EFFECT OF MOISTURE CONTENT ON PRESERVATIVE RETENTION IN SAWN TIMBER

SING-LAI CHONG
New Zealand Forest Service, Utilisation Development Division, Auckland

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ABSTRACT

Samples of radiata pine (**Pinus radiata** D. Don) sapwood at six moisture content levels from 25% to 50% were treated with a proprietary copper-chrome-arsenate preservative at concentrations of 2% and 4%. Simple linear regressions of preservative retention on moisture content were highly significant.

The claim that timber with moisture content greater than 30% can be treated to obtain adequate retention to meet Timber Preservation Authority standards is conditionally supported, but is probably not practical in commercial plants.

INTRODUCTION

The New Zealand Timber Preservation Authority (T.P.A.) requires that wood of *Pinus* species to be treated by vacuum pressure impregnation must not have moisture content greater than 30%. Some preservation plant operators have contended that they could obtain adequate retentions in timber of higher moisture content.

The purpose of this investigation was to determine the effect of moisture content on the retention of copper-chrome-arsenate wood preservative in radiata pine sapwood treated by the vacuum pressure method. From the results, the practicability and economic aspects of treating wood with higher moisture contents than those specified by T.P.A. were considered.

MATERIALS AND METHODS

Preparation and Treatment of Samples

Fifty pieces of freshly-sawn radiata pine sapwood, 4.3 m × 50 × 25 mm, were assembled for air drying. Five closely matched samples were placed at representative positions within the stack to monitor drying progress. Ends of all the boards and samples were sealed.

Once the moisture content of the stack reached around 50%, a 610 mm length was accurately cut from one end of each board, after first discarding 150 mm. Care was taken to avoid any knots and other defects so as to produce "clear" samples for treatment. Cross sections 25 mm thick were taken from the ends of the sample for moisture content determination by oven-drying. The newly-sawn ends of the boards and the samples were sealed. After end sealing, the samples were immediately wrapped in 0.2 mm polythene sheet. Samples were again taken and wrapped when the moisture level of the stack was reduced to around 40% and 30% respectively. Each time a biscuit was taken from each end for moisture content determination. Twenty-five samples for each initial moisture level (i.e. 30%, 40% and 50%) were withdrawn from each wrapped stack. They were individually weighed immediately for moisture content checking. From known moisture content, each sample was then assigned to the appropriate category, i.e., 25%, 30%, 35%, 40%, 45% and 50%, within ± 2%. They were then randomly distributed through a charge, with 7-12 replicates for each moisture content category.

Two successive charges were treated according to the normal vacuum pressure treatment schedule, using the experimental treatment cylinder in the School of Forestry, University of Canterbury, Christchurch.

In order to eliminate the effect of wood density on retention, samples chosen were of uniform basic density.

Retention and Penetration Determination

After treatment, the samples were weighed again individually as soon as the surplus preservative had drained. The difference between the weights of individual specimens before and after treatment was taken as a measure of the liquid absorption and preservative retention. The net dry salt retention of each sample and the mean of each moisture group was computed.

The degree of preservative penetration was assessed by the rubeanic acid spot test for five treated samples at each moisture level.

For three samples at each moisture level, the Cu, Cr and As in the core of the sample were determined by X-ray spectrometer.

Analysis of Results

The data were analysed statistically to determine the amount of variation in preservative retention at each moisture level, and also to investigate the relationship between preservative retention and moisture content, by means of linear regression analysis.

RESULTS

Mean values for preservative retentions obtained by the weighing method are given in Table 1.

TABLE 1—Preservative salt retentions (kg/m^3, dry weight) for wood at various moisture levels treated with 2% and 4% preservative solution

	2% solution			4% solution		
Moisture Level	No. of Samples	Mean Retention	Standard Deviation	No. of Samples	Mean Retention	Standard Deviation
25	11	13.3	0.4	11	24.3	2.1
30	12	12.1	0.6	12	21.1	1.8
35	10	11.2	1.2	8	19.8	1.9
40	10	9.4	1.1	11	17.2	2.9
45	9	7.1	1.4	7	16.2	1.8
50	9	5.5	1.4	9	12.2	2.6

The simple linear regressions of preservative retention (Y) on moisture content (X) were statistically significant at the 1% level for both the 2% and 4% treatments. The equations are as follows:

Cu-Cr-As Solution	r value	Degrees of Freedom	Regression Equation	$SE(b_1)$
2%	—0.93*	60	$Y = 21.4 - 0.400X$	0.016
4%	—0.87*	57	$Y = 33.7 - 0.405X$	0.031

(* signifies significant at 1% level)

All samples chosen for spot testing using rubeanic acid were adequately and evenly penetrated.

Results for core analysis, calculated as net dry salt retention (kg/m^3) for a basic density of 400 kg/m^3, were as follows (standard deviations in brackets):

Moisture Content	25%	30%	35%	40%	45%	50%
2% solution	11.8 (0.2)	11.3 (0.5)	9.2 (0.2)	8.2 (0.1)	7.4 (1.8)	7.1 (0.6)
4% solution	31.9 (2.6)	28.8 (0.4)	26.3 (0.6)	20.1 (1.6)	20.7 (2.3)	14.6 (2.2)

DISCUSSION

Effect of Moisture Content and Solution Strength

The correlation coefficients were —0.93 and —0.87 for samples of different moisture contents treated with 2% and 4% solution respectively. The negative values indicate that the preservative retention is inversely proportional to the moisture content and there is a strong linear association between the two variables. The range of preservative retention for each moisture level, however, increases with an increase in moisture content (Table 1).

From the rubeanic acid spot test, distribution of preservative was in general very even. Wood of moisture content up to 50% can therefore be treated without failing to meet the current requirements of the T.P.A. with regard to sapwood penetration. Nevertheless we should not overlook the possible penetration problem if greater dimensions of sawn timber or posts are treated.

By doubling the solution strength, the average cross section loadings of each moisture level were nearly doubled (Table 1). However, if greater dimensions of sawn timber or posts were treated, increasing the solution strength might have less effect on retention in the cores than was the case in this experiment.

Provided that there were no penetration problems, timber of high moisture content could be treated to achieve the necessary retention to meet the T.P.A. specifications by increasing the solution strength.

Economic Aspects

Although the "oscillating" and "alternating" pressure methods of treatment have been approved by the T.P.A., the capital outlay required to convert the conventional vacuum pressure cylinder is excessive for the medium and small plants. For these the cost of initial drying to below 30% M.C. is quite an important item. It involves the operating cost of drying from green to a suitable moisture content for pressure treatment, the tying up of capital and the need for ground space.

Thus, a method based on this study seems to hold some promise for decreasing drying time and operating costs and the final product could well be quite satisfactory if adequate quality control is undertaken. An added advantage of this method is that the shorter drying time increases output of treated timber. A further advantage is that the risk of attack from mould, sapstain and wood-decaying fungi, particularly of timber in large sizes, could be lessened. Furthermore, Kininmonth (1958) found that the retarded drying of treated timber is due primarily to pit aspiration arising during pre-treatment drying to below fibre saturation point. It is expected, therefore, that with semi-green timber, pit aspiration is less.

Despite these attractions, there are disadvantages inherent in the method. Because the variation in moisture content is likely to be high in part dry material the operator would have the difficult taks of determining the maximum moisture content of any piece within a charge and adjusting his solution strength accordingly. This would result in the majority of pieces being over-treated and would add to the preservative salt cost.

Quality Control

It is clear that closer quality control would be necessary if timber with moisture content greater than 30% was to be treated. Plant operators would need to thoroughly understand the behaviour of moisture in wood and wood preservation in general. In particular, the implications of treating timber at moisture contents above fibre-saturation point should be understood. The solution strength required to meet the mean retention of the charge for a specified moisture content would have to be known and carefully adhered to. It is important for the quality control officer or plant operator to know the limits within which acceptable treatment results are obtained, otherwise the method is not warranted if rejects are too many and retreatments are necessary.

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