DRYING PROPERTIES OF NEW ZEALAND-GROWN ACACIA MELANOXYLON

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ABSTRACT

The performance of **Acacia melanoxylon** R. Br. (Australian blackwood) boards 25 mm and 50 mm thick was assessed in terms of drying time, shrinkage, collapse, and degrade from warping and checking after either air drying, dehumidification drying, conventional kiln drying, or high temperature kiln drying. Even kiln drying at a dry bulb temperature of 70°C, wet bulb 60°C, did not cause undue surface checking. The major problem encountered was the extreme variability of drying rate; quarter-sawn heartwood took twice as long to dry as flat-sawn heartwood. Accelerated drying methods increased this difference and for this reason it is recommended that all material, particularly 50 mm and thicker, be air dried to about 30% moisture content before kiln drying. Air drying of 25-mm boards can be achieved in 12–20 weeks in Rotorua with final kiln drying taking 4–5 days.

Blackwood is a medium density hardwood which has a low shrinkage with only a slight tendency to collapse when dried at elevated temperatures. Preliminary air drying will minimise collapse, making final reconditioning unnecessary. Spring and twist were a problem in the material studied but this could largely be attributed to poor tree form. Warp should be low to minimal in material from silviculturally tended trees.

INTRODUCTION

Australian blackwood is a native of south-eastern Australia and Tasmania. It has been introduced to South Africa and is now being planted in increasing quantities in New Zealand.

The New Zealand Forest Service policy on Exotic Special Purpose Species (N.Z. Forest Service 1981) recognises the need for specialty timbers for uses which have traditionally been supplied from either indigenous resources or imports. As both these sources are subject to price or supply limitations, an exotic specialty timber resource needs to be established. The policy not only identifies specialty uses and their required timber properties but also nominates suitable species, as well as designating planting areas and priorities. Blackwood has been included as a species having plantation potential and many of the desirable end-use properties.

Blackwood from Australia is a medium-density hardwood with a variable heartwood colour and an even medium-to-fine texture. It is a high-quality timber which can be used for a wide variety of decorative uses, as well as turnery and veneer slicing (Boas 1947).

There have been no previous drying studies of New Zealand-grown blackwood but it has been reported (Boas 1947; Hartwig 1964) that blackwood grown in Australia and South Africa seasons well and may be either air dried or kiln dried from green with no major degrade in sizes up to 50 mm thick. The species exhibits medium shrinkage and even when kiln dried from green there is usually insufficient collapse to warrant reconditioning. The usual types of drying degrade encountered are surface checking and the cupping of wide flat-sawn boards. Weighting of stacks is recommended to reduce cupping; however, should it occur, steaming at the conclusion of drying will appreciably reduce this.

The kiln schedule recommended for Australian material (Table 1) will dry 25-mm and 50-mm stock from green in 14 and 30 days respectively.

TABLE 1—Kiln schedule for blackwood in Australia

Moisture content change points	Dry bulb temperature (°C)	Wet bulb depression (°C)
Green	54.4	6.7
40%	60.0	8.8
30%	65.6	13.0
20% to final	71.1	13.0

The air drying and kiln drying properties of New Zealand-grown material were assessed in a comprehensive drying study. The kiln schedules used ranged from mild dehumidification drying through to high temperature drying, whilst the air drying was done in commercial-scale air seasoning stacks.

MATERIAL AND PROCEDURE

Material for the seasoning study was obtained from a 72-year-old stand in Whakarewarewa Forest as part of the over-all evaluation of the utilisation properties of blackwood. Apart from two thinnings the stand had received no silvicultural tending and as a consequence stem form was extremely poor. This meant that much of the sawn timber had substantial grain deviation and a high incidence of tension wood. Results of the sawing study have been recorded by Grubner *et al.* (1982).

Defect-free lengths of 150 × 25-mm and 100 × 50-mm heartwood were selected, and matched series of 0.6-m sample boards were prepared. The sample boards were end sealed, the shrinkage points were marked, and the samples were dried according to the schedules in Table 2 in either a 0.6-m experimental kiln or a dehumidifier.

In addition, approximately 17 m^3 of mixed sizes were stacked in two commercial-sized air drying stacks. Both these stacks were in a pole barn and their northern ends were protected by hessian.

TABLE 2—Drying schedules used in this study

Drying method	Schedule DB/WB (°C)	25 mm thick	50 mm thick
Air dry on a commercial scale	—	Yes	Yes
A. Preliminary air dry, kiln dry	55/50	—	from 30% m.c.
	58/50		after 1 day
	60/50		after 3 days
	65/50		after 5 days
B. Dehumidify with 2.4-m lengths	41/33	from green	from green
	45/31	after 16 days	after 16 days
	42/28	after 17 days	after 17 days
C. 0.6-m kiln	50/47	from green	from green
	50/45	after 4 days	after 6 days
	50/42	after 7 days	after 10 days
	55/45	after 10 days	after 14 days
	60/48	after 14 days	after 17 days
	65/50	after 16 days	after 19 days
D. 0.6-m kiln	55/50	—	from green
	55/47		after 4 days
	55/45		after 7 days
	65/50		after 10 days
E. 0.6-m kiln	55/50	from green	—
	55/47	after 3 days	
	60/50	after 6 days	
	65/50	after 9 days	
F. 0.6-m kiln	70/60	from green	—
G. 0.6-m kiln	115/70	from green	from green

Drying degrade was assessed from the 0.6-m samples. This included measurements of shrinkage, collapse, and checking. Warping and checking were also recorded from the air-seasoned and dehumidification-dried lengths.

RESULTS

Physical Properties

The heartwood of blackwood (especially within 100 mm of the pith) has a high level of moisture saturation whereas the sapwood is substantially drier. The test trees averaged 79% heartwood and the wide variation of moisture content and saturation (Table 3) was largely due to the unavoidable inclusion of samples containing some sapwood.

The basic density of the sample boards was extremely variable and this reflects the typically high level of variability both between and within the trees. A comprehensive density survey of the test trees revealed whole-tree densities ranging from 465 to

TABLE 3—Physical properties of sample cross sections

No. samples	Sample size (mm)	Moisture content (%)			Basic density (kg/m³)			Moisture saturation (%)		
		Mean	Range	CV %	Mean	Range	CV %	Mean	Range	CV %
145	150 × 25	105.1	54.8–155.2	19.2	574	440–726	11.0	95.9	50.2–100.0	8.5
100	100 × 50	102.5	66.4–156.0	18.8	579	423–754	12.0	95.5	52.0–100.0	8.9

TABLE 4—Percentage shrinkage after drying to 12% moisture content

	Ring angle* (degrees)	Thickness		Width		Comments
		Before reconditioning	After reconditioning	Before reconditioning	After reconditioning	
25 mm thick (mean of 14 samples)						
Air dry	20	2.0	2.2	3.4	3.0	
Schedule B	52	3.3	2.6	3.9	3.4	
Schedule C	32	3.6	2.9	5.2	4.2	Slight collapse in one sample
Schedule E	33	3.8	3.3	4.3	3.9	Slight collapse in one sample
Schedule F	34	3.8	3.3	4.9	4.4	One sample surface checked
Schedule G	38	6.2	4.9	3.5	3.5	Four samples internally checked
50 mm thick (mean of 12 samples)						
Air dry	32	2.0	2.2	3.1	3.0	
Schedule A	33	2.9	2.6	4.1	3.7	
Schedule B	45	3.0	2.7	4.2	3.7	
Schedule C	34	3.6	3.5	4.2	4.0	
Schedule D	36	4.8	3.9	4.4	4.1	
Schedule G	31	6.3	—	3.2	—	All samples internally checked

* 0° is flat-sawn

670 kg/m^3, with a mean of 581 kg/m^3; this is very similar to that reported for Indian-grown blackwood (Sekhar & Kukreti 1979). Within-tree variability was confined to the radial profile only, there being virtually no vertical variation. Radially, basic density increased steeply over the first 150 mm (520 increasing to 600 kg/m^3), then levelled off, and finally decreased to approximately 580 kg/m^3 in the sapwood. The species would thus be classified as a medium-density hardwood.

The blackwood had a fine even texture, but cross-grain was extremely common in the study material because of poor stem form. The sapwood had a distinct white to straw colour and was typically 20 to 50 mm in width. The heartwood varied in colour from yellow-brown to reddish through to almost black. The wood had a very distinctive figure due to the prominence of growth rings and frequency of tension wood.

The blackwood boards had a low shrinkage after drying to 12% m.c. (Tables 4 and 5) with only a slight tendency to collapse. There was a trend for collapse to increase with increased drying temperature but most of this could be recovered with a period of reconditioning, although this was not effective in collapse associated with tension wood zones. The air-dried material had a tangential to radial shrinkage ratio of 2 : 1 (Table 5).

TABLE 5—Shrinkage (%) of 25-mm-thick boards

Drying schedule	Tangential shrinkage		Radial shrinkage	
	Before reconditioning	After reconditioning	Before reconditioning	After reconditioning
Air dry	3.5	3.3	1.4	1.6
Schedule C	5.6	4.5	1.6	1.6
Schedule F	6.1	5.1	2.2	2.0

Drying Times

The blackwood had a moderate drying rate (Table 6), slightly slower than that of tawa (*Beilschmiedia tawa* D. Don), a species with which it might be compared locally. All the slowest drying samples were quarter-sawn heartwood material and although increasing the severity of drying conditions reduced drying times it also increased the variability. Thus although the species does not suffer significant degrade when drying is accelerated, variable drying rates make kiln drying from green a somewhat lengthy and unattractive proposition.

Drying Degrade

In spite of the generally poor form of the logs and the large number of lengths with cross grain and tension wood, the timber dried with surprisingly little warp (Tables 7 and 8). As could be expected, a higher proportion of the dehumidification-dried 2.4-m lengths than the longer air-dried lengths had excessive warp. This difference could be attributed to the lower moisture content of the dehumidification-dried material and an increasing restriction on warp as length decreases. For the air-dried material, spring

TABLE 6—Drying times to 15% moisture content

Schedule	Time (days)	
	Mean	Range
25 mm thick (14 samples)		
Air dry	9.9*	5.5–14.7*
Schedule B	20.5	14.8–26.3
Schedule C	11.6	9.0–19.8
Schedule E	8.7	6.4–14.6
Schedule F	6.3	4.0–10.3
50 mm thick (12 samples)		
Air dry	19.0*	13.9–26.1*
Air dry, Schedule A	6.0	5.0–11.1
Schedule B	39.3	27.3–57.4
Schedule C	22.0	16.8–29.8
Schedule D	16.5	11.2–25.6

* Air drying times (weeks) to 30%

was the major type of warp; 127, or 15.5% of the lengths, were rejected (Table 8). However, twist became a more significant defect in those full lengths which were subsequently kiln dried to 9% m.c. For the dehumidification-dried charge, spring was the major cause of rejection in 150 × 25-mm lengths and twist for the 100 × 50-mm lengths (Table 7).

TABLE 7—Warp and rejection* of 2.4-m lengths (n = 36) dried in dehumidifier (Schedule B)

Size (mm)	Spring		Bow		Twist		Cup		Total No. rejected	Mean m.c. (%)
	Mean mm	No. rejected	Mean mm	No. rejected	Mean mm	No. rejected	Mean mm	No. rejected		
150 × 25	10.5	25	6.7	0	8.9	8	1.6	4	28	10.5
100 × 50	7.9	11	7.6	1	5.5	17	–	–	23	11.2

Results confirm that blackwood is not collapse susceptible, even when dried at 70°C (Table 4), and that any collapse can be removed by reconditioning unless it is associated with tension wood. There was no internal checking in the 25-mm-thick material when dried at 70°C, and when dried at 115°C (Schedule G) only four of the 14 samples had internal checking. Surface checking was not a major problem even in wide flat-sawn boards – only 2% of the air-dried lengths had surface checking (Table 9). Surface checking and splits were often at the pith line and thus there was little that could be done to reduce their occurrence. End splitting was a common defect in the air-dried lengths (Table 9) and this was due to a combination of growth stress, end drying, and lack of fillet restraint in the overhanging ends.

TABLE 8—Number of air-dry lengths downgraded by warp (mean m.c. 15%)

Size (mm)	Spring		Bow		Twist		Cup/Collapse	Total No. rejected		Total No. lengths
	No limit for Factory	Factory* limited	No limit for Factory	Factory limited	No limit for Factory	Factory limited	Factory limited	No limit for Factory	Factory limited	
50 × 50	–	–	–	–	–	–	–	–	–	48
75 × 25	8	11	1	1	0	0	0	9	12	49
75 × 40	–	–	–	–	–	–	–	0	0	11
75 × 50	2	4	2	3	0	0	0	4	7	47
100 × 25	14	27	2	2	1	1	2	17	31	134
100 × 40	9	25	0	0	0	0	2	19	26	71
100 × 50	5	12	1	2	0	0	0	6	14	118
100 × 75	3	3	1	2	0	0	0	4	5	13
100 × 100	5	6	0	0	0	0	0	5	7	11
125 × 25	1	4	0	0	0	0	0	1	4	20
125 × 50	0	0	0	0	0	0	0	0	0	5
150 × 25	10	5	0	0	1	1	4	11	19	92
150 × 40	8	11	0	0	0	0	0	8	11	53
150 × 50	1	1	0	0	0	0	0	1	1	38
200 × 25	8	8	0	0	0	0	0	8	8	78
200 × 40	0	0	0	0	0	0	0	0	0	12
200 × 50	0	0	0	0	0	0	0	0	0	6
300 × 25	0	0	0	0	0	0	0	0	0	9
300 × 40	0	0	0	0	0	0	0	0	0	2
Total	84	127	7	10	2	2	8	93	145	817
Percentage	10.3	15.5	0.9	1.2	0.2	0.2	1.0	11.4	17.7	

* Maximum permissible warp limits applied for Factory grade lengths

TABLE 9—Other types of drying degrade in air-dried lengths

Defect	Number affected	Percentage affected	Total No. boards
Surface checks	15	2	817
Splits-shakes	26	3	817
End splits	64	8	817

DISCUSSION

The results of this drying study confirm those of Boas (1947) and Hartwig (1964) in that Australian blackwood can be dried without major problems. New Zealand-grown blackwood has a medium density and low shrinkage similar to material grown in Australia, India, and South Africa. Even flat-sawn boards of up to 300 mm width can be air seasoned without surface checking and excessive cupping. The end splitting that occurred was the result of the release of growth stresses and end drying but it could be minimised by either end coating or placement of fillets right at the ends of boards. None of the end-sealed kiln samples showed end splitting.

Warp, notably spring in 25-mm-thick boards and twist of thicker material, proved to be somewhat of a problem. Much of this could be attributed to poor tree form causing tension wood and cross grain. The test material would be the most warp-prone material that is likely to be produced; it would be reasonable to expect that material sawn from silviculturally tended stands would show less warp and be similar to that observed in other countries.

The species has a moderate drying rate and can be kiln dried from green; however, this accentuates the variability of drying rates. Quarter-sawn material, particularly 50-mm and thicker, takes up to twice as long to dry as flat-sawn material when kiln dried from green, and kiln residence times must be significantly prolonged to ensure that all the load is dried sufficiently. For this reason it is recommended that blackwood be air dried to approximately 30% m.c. and finished off in a kiln. The recommended drying procedure is outlined in Table 10.

TABLE 10—Recommended drying procedure for New Zealand-grown blackwood

Air dry		
25 mm thick - dry for 3–5 months to 30% m.c.		
50 mm thick - dry for 5–7 months to 30% m.c.		
Kiln dry	Dry bulb (°C)	Wet bulb (°C)
Mean m.c. 30–40%	65	60
Mean m.c. 20%	70	60
Final conditioning (4 h/25-mm thickness)	75	74

Average kiln-drying times by this procedure will be 4–5 and 8–10 days for 25- and 50-mm-thick material, respectively.

Blackwood offers many advantages compared with the other special-purpose timber species which fulfil a similar role, such as the ash eucalypts. The utilisation of the ash eucalypts presents many problems – growth stresses, internal and surface checking, high shrinkage and dimensional instability, and coarse texture. Blackwood is also less demanding in its growth site requirements in that it copes well with wet sites. For these reasons, as well as its favourable appearance and end-use properties, blackwood will probably increase in importance compared with the ash eucalypts.

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