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# COPPER-CHROME-ARSENIC DISTRIBUTION IN SELECTED MALAYSIAN TIMBERS AFTER FULL CELL PROCESS

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**SALAMAH SELAMAT & ZAITUN SAID. 1991. Copper-chrome-arsenic distribution in selected Malaysian timbers after full cell process.** The amount of CCA preservatives absorbed by wood samples of five Malaysian non-durable timbers after the completion of vacuum pressure treatment was found to be 78, 83 and 89% (w/w) for copper, chromium and arsenic respectively. The strength of the solution dropped from 3.0 to 0.73% (w/v) after the treatment. The chemical concentration of each element also varied according to the depth of the timber.

Key words: CCA - vacuum pressure treatment - individual salt content - treatment solution - treated timbers

## Introduction

The Malaysian Standard MS 360 requires that all non-durable timbers for exterior and some interior uses (MTIB 1981) be treated with copper-chrome-arsenic (CCA) preservative by full cell process (SIRIM 1986). In CCA wood preservative, chromium is a fixation agent for copper and arsenic in the wood (Richardson 1978). Therefore, the treated wood having a big proportion of copper (Suzuki *et al.* 1981) or arsenic compound (Richardson 1978) generally tends to leach out the respective compounds. Hence, the component balance of the individual salts in CCA preservative is very important in the chemical fixation after penetration into the wood. In order to ensure maximum fixation, the toxic elements in CCA preservative should be present at the following proportion of 46% $CrO_3$, 17% CuO and 38% $As_2O_3$ (Richardson 1978).

Generally, wood preservation companies, when dealing with mixed hardwoods, treat them in one charge. Since the permeability of each species to preservative varies, the proportion of chemicals left in the treatment solution after the treatment is very much different (SIRIM 1986). However, there are no data available for local timbers on the proportions of chemical uptake of preservative after pressure or nonpressure treatments and the amounts of individual chemicals left. This study was initiated to determine the effect of permeability of selected local timbers on the uptake ratio of individual compounds in CCA preservative and the distribution of individual compounds at different depths of wood. The amount of chemicals remaining in the treatment solution after the treatment was also determined.

## Materials and method

### *Sample preparation*

Five non-durable Malaysian timbers namely kempas, keruing, mempisang, geronggang and pulai were selected for this study based on their strength and treatability properties as shown in Table 1. All of them have medium to very large vessels (Menon 1967, Wong 1982). The wood samples, free from sapwood and any defect, were cut into size of 8 × 8 × 30 *cm*. Eight replicates of each timber were epoxy end-coated. Their moisture content (M.C.) was controlled below 25% at air dry weight. The density was determined for each wood and used in retention calculations (SIRIM 1983).

**Table 1.** Properties of the wood species studied

| Type of wood | Density classification* | Strength group* | Treatability** |
|---|---|---|---|
| Kempas | Medium hardwood | A | Easy |
| Keruing | Medium hardwood | A & B | Easy |
| Mempisang | Light hardwood | B & C | Very easy |
| Geronggang | Light hardwood | D | Very easy |
| Pulai | Light hardwood | D | Very easy |

Note: *Wong 1980, **SIRIM 1986

### *Preservative solution*

CCA treatment solution of Type 1 with the concentration of about 3% (w/v) was used in this study.

### *Full cell process*

The capacity of the treatment plant cylinder used in this study was about 0.19 $m^3$. The test samples were treated in one charge according to the following schedule:

| | | |
|---|---|---|
| Initial vacuum | : | 635 *mm* Hg |
| Vacuum period | : | 1.75 *h* |
| Pressure | : | 10.55 $kg\ cm^{-2}$ |
| Pressure period | : | 2.5 *h* |
| Final vacuum | : | 635 *mm* Hg |
| Vacuum period | : | 20 *min* |

All specimens were air dried for two weeks before the depth of penetration was measured. The zone of penetration by the preservative on the cross-cut surface of each section was confirmed by spraying with Chrome Azurol-S reagent (Anonymous 1980). Penetrated and unpenetrated zones were determined by the appearance of royal blue and red brown colours respectively after five minutes treatment with this reagent.

### *Quantitative analysis*

The quantitative analysis used in this study was based on dry salt retention (D.S.R) determination as recommended by the Malaysian Standard MS 821 (SIRIM 1983).

## Results and discussion

The concentrations of copper, chromium and arsenic in the treatment solutions before and after treatment are shown in Table 2. The amount of each element absorbed by the wood samples in relation to that in the original solution after full cell process was 78.0, 83.1 and 88.9% (w/w) for copper, chromium and arsenic respectively. The high chemical absorption by the various type of woods during the treatment reduced the solution strength in the treatment solution by nearly 76% . The results also show that the ratio of the salts in the treatment solution was totally changed before and after treatment. However, the ratio of individual salts in CCA preservative is very important in the chemical fixation after penetration into the wood (Richardson 1978, Suzuki *et al.* 1981). Therefore, more CCA is needed to increase the solution strength before the next treatment could be carried out to comply with the Malaysian Standard MS 733:1981 requirements (SIRIM 1981). It has been recommended that no more than three charges of treatment be used commercially before adding freshly made up CCA (Norton personal communication).

**Table 2.** The amounts of copper, chromium and arsenic in the treatment solution before and after treatment determined by atomic absorption spectrometer (AAS)

| | The amount of element in the 1 *ml* solution ($\mu g$) | | | The percentage of salts in the treatment solution (w/v) | | | Solution strength (% w/v) |
|---|---|---|---|---|---|---|---|
| | Cu | Cr | As | $CuSO_4.5H_20$ | $K_2Cr_2O_7$ | $As_2O_3.2H_2O$ | |
| Before treatment (BT) ($\times 10^3$) | 2.657 | 4.910 | 5.073 | 0.94 | 1.25 | 0.81 | 3.0 |
| After treatment (AT) ($\times 10^2$) | 5.713 | 8.296 | 5.631 | 0.17 | 0.25 | 0.31 | 0.73 |

The chemical loading and dry salt retention in the treated wood after this treatment were dependent on wood density as shown in Table 3. The amount of chemicals absorbed by the wood was lower for higher wood density, except for geronggang. The amount of each salt at various depths in the treated woods (Figure 1) shows that the absorption rate for each salt was totally different for each timber. Kempas absorbed more arsenic up to the core of the sample compared to mempisang even though the chemical loading in the latter wood was higher. The same behaviour was also shown for copper and chromium at more than 2 *cm* depths. This phenomenon shows that the salt ratio in the various depth of wood can vary from one timber to another.

**Table 3.** The amount of dry salt retention in the wood (at the first 1 *cm* layer) and the result of penetration test using Chrome Azurol-S reagent

| Wood | Density ($kg\ m^{3}$) | D.S.R. ($kg\ m^{3}$) | M.C.* (% w/w) | Penetration test** pattern | colour |
|---|---|---|---|---|---|
| Keruing | 794 | 5.5 | 20.3 | dispersed | heavy |
| Kempas | 784 | 6.9 | 21.1 | complete | heavy |
| Mempisang | 735 | 8.7 | 19.8 | complete | heavy |
| Pulai | 490 | 12.5 | 16.5 | complete | heavy |
| Geronggang | 445 | 4.1 | 18.3 | uneven | heavy |

Note: *based on oven dried weight, **Salamah & Habibah 1990

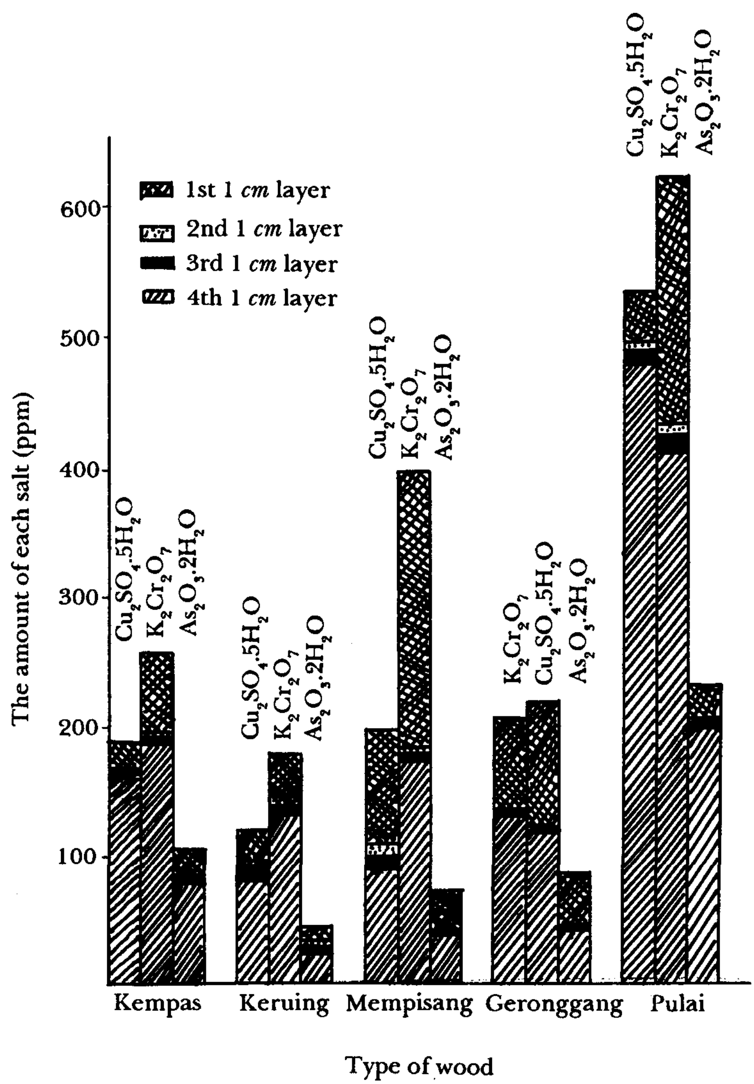


**Figure 1.** The CCA distribution as $Cu_2SO_4.5H_2O$, $K_2Cr_2O_7$ and $As_2O_3.2H_2O$ at various depths in the wood after full cell process

Figure 1 also shows that, the amount of the individual salts in the outer layer of each treated wood was higher than those in the inner layer after treatment. However, there was no marked difference in the salt content among the inner layers. The high amount of salt in the first layer was mainly due to the close contact with the higher preservative concentration in the treatment solution. On the other hand, the lower salt content in the inner layers may be due to the wood surface acting as a barrier for the preservative penetration.

The degree of chemical loading also depends very much on the make-up and cell structures of the wood as the cell walls are not smooth but pitted. These pits offer access to the cells in the movement of fluids and play an important role in absorption, transpiration, translocation and secretion (Greaves 1974, Lim 1984). In addition, the presence of extractives and other organic materials can also seriously affect the penetration of preservatives into the wood. Thus, low chemical loading in the geronggang samples might have been due to the presence of tyloses in the vessels which can block the chemical movement (Menon 1967).

## Conclusion

Chemical analysis is obviously a very important tool in determining the quality of treated wood and treatment solution. This is especially so when mixed timbers are treated at the same time. The results from this analysis can confirm whether treated timbers and the chemical used in the treatment follow the standard specifications as recommended for different classes of timber products by the local government. At the same time, the anatomical structures of the woods to be treated should be considered before any treatment can be carried out to ensure a high quality of treated timber.

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