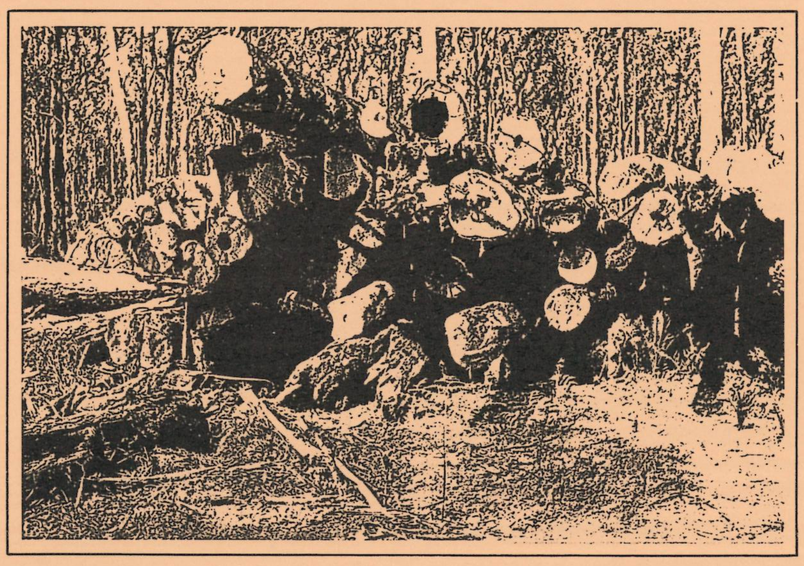
Small Eucalypt Processing

Moisture Content of Jarrah Logging Residues

by G.K. Brennan and B.R. Doust



Report No. 3

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Wood Utilisation Research Centre

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CONTENTS

TABLES

APPENDIX

SUMMARY

Moisture contents of jarrah (*Eucalyptus marginata* Donn ex Sm.) logging residues were assessed from five different sites in the Harvey District. These residues received one, two, three, four or six summers of drying and within each site four log diameter classes were assessed. Logs with their bark intact were sampled in preference to logs without bark.

The study provided quantitative data on the trend of decreasing moisture content with increasing summers of drying. Within diameter classes, the rate of moisture content loss decreased with increasing log size, with an anomaly in the data from the 45 to 60 cm class. Drying time had more effect on moisture loss than differences in log diameter class. Loss of weight and increase in calorific value is associated with this decrease in moisture content.

Regression analysis indicated that the average moisture content of all diameter classes would be about 20 per cent after 10 summers.

To assess possible use of these logging residues for energy production, the weight of residues after a number of summers of drying, transportation costs and gain in calorific value following drying can be estimated from the mean moisture contents. Debarking and/or mechanical splitting of residue logs would greatly increase the drying rate in the field, but increase the overall costs of harvesting and transport.

INTRODUCTION

Wood is an important source of fuel, and has been used for producing domestic energy in Western Australia for many years. Fuelwood from the jarrah *(Eucalyptus marginata* Donn ex Sm.) forest can also be upgraded to charcoal or activated charcoal, and then used as a high grade fuel, a source of carbon or a reducing agent in mineral extraction. The residues left after thinning and logging operations and from dieback sites, are potential resources for a domestic fuelwood industry or charcoal manufacturing industry.

Moisture contents of these residues is important. High moisture contents increase the weight of the wood, increasing transport costs. In addition, the moisture content is critical for the economics of the fuelwood and charcoal manufacturing industries, as additional energy for drying or additional drying space would be required.

The aim of this trial was to compare the moisture contents of different sized jarrah residue logs lying in the forest for up to and including six summers of drying.

MATERIALS AND METHOD

The trial was carried out in the Northern Forest Region. Areas sampled contained residues which had been drying from one to six summers. They were:

a) one summer (logged June 1985) - Map ref:EA 5732, Hadfield Block, Harvey;

b) two summers (logged June 1984) - Map ref: DZ 5785, Hadfield Block, Harvey;

c) three summers (logged December 1983) - Map ref: DV 6613, Kent Block, Harvey;

d) four summers (logged April 1982) - Map ref: EA 6049, Hadfield Block, Harvey;

e) six summers (logged August 1980) - Map ref: DO 6827, Tumlo Block, Dwellingup.

In each sampling area, moisture contents were assessed on five discs (one per log) in each of the following log diameter classes:

a) 15 to 30 cm,

b) 30 to 45 cm,

c) 45 to 60 cm,

d) greater than 60 cm.

The five logs in each diameter class were randomly selected, with the requirements that logs with their bark intact were chosen in preference to logs without bark, as they are likely to contain more moisture. The sample discs were taken at least 0.5 m from the log end to eliminate the effects of the faster drying rates that occur on the log ends.

Radial sections were cut from each disc using a chainsaw in the forest, or a portable bandsaw at the Wood Utilisation Research Centre (WURC) Harvey. The moisture content of these sections was determined by the oven dry method (CSIRO Division of Building Research 1974).

The data were analysed to determine the effect of log diameter and summers of drying on moisture content. Regression analysis was used to produce a table of residue log moisture content by diameter class and summers of drying. The data were then assessed using analysis of variance and Duncan's multiple range test.

RESULTS

Summers of drying and log diameter class interaction

Table 1 summarises the mean moisture contents by diameter classes for the summers of drying investigated. Moisture content decreased with diameter class as the drying time increased. The only increase in moisture content occurred in the 45 to 60 cm and greater than 60 cm classes, between three and four summers of drying. When combining the summers of drying, the 45 to 60 cm class had a higher mean moisture content than the greater than 60 cm class.

Within each diameter class moisture content decreased with increasing drying time, as expected. Samples for four summers of drying were expected to be drier than they were as they only showed a slight decrease compared with those of three summers (the mean difference of combined samples was only 0.7 per cent). In the 45 to 60 cm and greater than 60 cm classes, the moisture content for four summers was actually greater than that for three summers (Table 1). Within each summer of drying, moisture content increased with increasing log size, except the 45 to 60 cm class which had higher moisture contents than the greater than 60 cm class (the mean difference of combined samples was 5.4 per cent).

Results of regression analysis are given in Table 2. The moisture contents for seven to ten summers of drying have been estimated by extrapolation. Table 2 indicates a smooth trend both within each diameter class and summers of drying.

Using Duncan's multiple range test, the significant differences between summers of drying at $P < 0.01$ were calculated. The results for one and two summers were significantly different from those for three and four, which were significantly different from those for six (Table 3).

Differences between diameter classes at $P < 0.01$ are shown in Table 4. The 15 to 30 cm and the 45 to 60 cm diameter classes showed the only significant differences.

Table 1
Mean moisture content of jarrah residue logs after varying drying times

Log diameter class (cm)	Moisture content(%)	Summers of Drying 1	2	3	4	6	Combined
15 - 30	Mean	51.3	46.0	35.8	26.9	28.3	37.3
	S.D.	3.1	8.0	10.1	5.0	3.8	11.5
30 - 45	Mean	55.5	50.5	41.0	40.7	29.2	42.9
	S.D.	7.0	11.5	10.9	5.8	7.4	12.2
45 - 60	Mean	59.2	52.9	50.9	51.5	37.4	50.3
	S.D.	5.6	7.3	15.3	10.5	14.2	12.5
> 60	Mean	56.3	50.1	39.9	44.2	34.0	44.9
	S.D.	8.2	14.8	8.9	5.1	9.7	11.9
Mean moisture content by season	Mean	55.6	49.7	41.4	40.7	32.2	
	S.D.	6.4	10.0	12.0	11.0	9.6	

Table 2
Regression table showing residue moisture content with various interactions of log diameter and summers of drying

	Summers of drying									
Log Diameter Class (cm)	1	2	3	4	5	6	7	8	9	10
15 - 30	47	42	38	34	30	27	24	21	19	17
30 - 45	53	47	42	38	34	30	27	24	21	19
45 - 60	57	51	45	41	36	32	29	26	23	21
> 60	59	53	48	43	38	34	30	27	24	22

NOTE:

1. Moisture contents for 7 to 10 summers of drying have been extrapolated from the 1 to 6 summers of drying results.
2. The r^2 value for the regression is 0.47.

Table 3
Effect of summers of drying on mean moisture content of logs (all diameter classes combined)

No of summers of drying	Mean moisture content (%)	Significance
1	55.6	a
2	49.7	a
3	41.4	b
4	40.7	b
6	32.2	c

The means followed by the same letter are not significantly different at $p < 0.01$ (Duncan's multiple range test).

Table 4
Effect of log diameter class on mean moisture content (all summers of drying combined)

Diameter class (cm)	Mean Moisture content (%)	Significance
15 - 30	37.7	a
30 - 45	42.9	ab
45 - 60	50.3	b
> 60	44.9	ab

Means followed by the same letter are not significantly different at $p < 0.01$ (Duncan's multiple range test).

DISCUSSION

The mean moisture content of the logging residues decreasd as the drying time increased, as expected (Table 1). The samples for four summers of drying were expected to be drier than they were (mean difference between moisture contents for three and four summers was only 0.7 per cent). One reason for this anomaly is that the sampling area for the four summers is on the edge of the Darling Scarp, and according to rainfall records receives more localised rainfall than does the three summers area, which is located about eight kilometres from the edge of the Scarp.

The mean moisture content for the combined log diameter classes increased with increasing log size, except for the 45 to 60 cm class (Table 1). The smaller section material possibly came from logging tops in more aerated positions than the larger material, and the moisture in the core of the smaller sections is closer to the wood surface. The majority of the larger material was the butt sections of large or defective logs left after a logging operation. The large sections would be in contact with ground moisture and not as exposed as the logging tops. In the combined summers of drying, the 45 to 60cm class had moisture contents greater than the greater than 60cm class. Inspections indicated that the bark on logs in the 45 to 60cm class is more likely to remain in place than bark on logs in the greater than 60cm class, thus restricting the removal of moisture from logs in the former class.

The regression table (Table 2) showing the interaction of log diameter and summers of drying indicated that after ten summers the moisture content of all classes would be about 20 per cent, and between six and ten summers the moisture content would only decrease about 10 per cent. As the drying time increases the rate of moisture removal decreases. To increase the drying rate, debarking and/or mechanical splitting then air drying or kiln drying would be necessary.

With all log classes combined, significant differences in moisture content occurred between two and three years, then between four and six (Table 3). These results indicated reasonably consistent drying overall.

The results in Table 4 indicated the significant differences in moisture content for the diameter classes. Only the 15 to 30 cm and the 45 to 60 cm classes were significantly different. These results had a more irregular trend than those in Table 3. This is due to the unexpectedly high moisture contents in the 45 to 60 cm diameter class and the smaller range of moisture contents than in results for summers of drying.

As moisture content decreases, the weight of a cubic metre of logging residue decreases and the calorific value increases, because less energy is required to remove the water. Leaving the residue in the forest to dry for six summers compared with one summer has the advantage of a decrease in weight (reducing transport costs) and an increase in calorific value. A useful method for calculating calorific weight is given in Bootle (1983). The disadvantage of extracting logging residues that have dried for six summers is that this resource may be spread throughout the forest, increasing extraction costs. If a fuelwood operation begins, then logging residues would be snigged to a central landing where they could be stacked, in an integrated harvesting operation with general purpose sawlogs and poles. This would prevent logging machinery moving over the same area twice and increasing the risk of spreading dieback and compacting soil.

The cost of drying jarrah residues to reduce moisture content levels in a commercial kiln depends on the fuel (eg. oil, gas, electicity or wood) used for energy, fixed investment and operating costs. Approximate costs of various fuels reduced to an actual cost in cents per megajoule of usable heat are listed in Appendix 1, taken from Fung (1984). These figures serve as a guide only because they were based on 1984 Australian prices. Fung (1984) discusses the capital and operating costs for energy production in detail.

In conclusion, this study of the moisture content of logging residues provided data on the trends of decreasing moisture content with increasing summers of drying. Within diameter classes, moisture content losses were significantly slower in the larger diameter classes except for the 45 to 60 cm diameter class. Loss of weight and increase in calorific value is associated with this decrease in moisture content. The weight of the logging residues after a number of summers of drying, transportation costs and gains in calorific value following drying can be estimated from the mean moisture contents. Debarking and/or mechanical splitting would greatly increase the drying rate in the field, but increase the overall costs of harvesting and transport. The major problem with cutting and stacking firewood in the forest is security, with a high risk of theft.

REFERENCES

BOOTLE, K.R. (1983). Wood in Australia-Types, properties and uses. McGraw-Hill Book Company, Sydney. 443pp.

CSIRO DIVISION OF BUILDING RESEARCH (1974). Testing timber for moisture content. Special Report.

FUNG, P.Y.H. (1984). Factors influencing the choice of wood energy systems for timber drying. Paper presented at the Timber Drying Seminar Forest Research Institute, Rotorua, New Zealand, 20-22 March 1984.

Appendix 1 Approximate cost of energy for various fuels (From Fung (1984))

Fuel	Basis of costing	Calorific value (MJ/tonne)	Heat recovery efficiency	Fuel cost c/MJ
Wood residue	Sawdust (green) ex mill at $3.50/tonne Woodchips (green) ex mill at $6.00/tonne	10 000	0.65	0.054 0.092
Bituminous steaming coal	5% MC, 14.5% ash) ex mine: $40/tonne 0.35% S) + 60kmcartage: $47/tonne	30 200	0.75	0.177 0.208
Brown coal	150% MC, 7.4% ash) ex mine: $6.50/tonne 1.5% S) + 30 km cartage: $12.50/tonne	9 900	0.55	0.119 0.230
Industrial diesel fuel	$502/tonne	45 500	0.75	1.471
Furnace fuel	Low S 1.0% $316/tonne High S 3.0% $284/tonne	44 500 42 900	0.75 0.75	0.947 0.881
LPG	Ex refinery $304/tonne	50 000	0.75	0.811
Natural gas	*0.261-0.642c/MJ) cost at meter 0.274c/MJ typical)	53 200	0.75 0.75	0.348-0.856 0.365
Electricity	*2.70-19.27c/kWh 7.73c/kWh typical Reverse cycle) off-peak 2.70c/kWh e.g. dehumidifiers) typical 7.73c/kWh		0.95 0.95 3.5 3.5	0.789-5.635 2.260 0.214 0.613

* Melbourne (Australia) Industrial Tariffs