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Pressure Treatment of Fresh and Ponded *Heritiera minor* (Roxb.) Logs with Chromated Copper Arsenate (CCA)

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ABSTRAK

Sundri (Heritiera minor *Roxb.*) *adalah spesies kayu keras yang mempamerkan kualiti kekuatan yang baik. Ia mempunyai potensi sebagai tiang elektrik, tetapi jangka hayat khidmatnya yang pendek menimbulkan masalah. Kajian ini menguji sama ada rawatan dengan pengawet Kuprum Arsenat berkromat, atau 'Chromated Copper Arsenate' (CCA) melalui cara tekanan penuh-sel pada 15.40 – 16.10 kg/cm² selama 8 jam, boleh memanjangkan jangka hayat khidmatnya. Sampel ujian adalah kayu segar dan kayu rendaman, kira-kira 1 m panjang dengan lilitan jejari 0.25 m. Keputusan menunjukkan nilai purata kemasukan ialah 23.84% lilitan jejari untuk spesimen segar dan 32.29% untuk rendaman. Walau bagaimanapun, kedua-dua sampel masih tidak melepasi nilai piawai kemasukan, iaitu 44% lilitan jejari kayu. Hanya nilai kesimpanan pengawet untuk kayu rendaman sahaja dengan nilai dalam lingkungan 20 kg/cm², yang mencapai nilai piawai berasaskan bahan oksida kering. Dengan itu, rawatan melalui tekanan sel-penuh mampu memanjangkan jangka hayat khidmat* H. minor *pada kadar yang terhad iaitu kayu rendaman memberi rangsang balas yang lebih memberangsangkan untuk rawatan dengan pengawet.*

ABSTRACT

Sundri (Heritiera minor *Roxb.*) *is a hardwood species which exhibits good strength qualities. They have potential for use as electric poles but their short service life posed a problem. This study examined whether treatment with the preservative Chromated Copper Arsenate (CCA) by full cell pressure method at 15.40 – 16.10 kg/cm² for 8 hours could extend their service life. The samples tested were processed fresh and ponded* H. minor *logs of approximately 1 m length and 0.25 m diameter. Results showed that that the preservative treatment gave a mean penetration value of 23.84% log radius for fresh specimens and 32.29% for ponded logs, which were short of the standard requirement of 44% log radius penetration. The preservative retention of ponded logs was within the acceptable standard values of 20 kg/cm² of dry oxide basis, but that of fresh logs did not meet the standard requirement. Thus, the full pressure treatment can extend the service life of* H. minor *to a certain extent in which ponded logs gave encouraging response to the preservative treatment.*

INTRODUCTION

The application of chemical preservatives to wooden electric poles is a routine exercise in countries such as USA, Finland, Philippines, Norway, Canada and Bangladesh. The advantage of using wooden poles for electrification is its low cost. In his studies, Finntrepo (1987) showed that the cost of one wooden pole is 2 to 5 times lower than that of a traditional steel or concrete pole. The availability of competitively priced wooden poles would also mean that more countries, particularly the developing nations, can now afford to supply vast areas with power sources. Apart from its low cost, wooden poles are easier to handle in terms of transportation as well as for erecting and climbing purposes. They are non-conductive and can easily be re-cut for conversion if the need arises.

As with most developing countries, electrical supply in Bangladesh is mainly confined to the urban and semi-urban areas. To supply electricity to the rural areas, which makes up a major portion of the country, the importation of wooden poles for rural electrification purposes was endorsed. However, this was later found to be ineffective in the long run because improperly-treated poles generally deteriorated within a few years' installation, resulting in a high replacement frequency. Thus, research on wood preservation is very essential as properly-treated poles can extend the service life to at least 40 more years (Hunt and Garratt 1953). Presently, 65 to 75 % of the total local demand for poles was met as imported commodities. It is thus timely that the use of properly-treated woods be sourced from within the country as this could prove to be a more cost-effective move besides creating employment for the local community.

Sundri (*Heritiera minor* Roxb.) is a mangrove species, abundantly found in the Sundarban forests and coastal areas of Bangladesh. It constitutes about 74.2 % of the total mangrove population in the Sundarbans (Satter and Bhattacharjee 1987). It is a moderate to large-sized evergreen tree, attaining an average girth of 60 to 120 cm and a height of 12 to 15 m. Currently, they are mainly used as anchor and stabilizer logs. According to estimates, about 50,000 sundri poles could be extracted annually from the Sundarban forests (Latif 1965). Sundri woods exhibit very good strength properties but when untreated, woods are prone to decay in a very short period. Latif *et al.* (1989) found that the average service life of fresh, untreated sundri wood in graveyard tests was only 18 months.

As a hardwood species, sundri logs are also very difficult to impregnate with preservatives. Nevertheless, several options are still available to the researcher when experimenting with chemical preservatives, based on the Book of Standards (1986) of the American Wood Preserver's Association (AWPA). Logs to be used as electric poles fall under Commodity Standards C1-86 of the AWPA (1986). Under this category, several types of preservatives were recommended, one of which was of 'waterborne preservatives' (Standard P5) which has given excellent service with products that are clean and paintable. Of the preservatives listed, chromated copper arsenate (CCA Type C oxide formulations) was selected for use in this study. Thus, all procedures undertaken were in accordance with American Wood Preservers Association (AWPA) standard P5–86, sections 6 and 9.

The present investigation undertakes to determine whether CCA could be impregnated in sundri logs using 5.5% CCA by full cell pressure method. The efficacy is measured based on the ability of the preservative's penetration and retention within the samples. For effective penetration, the standard requirement is a minimum of 44% penetration of the log radius and 100% of sapwood. For effective retention, the standard requirement is that the pressure in the specified assay zones should not be less than 20 kg/cm^2 for logs with sapwood thickness of between 0.01 to 1.3 cm (Anon 1992).

MATERIALS AND METHODS

Source of Log Samples

Two types of samples, namely fresh and ponded logs were used in this study. Fresh logs for the production of anchor and stabilizer logs were collected from the Sundarban mangrove forests by the Bangladesh Forest Industries Development Corporation (BFIDC) at Khulna. Ponded samples consisted of logs that had been submerged for at least 3 years for the local use of the Cabinet Manufacturing Plant (CMP). A total of 20 pieces each of fresh and ponded logs were collected and cut to sizes ranging from 1.0–1.20 m in length and 0.2 to 0.3 m in diameter with each being conditioned prior to treatment. Conditioning was done by drying the logs to 13–25% moisture content at 3.80 cm depth from the log surface, in a steam-heated kiln.

Source of Preservative

The preservative selected was 5.5% Chromated Copper Arsenate, a waterborne preservative, whose preparation follows Standard P5 as stipulated by the American Wood Preservers' Association (AWPA). The active ingredients of each of the CCA component were 47.5% chromium oxide (CrO_3), 18.5% cupric oxide (CuO) and 34% arsenic oxide (As_2O_5) respectively.

Full-cell Pressure Treatment

Based on previous undertakings, the protocol selected for this study was by the Bethell method or full-cell pressure treatment, which recommended a 5.0 to 5.5% concentration of

CCA applied at 14.0 to16.15 kg/cm^2 of pressure, for 6 to 8 hours. Thus, after conditioning, both log types were treated with 5.5% CCA at a pressure of 15.44 to 16.14 kg/cm^2 for 8 hours.

The treatment cylinder into which the preservative was filled measured 2.0 m in diameter and 11.5 m in length. It was equipped with an initial and final vacuum pump. Impregnation pressure was applied by a pressing pump for liquid pressure.

Measurement of Preservative Penetration and Retention

After treatment, a total of 40 bore samples of 0.2 m diameter were extracted up to a depth of 5.0 m from both types of logs. The preservative retention of each of the CCA components was determined as kg/cm^2 of CrO_3, CuO and As_2O_5 respectively, of samples taken from treatment zones 0.0 to 1.3 cm, 1.3 cm to 2.5 cm, 2.5 cm to 3.8 and 3.8 to 5.0 cm of the outermost to the inner depths of samples.

Penetration of CCA was measured by using chromazurol solution (a Copper indicator) as described in AWPA-A3-84 Book of Standards (AWPA 1984). CCA retention was measured by using X-ray spectroscopy (Asoma Instrument) as indicated in AWPA-A9-86 Standard (AWPA 1986).

RESULTS

CCA Penetration

The overall CCA penetration was found to be 2.10 (± 1.34) cm or 23.84% radius for fresh logs and 2.80 (± 0.68) cm or 32.29% radius for ponded logs. Although both samples showed that chemical penetration was higher for ponded logs, neither sample type actually met the standard requirement, which was a minimum of 44% or 3.8 cm penetration of log radii. The readings obtained were lower than the standard requirement by 20.16% and 11.71% for fresh and ponded logs, respectively (Table 1). In addition, 25% of the fresh logs showed irregular chemical penetration in the outer zone. This irregularity was absent in ponded logs (Table 2).

CCA Retention

The mean preservative retention of fresh *Heritiera* logs was 8.68 kg/cm^2, which was well below the

TABLE 1
CCA penetration in treated *H. minor* logs

	Fresh Logs	Ponded Logs
Mean radius of logs (cm)	8.78 ± 0.63	8.68 ± 0.50
Mean penetration (cm)	2.10 ± 1.34	2.80 ± 0.68
percentage of radius	23.84 %	32.29 %
No. of irregular penetration in bore samples	10/40	None
Remarks on chemical penetration:	20.16% lower than standard requirement.	11.71% lower than standard requirement.

* ± denotes standard deviation.

TABLE 2
CCA retention (kg/cm^2) in *H. minor* logs

Depth of zone (cm)	Fresh Logs				Ponded Logs			
	CrO_3	CuO	As_2O_5	Total	CrO_3	CuO	As_2O_5	Total
0.00 – 1.3	9.63	3.00	4.89	17.53	16.38	5.39	8.81	30.59
1.3 – 2.5	4.68	1.65	2.06	8.36	11.05	4.13	5.58	20.75
2.5 – 3.8	3.99	1.15	1.42	6.32	7.47	2.80	3.40	13.69
3.8 – 5.0	1.34	0.49	0.67	2.51	4.38	1.80	2.00	8.19

standard requirement of 20 kg/cm². The retention readings too could not meet the 10 % contingency range of 18.0 kg/cm² up to 21.6 kg/cm² of the standard requirement limits allowable during the time of inspection of the material.

For ponded *Heritiera* logs, the retention values of the 2 outermost sampling zones was within the standard requirements. The assay zones of 0.00-1.3 cm and 1.3-2.5 cm gave retention values of 30.59 kg/cm² and 20.75 kg/cm² respectively. This was in excess of the standard requirement by 10.59 kg/cm² and 0.75 kg/cm² respectively. The overall mean retention value of 18.31 kg/cm² was also within the standard requirement, exceeding slightly the 18.0 kg/cm² contingency limit of 10% allowed at time of inspection.

DISCUSSION AND CONCLUSION

Studies have shown that wooden poles are more cost-effective than concrete poles for electrification. Although wooden poles are used in Bangladesh, they are all resourced as imported materials. *Heriteria minor* or 'sundri' is a local hardwood species found in abundance and they offer a good alternative for electric poles. Its only drawback is that it is prone to decay. Thus, studies on proper preservative treatment are necessary in order to extend its service life. Latif *et al.* (1982) used oilborne preservatives on sundri poles and found them to be ineffective. Subsequent studies by Ilias and Kabir (1994) also showed poor preservative penetration and retention by sundri, resulting in very poor service life after treatment. This study used CCA as a waterborne preservative and found that a treatment schedule of 15.40 – 16.14 kg/cm² for 8 hours may extend the service life to a certain extent compared to non-treated poles.

The preservative penetration readings were better for ponded logs compared to fresh ones, but neither sample actually met the standard requirements set by the AWPA. The preservative retention of fresh logs too could not be accepted, but the mean retention value of 18.31 kg/cm² for ponded logs was within the accepted range of the standard requirement. This study shows that unlike the fresh samples, ponded logs gave regular chemical penetration and good retention properties. Further studies should be carried out to upgrade the penetrability of the preservative before ponded logs can be recommended as electric poles. The results obtained may give direction towards better choice of chemicals or its mode of treatment. Thus, more studies should be carried out in order to find the most effective method in the treatment of sundri poles.

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