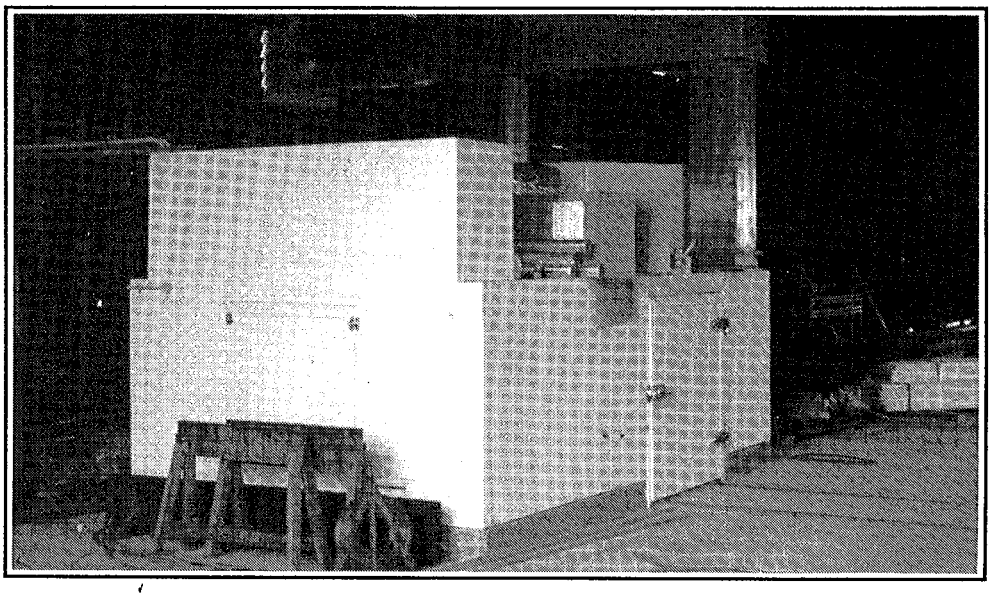
VALWOOD

Small Eucalypt Processing

Moisture Content Fluctuations of Regrowth Jarrah and Karri under Different Environmental Conditions

P. Newby and G.K. Brennan



Report No. 18

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Wood Utilisation Research Centre
Department of Conservation and Land Management

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This report was part of a program of industrial research and development aimed at establishing techniques and developing equipment to allow processing of small eucalypt regrowth logs in a commercially viable manner, particularly with a view to use in high quality furniture. The research program was funded jointly by the Commonwealth Government under a Public Interest Project, the Department of Conservation and Land Management, and the Western Australian timber industry.

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SUMMARY

Wood used where atmospheric conditions fluctuate will vary in moisture content until it comes into equilibrium. A trial assessed moisture content fluctuations in 300 x 100 x 30 mm sections of regrowth jarrah (*Eucalyptus marginata* Donn ex Sm.) and regrowth karri (*E. diversicolor* F. Muell.) dried to either 8 per cent or 12 per cent moisture content, which were subsequently either wrapped in poly vinyl chloride (P.V.C.) or left unwrapped, and then stored at equilibrium moisture contents (e.m.c.'s) of 6 per cent or 20 per cent.

The moisture content of wrapped samples changed only slightly, and rates of adsorption and desorption for both jarrah and karri were similar. The largest changes in moisture content occurred in the unwrapped samples originally dried to 8 per cent and exposed to an e.m.c. of 20 per cent.

The results indicated that timber used in furniture manufacture should be dried to the moisture content required for its final use, and then stored in a controlled environment to maintain it at the required moisture content. Wrapping in P.V.C. film is a method of quality control that would substantially reduce the need for strict environmental controls in storage.

INTRODUCTION

As green wood dries in the desorption process, it initially loses free water from the cell cavities, and then loses bound water from the cell walls. The moisture content level at which shrinkage commences is the fibre saturation point (f.s.p.) at approximately 30 per cent moisture content, and shrinkage continues from f.s.p. to equilibrium moisture content (e.m.c.) and below.

If its moisture content is below e.m.c., wood has adsorptive properties which give it the ability to remove water vapour from the surrounding air until it is in moisture equilibrium with the air i.e. it is a hygroscopic material (Haygreen and Bowyer 1982).

The amount of water held by wood cells is not only dependent on the equilibrium relative vapour pressure, but also dependent on the direction from which equilibrium is approached. The phenomenon is known as `sorptive hysteresis' (Stamm 1967). The amount of water adsorbed from the dry condition is always less than the amount retained on desorption at a fixed relative vapour pressure.

As a general rule the atmospheric conditions in any one place vary from day to day and season to season. Consequently, the moisture content of wood in use will be constantly changing, even in a sheltered position, but at a much slower rate than the atmospheric condition. Wood used where the humidity fluctuates will continually change moisture content, and therefore dimension (Haygreen and Bowyer 1982). Problems can arise when a wood product is used in widely varying humidity and temperature conditions, if the design and application of that product have not anticipated changes in dimension. For satisfactory performance in interior furniture, it is essential to use timber with moisture content close to the equilibrium moisture content in use. Shrinkage can result in checking and warping of timber, and swelling in humid conditions results in jammed doors and windows, and buckled table tops. It is desirable to determine the limits of moisture contents which the wood is likely to attain, and to dry it to the mean of those limits, to minimize the problems associated with the variation in dimensions which accompanies changing moisture content. Shrinking and swelling are generally but not exactly reversible processes.

The present study was conducted at the Wood Utilisation Research Centre (W.U.R.C.). It determined the rate of moisture desorption and adsorption of regrowth jarrah (*Eucalyptus marginata* Donn ex Sm.) and karri (*E. diversicolor* F. Muell.) boards, initially dried to an average 8 or 12 per cent moisture content, and wrapped in polyvinyl chloride (P.V.C.) or left unwrapped, when stored in controlled environment rooms at 6 per cent or 20 per cent e.m.c. The results have practical application in organising storage of high quality timber after drying and before use in furniture manufacture.

METHODS

The 48 to 58-years-old regrowth jarrah for this trial came from a stand in Arklow Block, Collie District. This stand was heavily cut in the 1930s and the residual stand was subsequently thinned. The regrowth karri (52-years-old) came from a two-tiered stand in Treen Brook Block, Pemberton District, which was naturally regenerated following a fire in the 1930s.

The logs were milled into 100 x 30 mm boards. Eighty 300 x 100 x 30 mm specimens of each species were initially air-dried to below f.s.p., then dried to either 8 or 12 per cent in an experimental kiln, operating at a dry bulb temperature of between 50°C and 80°C. Moisture contents were measured using a `Bollman' electrical resistance meter.

Half the samples were wrapped in a semi-permeable surface coating of P.V.C. film and the other half were left unwrapped. A system had been developed by the Tasmanian Timber Promotion Board to reduce surface checking in backsawn Tasmanian oak by using P.V.A. emulsion to adhere P.V.C. film onto green timber (Schaffner and Doe 1984). However, in the present trial P.V.A. emulsion was not used because water from the adhesive would increase the timber's moisture content.

Equal numbers of wrapped and unwrapped samples were weighed on a `Sartorius' scale to an accuracy of 0.01 g, and placed in controlled environment chambers at 6 per cent or 20 per cent e.m.c. Weighing was done three times per week to determine a weight loss or gain over a four week period. After four weeks, the specimens were oven-dried, and mass and final moisture content determined using the method outlined in AS1080, Part 1 (Standards Association of Australia 1972). Using the oven-dried mass and the masses recorded during the trial, moisture contents at different stages of adsorption and desorption were calculated.

RESULTS AND DISCUSSION

As stated in the Introduction, wood used where atmospheric conditions fluctuate will vary in moisture content until it comes into equilibrium. When the wood is below f.s.p., changes in dimensions are associated with the loss or gain of moisture, resulting in the wood shrinking or swelling. Due to the 'sorptive hysteresis' effect, the initial desorption curve is always above subsequent desorption curves (Stamm 1967).

Both P.V.C. wrapped and unwrapped regrowth jarrah (Figs. 1 and 2) and karri (Figs. 3 and 4) lost or gained moisture to approach a new e.m.c. (6 per cent or 20 per cent) when stored in controlled humidity rooms.

Samples wrapped in the P.V.C. film showed very little variation when exposed to the different e.m.c.'s, and the greatest variation of 1.2 per cent for jarrah, and 0.8 per cent for karri, occurred with the samples dried to 12 per cent and exposed to an e.m.c. of 6 per cent.

The P.V.C./P.V.A. wrapping system developed in Tasmania (Schaffner and Doe 1984) is used commercially in Western Australia by Bunnings Forest Products Ltd, to reduce surface checking in high quality 38 mm and 50 mm thick select grade jarrah (Lembke 1989). This system obviously allows only slow diffusion of moisture between the P.V.C. film and the atmosphere, thus reducing rapid surface drying and checks caused by rapid initial drying. Wrapped samples in the present trial showed a very small loss or gain of moisture compared to the unwrapped samples (Tables 1 and 2). The results confirmed that some moisture vapour is diffusing through the P.V.C. coating.

The largest increases in moisture content occurred in the unwrapped samples dried to 8 per cent and exposed to an e.m.c. of 20 per cent. Mean values and standard deviations for each treatment and measurement are given in Tables 1 and 2. The standard deviations of the moisture contents in boards dried to a nominal 12 per cent were larger than those for boards dried to 8 per cent.

Table 1
Moisture contents of regrowth jarrah dried to 8 or 12 per cent after exposure to e.m.c.s of 6 or 20 per cent

Moisture content (%)	8								12							
Wrapping	Wrapped				Unwrapped				Wrapped				Unwrapped			
e.m.c. (%)	6		20		6		20		6		20		6		20	
Exposure time	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Initially	8.1	0.7	8.1	0.6	6.6	1.0	8.6	0.8	15.6	2.6	14.9	1.8	13.4	1.3	12.7	2.2
Week 1	8.1	0.7	8.1	0.6	5.9	0.7	13.0	1.1	15.3	2.6	14.9	1.8	9.1	0.5	15.7	1.8
Week 2	8.0	0.7	8.1	0.6	5.4	0.6	15.0	1.4	14.9	2.6	15.0	1.8	7.5	0.5	16.8	1.7
Week 3	8.0	0.7	8.2	0.6	5.1	0.5	16.2	1.5	14.4	2.6	15.0	1.8	6.5	0.6	17.1	1.6
Week 4	7.9	0.7	8.2	0.6	5.0	0.5	16.4	1.5	14.4	2.6	15.0	1.8	6.4	0.6	17.1	1.6
Mean difference	0.2		0.1		1.6		7.8		1.2		0.1		7.0		4.4	

Table 2
Moisture contents of regrowth karri dried to 8 or 12 per cent after exposure to e.m.c.s of 6 or 20 per cent

Moisture content (%)	8								12							
Wrapping	Wrapped				Unwrapped				Wrapped				Unwrapped			
e.m.c. (%)	6		20		6		20		6		20		6		20	
Exposure time	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Initially	7.3	0.4	7.7	1.0	6.1	0.3	6.6	1.5	14.6	3.5	13.0	2.0	13.0	1.7	11.6	2.9
Week 1	7.3	0.4	7.7	1.0	5.6	0.3	9.8	1.4	14.4	3.4	13.1	2.0	9.2	0.7	13.6	2.3
Week 2	7.3	0.4	7.8	1.0	5.2	0.2	11.3	1.3	14.2	3.3	13.1	2.0	7.6	0.4	14.2	2.0
Week 3	7.2	0.4	7.9	1.0	4.9	0.2	12.5	1.3	13.8	3.1	13.2	2.0	6.6	0.3	14.7	1.7
Week 4	7.2	0.4	7.9	1.0	4.9	0.2	12.7	1.2	13.8	3.1	13.2	2.0	6.5	0.2	14.7	1.6
Mean difference	0.2		0.2		1.2		6.1		0.8		0.2		6.5		3.1	

Figure 1. Desorption of jarrah exposed to an e.m.c. of 6 per cent

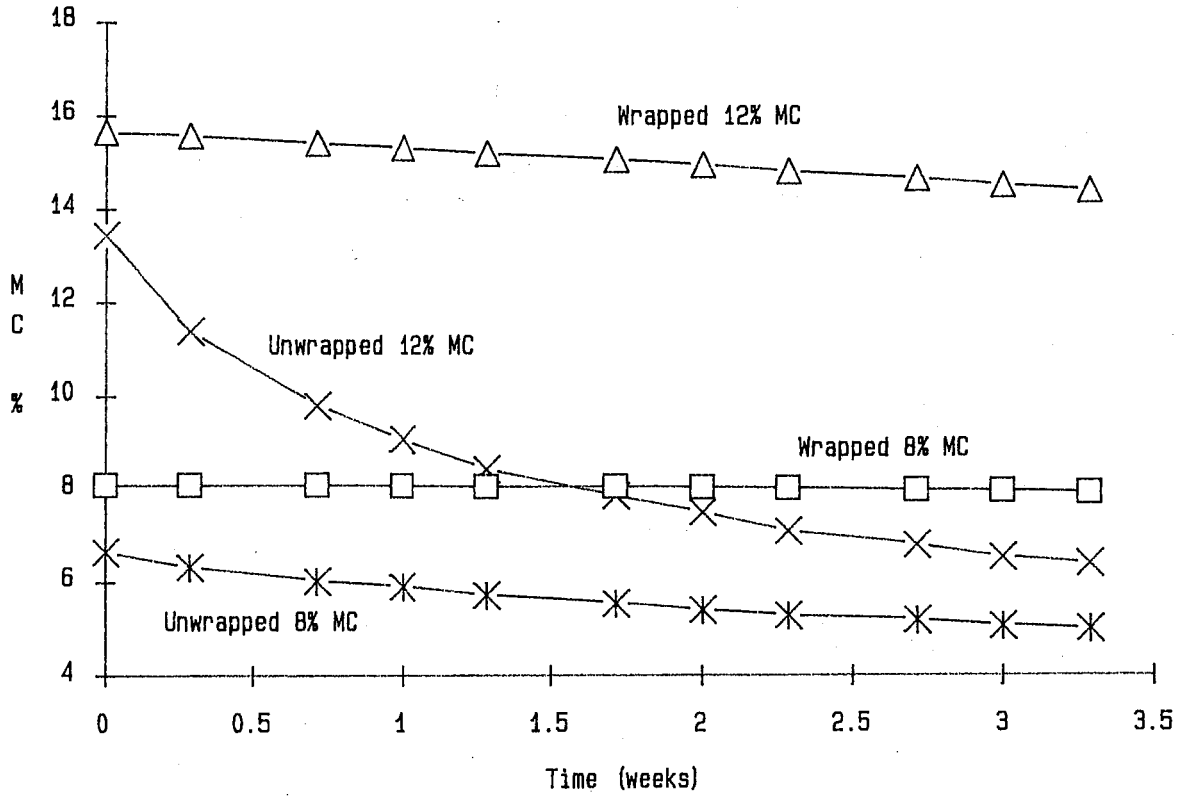


Figure 2. Adsorption of jarrah exposed to an e.m.c. of 20 per cent

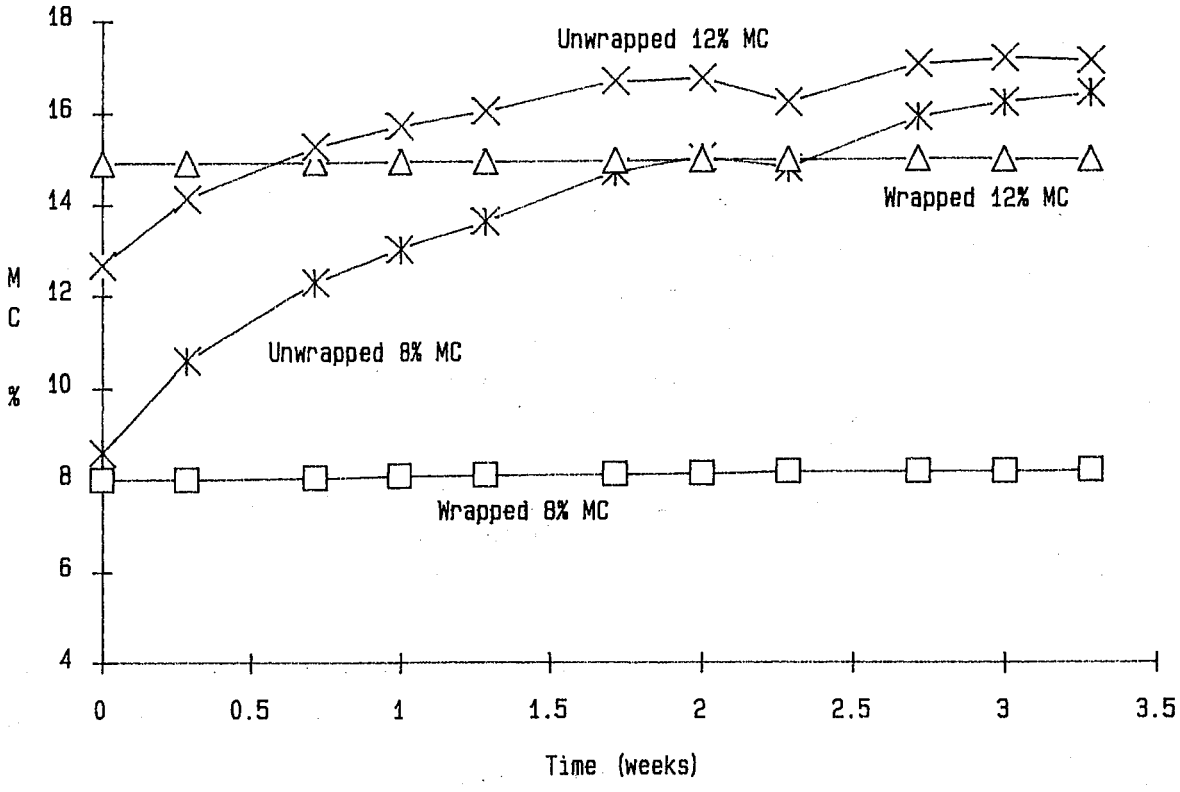


Figure 3. Desorption of karri exposed to an e.m.c. of 6 per cent

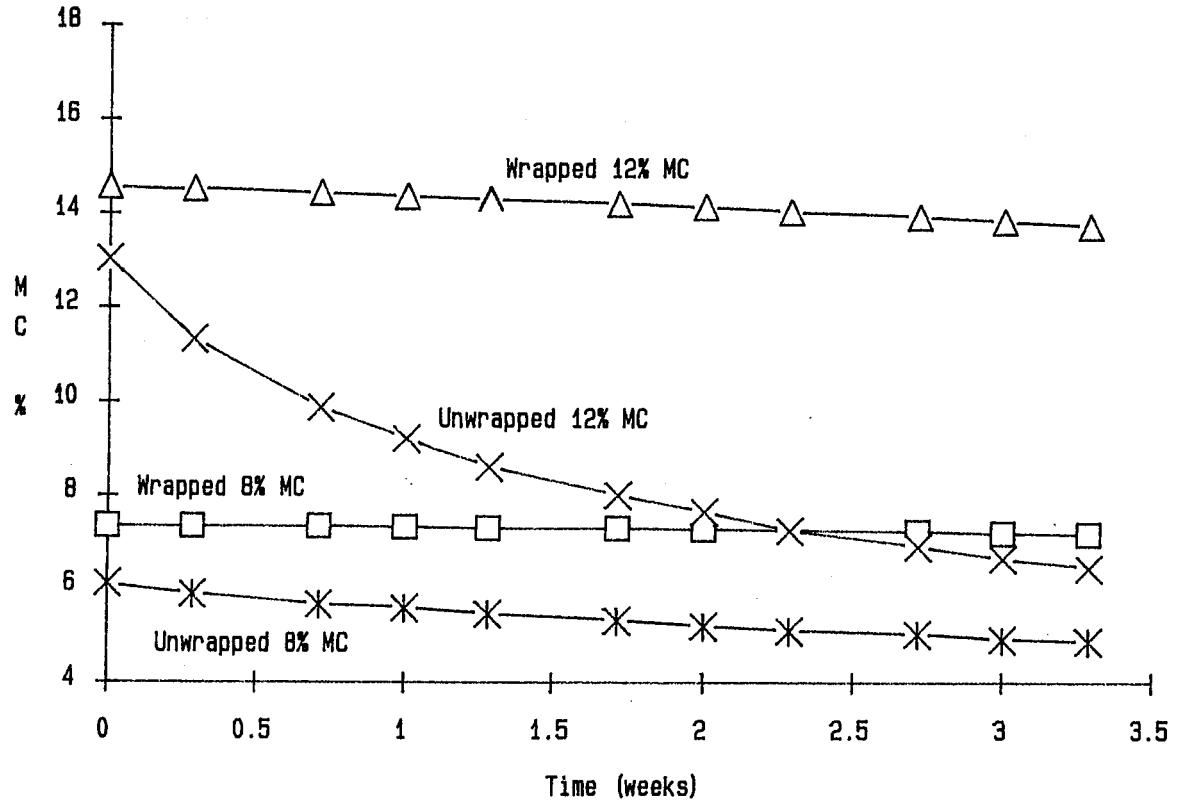
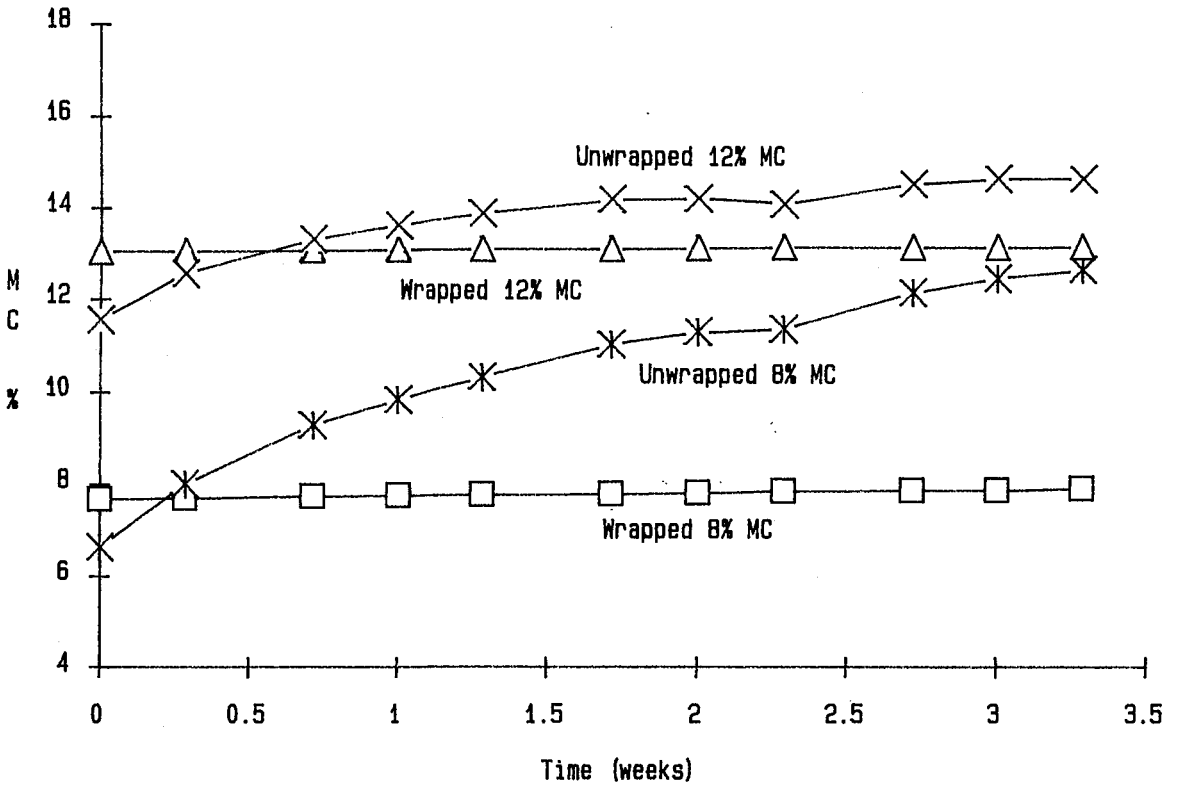


Figure 4. Adsorption of karri exposed to an e.m.c. of 20 per cent



The moisture content changes of the unwrapped specimens were considerably greater than those of the wrapped (Figs 1 - 4). The jarrah and karri originally dried to a nominal 12 per cent showed similar desorptive curves when stored at 6 per cent e.m.c. The moisture content losses in the first week were 4.3 per cent for jarrah (Table 1) and 3.8 per cent for karri (Table 2). The rate subsequently slowed to give overall losses of 7.0 per cent for jarrah and 6.5 per cent for karri by the fourth week..

The specimens of both species dried to a nominal 8 per cent lost moisture similarly when stored at 6 per cent e.m.c., with overall losses of 1.6 per cent for jarrah (Table 1) and 1.2 per cent for karri (Table 2). However, the actual final moisture contents indicated that conditions in the 6 per cent e.m.c. controlled humidity rooms were closer to 5 per cent e.m.c.

For adsorption, the specimens at the nominal 12 per cent showed substantial increases in moisture content during the first week in the 20 per cent e.m.c. chamber. Jarrah specimens gained 3.0 per cent and karri gained 2.0 per cent (Tables 1, 2). The overall gains in four weeks were 4.4 per cent for jarrah and 3.1 per cent for karri. The specimens at the nominal 8 per cent showed even larger increases during the first week, of 4.4 per cent for jarrah and 3.2 per cent for karri. The overall gains were 7.8 per cent for jarrah and 6.1 per cent for karri.

A comparison of unwrapped samples exposed to an e.m.c. of either 6 or 20 per cent showed that samples with the moisture contents furthest from equilibrium would attain these conditions at a faster rate, whether they are on the initial desorption or adsorption curves. Overall, the adsorption and desorption rates are continuously reducing.

The results of this trial indicated that timber used in furniture manufacture should be dried to the moisture content required for its final use, and then stored at a constant moisture content after final drying and processing. Both of these factors will minimize the effect of shrinking or swelling, which cause gluelines to fracture, and timber to warp and surface check. Wrapping in P.V.C. film is recommended as a method of quality control that would substantially reduce the need for strict control of the storage environment.

The key market for jarrah furniture wood is Perth. For this market the W.U.R.C. recommendation is that a moisture content of 8 ± 2 per cent is essential, otherwise the furniture manufacturer has the risk of timber movement (warping) and glueline failure. The adsorption of moisture from the adhesive is also a factor to be considered in deciding on final moisture content for the timber.

Trials assessing gluelines and stability of mature and regrowth karri panels of different moisture contents are in progress. Further research will assess unwrapped regrowth jarrah and karri samples at 8 and 12 per cent moisture content, exposed to monitored ambient conditions. Moisture content fluctuations and timber movement (shrinkage and swelling) will be measured. The results of these trials will be applicable to other regrowth eucalypt timber for value-added uses.

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