

Uptake of Organic Solvent Preservative by Plantation Grown Lodgepole Pine

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Introduction

By tradition, redwood and tropical hardwood are used in Ireland in the manufacture of external joinery products such as windows. During the late 1980s an increased availability of Irish grown lodgepole pine has created an awareness of the potential value added end-use of this species in the joinery product market. The increased availability is only recent and information is required on the properties of this plantation grown pine species.

In the effective use of lodgepole pine in joinery, such as windows, durability is a crucial factor in the acceptance of the material. The sapwood of lodgepole pine has, like other redwood species, very limited durability and is susceptible to decay (Anon. 1979, 1985). Modern silvicultural practices result in plantation grown redwood timber containing a large proportion of sapwood. When untreated external redwood joinery components containing sapwood are put into service, decay is likely to set in within five years. In timber products such as windows, such a short lifetime is not acceptable. However, the fungicidal and insecticidal action of a preservative treatment in external redwood joinery components can ensure a lifetime of up to 60 years (BS 5589: 1978).

Information on the preservative treatability is essential for the successful application of Irish lodgepole pine in the manufacture of external joinery. At present no data are available on the preservative uptake and retention properties of plantation grown lodgepole pine from North-West European origin. The Lodgepole Pine Taskforce (Evertsen, 1989) was set up to investigate technical properties of Irish plantation grown lodgepole pine. The work reported on here is part of the Taskforce programme.

Various methods of wood preservation are available. In the case of external joinery, the use of organic solvent based chemical formulations, applied

by the Double Vacuum Process, is the most widely used in Ireland (Cahill, 1989). While preservative treatment of timber adds value to the product, cost is incurred by the operating company. This cost is closely and directly related to the volume of preservative solution absorbed. Hence, minimal uptake for optimum wood protection is a constant objective. Excessive absorption is both unnecessary and costly. Furthermore, it can lead to problems of 'bleeding' in service, with subsequent damage to surface coating and surrounding plasterwork.

The objectives of this study were:

1. To measure the volumetric uptake of organic solvent preservative by plantation grown Irish lodgepole pine.
2. To determine the retention (loading) of the active fungicidal ingredient bis(tri-n-butyltin)oxide (TBTO) in the preservative solution used.

Materials and Methods

In this study, two pine species were used, Irish plantation grown lodgepole pine (*Pinus contorta*), and Swedish Red Deal (*Pinus sylvestris*). Joinery sized sections of both species were evaluated for the uptake of organic solvent based preservatives. A Double Vacuum redwood schedule, currently used for the treatment of imported Red Deal joinery, was applied. Throughout the study, imported Red Deal was used as control material.

The lodgepole pine was obtained from a stand of Yield Class 14 in Kilworth Forest, Co. Tipperary with an average of 9 rings/25mm. Logs were converted into 4.2m boards of 67mm in thickness at the Coillte Teoranta sawmill, Dundrum, Co. Tipperary. All sawn timber was stick-ered and air-dried to 17% moisture content. The Swedish Scots pine was obtained as a random 1 cubic metre parcel of unsorted grades (brand: "Crown CRN Crown")¹, from a local importer. The boards in this parcel showed an average of 17 rings/25mm.

A total of 50 samples were prepared for each species. The experimental samples were cut and planed to sections of 1.20m x 60mm x 73mm which are typical joinery stock sizes (IS 63, 1984). Each sample was selected to contain a minimum of 25% of both sapwood and heartwood. This criterion was confirmed by using a specific sapwood/heartwood stain on both ends of each sample (BS 5666, 1980).

All samples were treated in the research sized "Protim Pre-Vac"² Double Vacuum plant at Eolas (Fig. 1). To compute preservative uptake, samples were weighed, both pre- and post-treatment. Two preservation runs (charges) were required to accommodate the 100 samples. Each run comprised of 25 lodgepole pine and 25 Scots pine samples. The treatment schedule used was a standard Redwood schedule (Table 1).

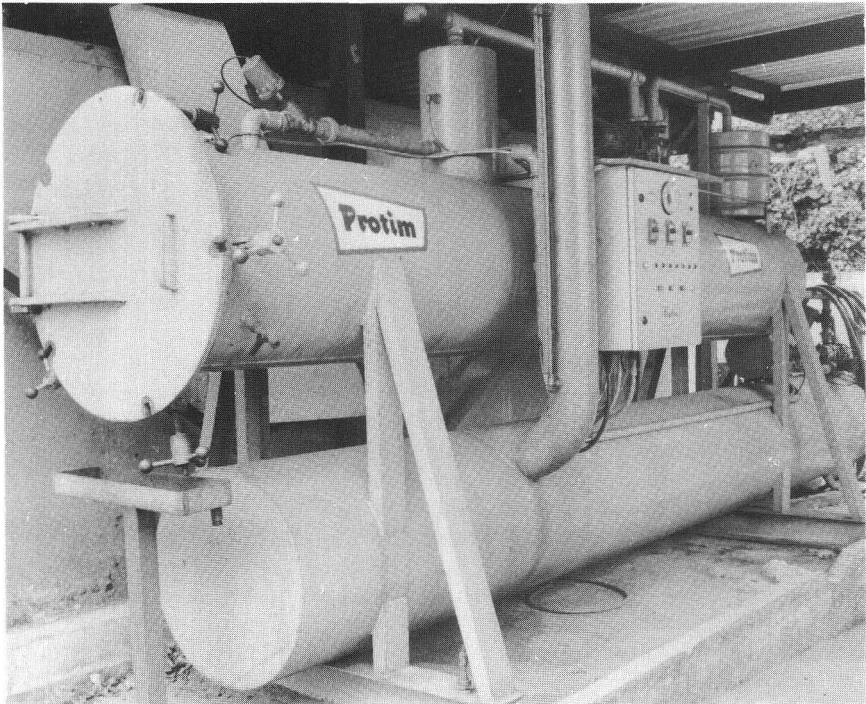


Figure 1: Protim Pre-Vac double vacuum plant in which the timber samples were treated.

Table 1: Preservative Treatment Schedule for Redwood, using Organic Solvent Preservative, (From: BS 5589, 1978).

Initial Vacuum		Pressure Stage		Final Vacuum	
Pressure (1)	Time (2)	Pressure	Time	Pressure	Time
-0.33	20	0	3	-0.67	20

(1)=BAR pressure.
(2)=minutes.

After treatment and before analysis, the samples were stickered and left to dry for 3 weeks outdoors under cover.

The preservative solution for the "Protim Pre-Vac" Double Vacuum process contained both, bis(tri-n-butyltin)oxide (TBTO) and pentachlorophenol (PCP) as the main fungicidal ingredients. The analysis of PCP in 'Prevac' treated wood is complicated and time consuming. This analysis is therefore not normally carried out. However, the determination of TBTO is considered to give an accurate picture of the level of 'Prevac' treatment. Irish Standard (IS 63, 1984) calls for a loading of 0.03% w/w TBTO (+0.13% w/w PCP) in the outer lateral 3mm sapwood layer of redwood. This is required to give protection against decay in an external but out of ground contact end-use application.

In preparing the treated samples for analysis of TBTO, a 10cm wide cross-section was cut from the mid-point of each 1.2m sample. From this subsample, a 3mm thick section was removed from the outer surface on both the sapwood and heartwood sides. The samples were processed and quantitatively analysed using an atomic absorption method in accordance with BS 5666, Part 7 (1980).

Results

The preservative uptake by 50 lodgepole pine and 50 Scots pine samples was determined. The preservative retention of TBTO in both heartwood and sapwood of each of the samples was analysed.

Table 2: Mean Gravimetric Uptake (grams) of Organic Solvent Preservative by Irish Lodgepole Pine and Imported Scots Pine.

Charge No.	Species	Uptake (grams)	
		Mean	Std.*1 Dev.
1	Lodgepole pine	118.4	65.9
	Scots pine	100.2	38.4
2	Lodgepole pine	76.2	45.2
	Scots pine	98.4	35.1
Average of 2 Charges:			
	Lodgepole pine	97.3 (22.77)*2	59.8
	Scots pine	99.0 (23.17)	36.6

*1 – Standard Deviation.

*2 – Equivalent in litres/m³.

Table 3: Average Retentions of TBTO (% w/w)*1 in Sapwood and Heartwood in Irish Lodgepole Pine and Imported Scots Pine and their 90% Confidence Intervals.

	Sapwood	Heartwood	(Sap + Heart)*2
Lodgepole pine	0.037	0.013	0.030
Scots pine	0.030	0.015	0.024
90% Confidence Interval			
Lodgepole pine	0.033-0.041	0.012-0.015	
Scots pine	0.026-0.033	0.013-0.017	

*1 – Weight to weight.
*2 – Average of (Sapwood + Heartwood) retention.

Table 2 gives a summary of the gravimetric uptake of preservative solution by species.

Table 3 shows the average retention of fungicide TBTO by the heartwood and sapwood sections of both plantation grown Irish lodgepole pine and imported Scots pine.

Table 4: Analysis of Variance*1 of TBTO Retention (% w/w) in Irish Lodgepole Pine and Imported Scots Pine.

Source	Degrees Freedom	Sum of Squares	Mean of Squares	F-value	P*2
Species	1	0.1237	0.1237	0.38	0.541 NS
Sap/Heart	1	35.7255	35.7255	162.60	0.000***
Samples	98	32.1906	0.3285	1.49	0.000***
Interaction	1	1.4964	1.4964	6.81	0.010***
Error	98	21.5326	0.2197		
Total	199	91.0688	0.4576		

Components of Variance:

Samples 0.054
Measurement 0.21972

*1 – Analysis of Variance is based on logarithms to base e.
*2 – NS=Not Significant; ***=Highly Significant.

The 90% confidence interval in Table 3 indicates that TBTO retention can be expected to be within the ranges indicated, for species and wood section, with a 90% surety.

The results of an analysis of variance and the components of variance are given in Table 4.

No significant difference was established between species. Highly significant differences were found between heartwood and sapwood of both species. Highly significant differences were also found between the samples of both species.

Discussion

The preservative treatment of softwood timbers exposed to weathering is essential in order to prolong the life-span of the timber components in service. In the Lodgepole Pine Taskforce programme, it was demonstrated that plantation grown Irish lodgepole pine was suitable for the manufacture of external joinery (Evertsen, 1989). To ensure satisfactory performance of this species, appropriate preservative treatment is essential.

Imported Red Deal (Scots pine) is the principal species currently used in Ireland for the manufacture of external softwood joinery. It is this material which Irish lodgepole pine has to compete with in the softwood joinery market place. For successful import substitution, lodgepole pine has to be at least comparable to imported Scots pine, in regard to quality and technical performance.

The treatability of a timber species indicates the amenability of that species to preservative impregnation. It reflects the level of preservative absorption and retention. The heartwood of North-American lodgepole pine and European Scots pine are resistant and moderately resistant³ respectively to preservative uptake (Anon, 1977, 1985). The sapwood of pine species is generally more permeable than its heartwood (Anon, 1977).

The gravimetric uptake of preservative solution by Irish lodgepole pine and imported Scots pine did not differ greatly. The lodgepole pine had an average uptake of 22.77 l/m³, while imported Scots pine showed an average preservative uptake of 23.17 l/m³. The 0.4l difference between the two species is statistically insignificant. It must be stressed however that these specific volumes of preservative uptake are only relevant to timber of the dimensions used in this study.

The average retention of TBTO by the lodgepole pine (sapwood + heartwood) was 0.030% (w/w), while the Scots pine showed a retention of 0.024% (w/w). The difference in the retention of the fungicide TBTO was found to be statistically insignificant.

Analysis of sapwood and heartwood of both species showed that sapwood retained 2-3 times more TBTO than heartwood (Table 3). However, the sapwood of the lodgepole pine retained up to 23% more TBTO than the

sapwood of the Scots pine. In contrast, the heartwood of lodgepole pine retained up to 13% less TBTO than the heartwood of Scots pine.

In Table 2, the preservative uptake values given show a large standard deviation for the mean uptake value. This may be explained by the difference in permeability between the sapwood and heartwood of both species. The greater standard deviation for lodgepole pine may be attributed to the greater permeability of Irish lodgepole pine sapwood than that of the imported Scots pine (Table 3). A similar trend was also evident in the retention of TBTO. Furthermore, the imported Scots pine heartwood shows a slightly higher TBTO retention than that of Irish lodgepole pine (Table 3).

However, from a commercial point of view, it is considered that both species had a similar uptake and retention of organic solvent preservative. Hence, these findings contribute to the support of the potential substitution of imported Red Deal with plantation grown Irish lodgepole pine.

Conclusions

1. Plantation grown Irish lodgepole pine can be successfully treated with an organic solvent preservative by the Double-Vacuum process.
2. The gravimetric uptake of preservative solution by Irish lodgepole pine is similar to that for imported Red Deal (Scots pine) of Swedish origin.
3. The retention of the fungicide bis(tri-n-butyltin)oxide (TBTO) by Irish lodgepole pine is similar to imported Red Deal.
4. The cost of organic solvent preservative treatment of Irish lodgepole pine is equivalent to imported Red Deal.
5. The treatability of Irish lodgepole pine contributes to the potential import substitution of Red Deal.

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NOTES

1. "Crown" – represents the crown symbol.
2. "Protim Pre-Vac" is a Registered Trademark for a Double Vacuum plant supplied by Fosroc Abrasives & Chemicals Ltd.
3. (From: Anon. 1977, 1985)
Moderately resistant – Fairly easy to treat; lateral penetration 6.3-19mm in \pm 2-3 hrs. under pressure.
Resistant – Difficult to impregnate; lateral penetration 3.2-6.3mm maximum.