ (T_3) and Na_2CrO_4 – $CuSO_4$ (T_8). These treatments, even if initially witfi greenish-brown, gradually changed to a more natural brown colour. The addition of NH_4OH (T_4 and T_6) to the aforementioned treatments, which were originally blackish-brown colour, turned to a uniform and pleasing dark brown colour.

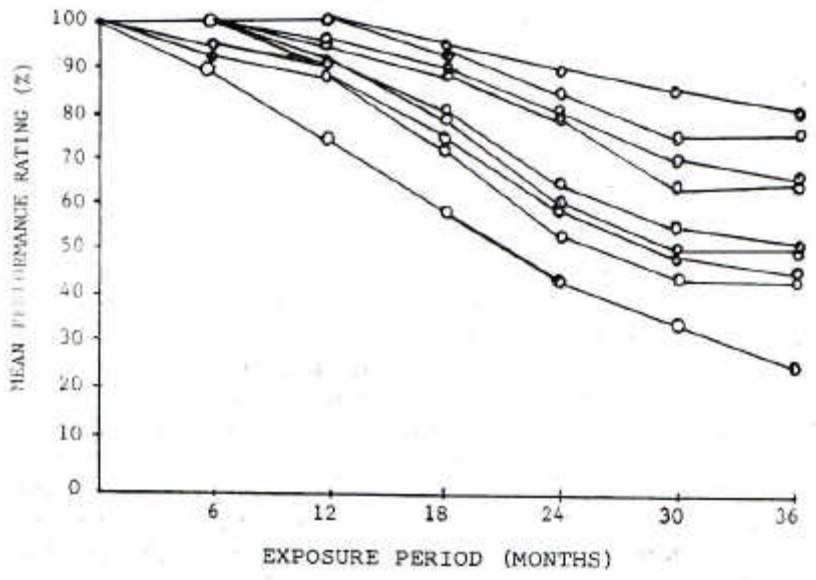

Figure 2. Effect of various surface treatments on the appearance of medium density sawn coconut lumber exposed outdoor for 36 mounths.

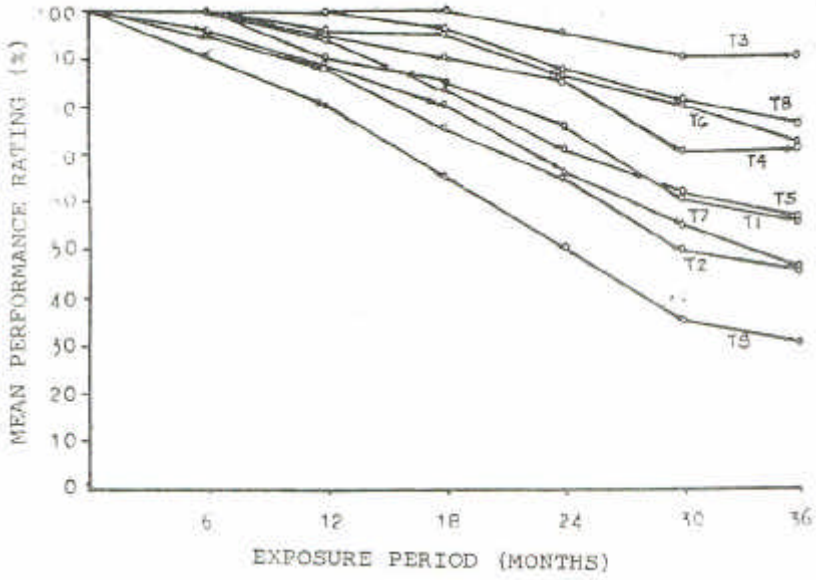

Figure 3. Effect of various surface treatments on the appearance of high density sawn coconut lumber exposed outdoor for 36 mounths.

The treatments with either H_2CrO_4 or Na_2CrO_3 (T_1, T_2, T_5 and T_7) although initially with light to dark brown colour, shortly changed to displeasing greenishgray colour. The change in colour occurred more rapidly on the medium density than on high density timber. The gray appearance maybe due to the accumulation of fungal spores and mycelium on the surface of the wood.

The untreated specimens totally turned from brown to blotchy dark gray appearance and were significantly inferior than the treated ones.

Resistance to degradation/fungal infection

The treatments most resistant to weathering were the mixture of H_2CrO_4 + $CuSO_4$ and Na_2CrO_4+ $CuSO_4$ with or without the addition of NH_4OH. Li4kewise, these treatments showed very good resistance to fungal growth. The major factor contributing to this performance was the presence of copper and chromium to the specimens which provided considerable protection from attack of fungi and at the same time gave permanence to the treatment. The application of either H_2CrO_4 or Na_2CrO_4 to the specimens indicated that the presence of chromium alone resulted to low resistance from weathering and fungal attack. On the other hand, the untreated ones markedly degraded faster than the treated specimens.

The ability of the chemicals employed to effectively provide resistance to weathering depends largely on the permanence, of the treatment. As reflected in Figures 4 and 5 there existed a widely varying rates of degradation among the different treatments used. In addition, the period wherein the treatments ceased to give acceptable quality could be readily determined from these figures.

In general, the performance of treated medium density coconut timber was slightly inferior than the hard density. This suggests that the density of coconut timber is an important factor in the selection of construction materials for exterior use.

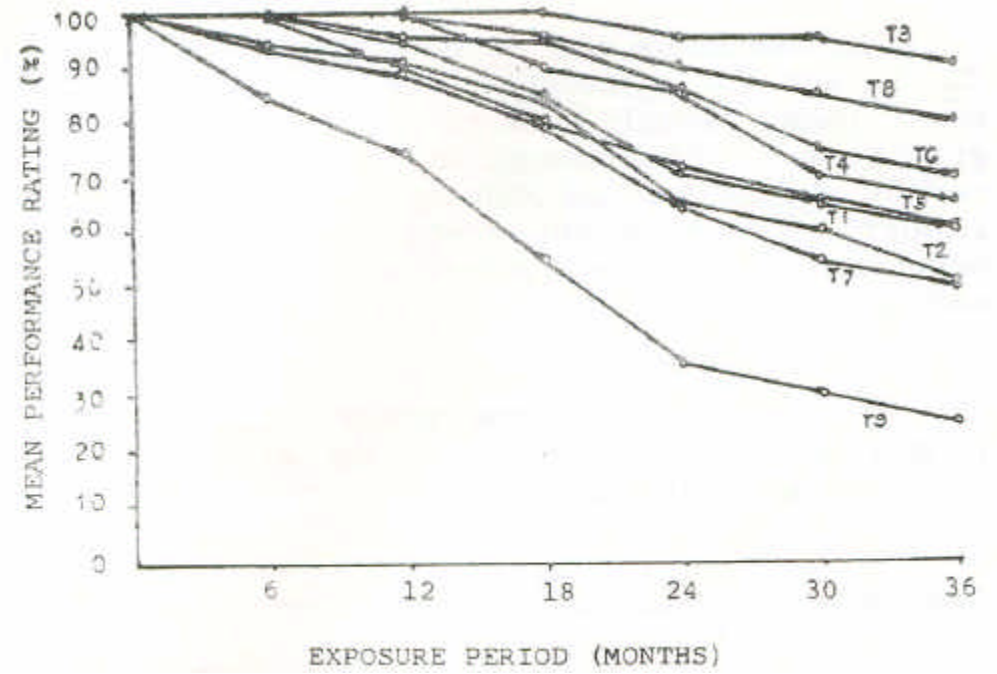

Figure 4. Effect of various surface treatments on the degradation of medium density sawn coconut lumber exposed outdoor for 36 mounths.

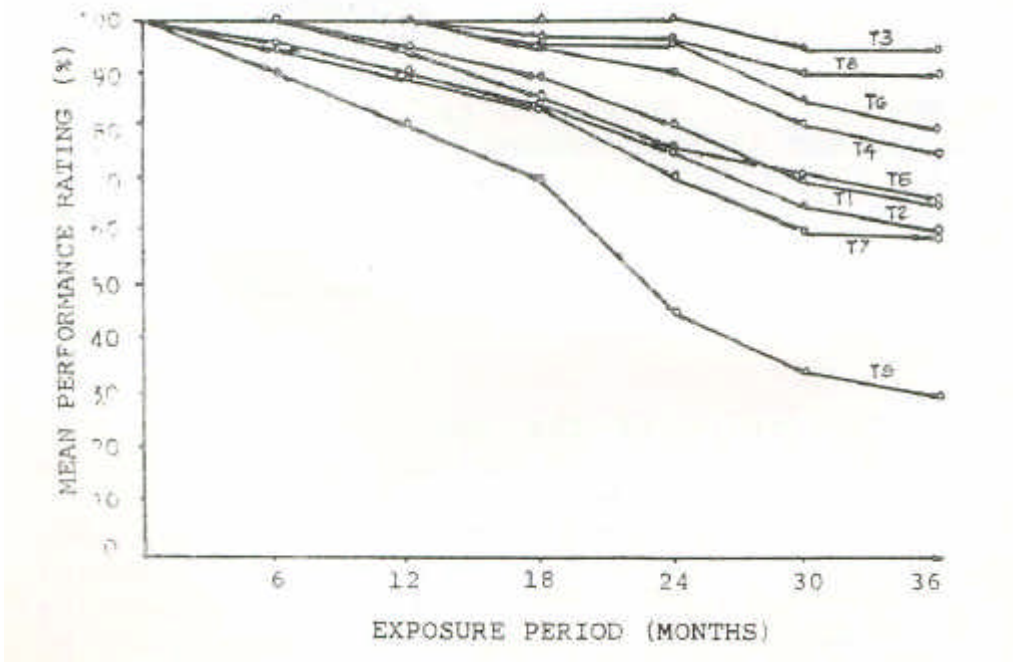

Figure 5. Effect of various surface treatments on the degredation of high density sawn coconut lumber exposed outdoor for 36 mounths.

Figure 6. A general view of the exposure site at PCA-ZRC graveyard.

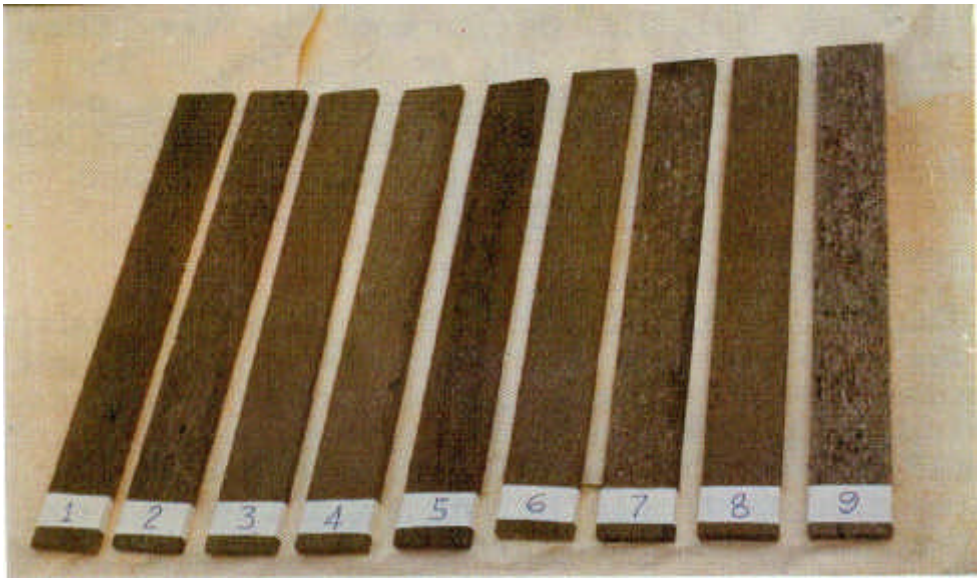

Figure 7. Appearance of representative sample after 36 mounths of outdoor exposure. The number labled in each sample board represents the treatment employed in the tests.

CONCLUSION AND RECOMMENDATIONS

The performance of three inorganic chemicals applied singly or in combination to coconut wood surfaces by brushing was evaluated after 36 months, of outdoor exposure. Results showed that, within the scope of the test, the treatments with the use of H_2Cr0_4 + $CuSO_4$ and Na_2Cr0_4 + $CuS0_4$ with or without the addition of NH_40H performed better than the application of either H_2CrO_4 or Na_2Cr0_4. The former treatments almost gave the specimens complete protection from degradation and still showed uniform and pleasing appearance after the exposure period.

Due to their fungal and weathering resistance, aqueous solutions of inorganic salts of copper and chromium (H_2CrO_4 + $CuSO_4$ and Na_2CrO_4 + $CuSO_4$) could be adopted as a low-cost exterior natural finish for coconut wood. The result of this study has great implication particularly for such uses as exterior walling and weatherboards for low-cost housing project.

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