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Department of Conservation
and Land Management

Wood Utilisation Research Centre

DRYING BEHAVIOUR OF 50mm THICK MATURE JARRAH IN A KILN HEATED BY SOLAR ENERGY AND WOOD WASTE

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W.U.R.C. Technical Report No. 42

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SUMMARY

A 40 m^3 charge of 50 mm thick mature jarrah (*Eucalyptus marginata* Donn Ex. Sm.) was dried in a developmental greenhouse style kiln heated by solar energy and wood waste. The charge dried from 65 per cent to 10 per cent moisture content (MC) in 126 days - a rate of 0.44 per cent MC per day. The timber was graded after drying and dressing, resulting in 60 per cent Select grade. Assessing a three bundle sample of the charge indicated that 45 per cent of downgrading was unavoidable because of timber defects, while a large proportion of the downgrading in the remaining boards may have been avoided by better sizing. This kiln therefore dried mature jarrah to an acceptable quality in an acceptable time.

INTRODUCTION

The objectives of the Wood Utilisation Research Centre include the establishment of techniques for drying timber with a minimum of degrade and the development of commercially viable equipment to operate those techniques (CALM 1991). Jarrah has long been regarded as a beautiful red timber suitable for joinery and furniture construction, but as a timber which is difficult to dry. This difficulty leads to long drying times or relatively high degrade levels, which adds to the final product cost. One way to reduce this cost is to concomitantly use a low-price kiln structure, and maintain low degrade levels while drying in the shortest time. Solar kilns with their low capital and low running cost may satisfy these ideals (Plumtre 1985), and have been described as producing better quality timber than that produced by either air or conventional kiln drying (Alvarez Noves and Fernàndez-Golfín Seco 1990).

This study was to determine the drying times required and resulting grades of medium sized charges of 50 mm thick jarrah dried in the CALM Mark II Drying System, in kilns heated by solar energy and by burning wood waste. The type of degrade was assessed in detail.

METHODS

A 40 m^3 charge of mature jarrah of variable quality timber was supplied to the Wood Utilisation Research Centre, Harvey, from the Bunnings' sawmill in Yarloop in 1990. The charge consisted of boards nominally 50 mm thick. The intention was to dry the timber conservatively to prove the system, not to minimize the time required. After a holding period with no air flow, controlled drying commenced on 17 July in the first drying chamber.

The CALM Mark II Drying System is a three chambered, greenhouse type kiln heated by solar energy and wood waste as described by McDonald (1991). Each chamber of this Drying System is automatically controlled and recorded by a process controller according to chosen set points. Initially the set points were not always achievable due to fluctuations of energy input by the solar and wood waste, of ambient temperature, and of ambient humidity. The timber charges received ambient temperature (mean of 12.4 ^{o}C) and high relative humidity (RH) (mean of 89.1 per cent) in chamber 1, followed by warmer drier conditions in chamber 2 (means of 20.2^{o}C, 87.6 per cent) and finally, in chamber 3, a further increase in temperature and reduction in relative humidity (means of 39.6 ^{o}C, 15.3 per cent) (Fig. 1). The charges were moved from one chamber to the next using a forklift as drying progressed. Because available space in Chamber 2 is less than in Chamber 1 it cannot hold the width of six bundles, and the original charge (six bundles wide) was therefore divided into one charge four bundles wide with the other two bundles and two additional bundles of 25 mm thick jarrah in a second charge. Most bundles (or lifts) were 3.6 m long by 1 m wide by 0.9 m high. Vertical stacks were composed of four bundles with bearers, resulting in a total height of 4 m. No additional weight restraint was used.

Drying rates were determined from weekly weighings of four 600 mm long sample boards within selected bundles. When the timber dried to 8 per cent moisture content (MC) it was moved to a dry storage shed and sent to Bunnings' Welshpool Processing Centre on 28 February 1991 for grading.

All bundles of each charge were graded by Bunning's staff (into Select or Standard grades) and a lineal metre tally recorded for each grade. Proprietary grades based on AS2796 (Standards Association of Australia 1986) were used. An intensive examination of a random sample (three bundles) was performed by W.U.R.C. staff to determine reasons for any downgrading. In this sample, 137 of the Standard Boards coming off the dry chain had the principle reason for degrade recorded. Boards of various lengths, complete or recently docked, and of random width, were assessed as individuals for this examination.

RESULTS AND DISCUSSION

Drying Conditions

Considerable variation of the drying conditions occurred in all chambers despite being controlled automatically (Fig. 1). In chamber 1 the large variation was due to insufficient water spraying to maintain RH, a problem which was subsequently solved. The variation in chamber 2 was much less and indicated the expected controls in the system. Chamber 3 showed variation in the drying conditions owing to diurnal fluctuations in the solar energy input, and because only two set points were used i.e. a maximum RH (50 per cent) and a maximum temperature (55 ^{o}C) set point. Thus in Chamber 3 the RH and temperature were allowed to fluctuate below the set points to retain kiln heat.

Drying Times and Rates

The 50 mm timber charge dried from 65 per cent to 10 per cent MC in 126 days (Fig. 2). Although the drying rate decreased with time (particularly in chamber 3) the average drying rate was 0.44 per cent MC per day. By 147 days, the MC was 8 per cent.

Figure 1. Drying conditions for 50 mm mature jarrah using the CALM drying system.

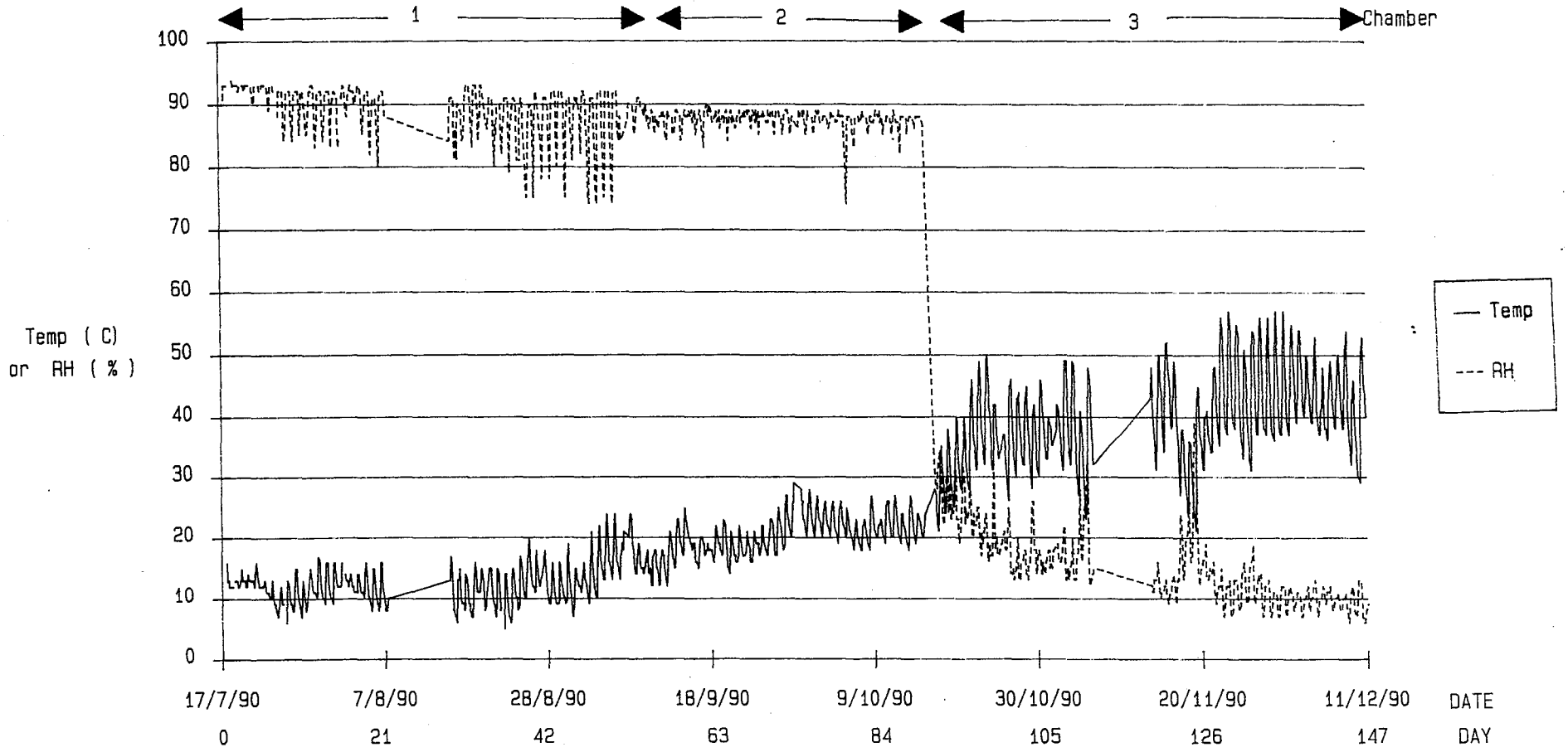
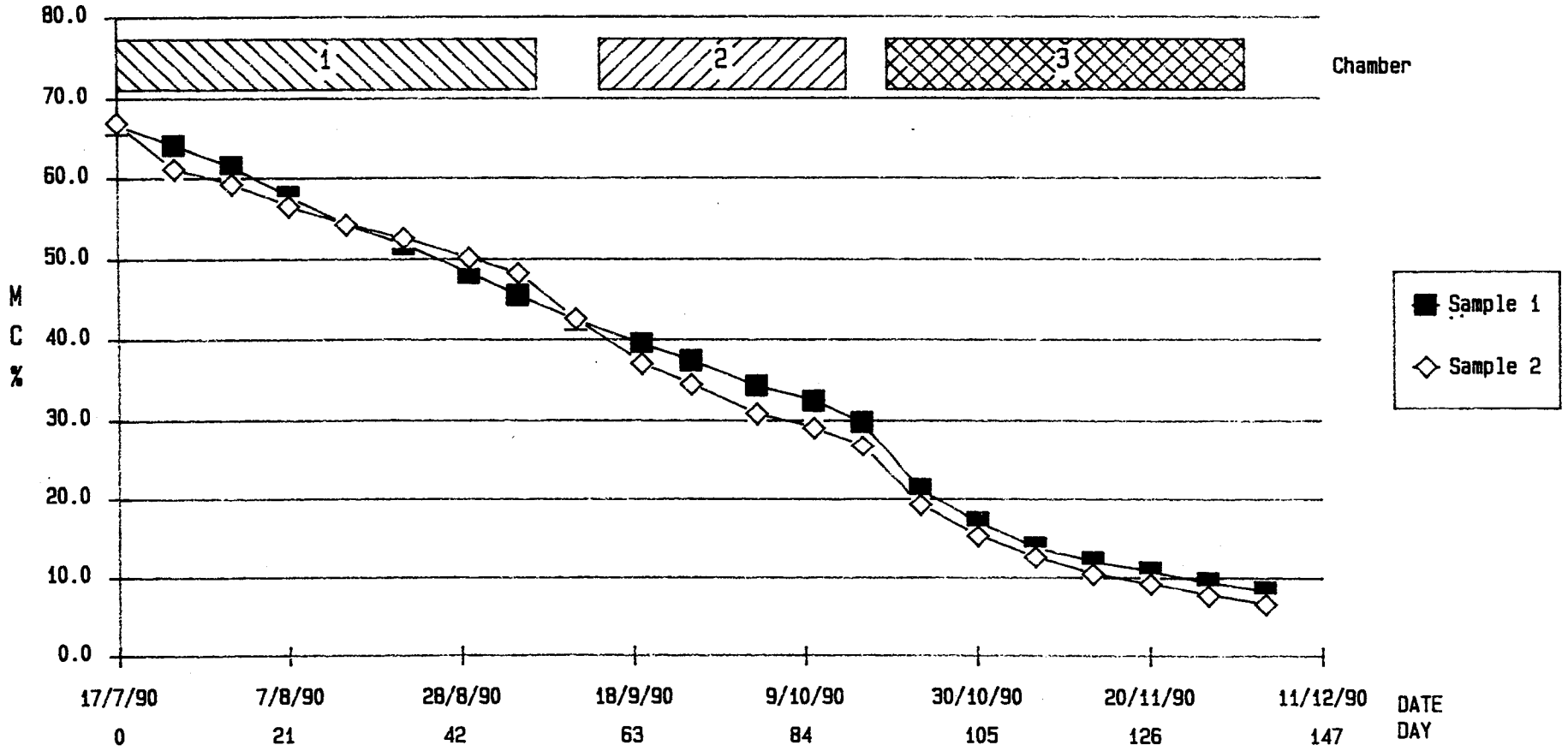


Figure 2. Drying curves for 50 mm mature jarrah using the CALM drying system .



The standard drying time for 50 mm mature jarrah by the local industry using conventional kilns is about 90 days. Thus drying of this charge in the CALM Drying System was slower by approximately one-third. Subsequent charges can be dried faster in the kiln without further degrade, by modifying the set points of the drying conditions. The lowering of the relative humidity and raising of the temperature in chamber 2, are modifications that would result in increased efficiency.

Even if the drying times in the CALM Drying System remain greater than the present industry average, the system must be assessed by its economical viability, which is a balance between capital depreciation costs, running costs, and degrade losses. A cost and performance study of this kiln is planned.

Grading

Following drying and skip dressing, the timber was graded by Bunning's staff into Select and Standard grades. The majority of the 50 mm material was Select grade (Table 1). The amount of material rejected was not recorded, but visual estimates suggested a result of less than 5 per cent by volume.

Table 1

Grading results of 50 mm thick jarrah dried in the CALM Drying System

Grade	Volume (m3)	%
Select	22.1	60.2
Standard	14.6	39.8
TOTAL	36.7	100

Any downgrading to Standard or Reject grades is a combined effect of initial faults and drying degrade. To estimate the comparative effect of these two sources of degrade, a small random sample of the 50 mm material was assessed. This assessment quantified the factors downgrading boards (Table 2). Twist and gum were the two most prevalent factors causing downgrading, and shelling the least prevalent. Surface checks, including checks associated with a wood feature, accounted for only 8 per cent of downgrading. Although twist, cup and spring accounted for 37 per cent of downgrading, it is considered that most would have been eliminated with more accurate milling of the timber. Large variations in thickness were noted in this charge, resulting in thin boards warping owing to the lack of restraint. Adding weights to accurately milled timber would further reduce these types of downgrading. In summary, an estimated 45 per cent of the downgrading was considered unpreventable (eg. timber features), and a large proportion of the downgrading of the remaining boards could have been prevented with improved milling to give more uniform thickness.

Examination of 360 board ends docked during grading revealed only one board with internal checks. A low frequency was expected because of the low temperatures and slow drying rates.

Table 2

Factors causing downgrading of 50 mm mature jarrah from Select to Standard grade

Defect	Number of boards downgraded	Per centage downgraded
Twist	26	19
Gum	25	18
Knots or rot	18	13
Cup	13	9
Spring	12	9
Indeterminable [a]	12	9
Collapse	11	8
Surface checks	10	7
Sawing faults [b]	3	2
Pin holes	2	1
Feature checks [c]	2	1
Bow	2	1
Shelling	1	1
Totals	137	100

a Indeterminable : A single major reason for downgrading could not be determined in the short time available.

b Sawing faults : Want, wane, sapwood or sloping grain.

c Feature checks : Surface checks closely associated with any feature e.g. epicormic buds.

In summary, the CALM kiln heated by solar energy and wood waste is considered efficient for drying timber. Mature jarrah boards of 50 mm thickness dried to 10 per cent MC in 126 days with acceptable amounts of degrade. Ongoing research aims to achieve considerable reductions in drying time as more efficient schedules and control techniques are developed. Further developments to the CALM Drying System that will be assessed include better insulation, active solar heat collection, and variable auxiliary heat.

ACKNOWLEDGEMENTS

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