Leaflet No. 6/2009

Ministry of Forestry
Forest Department
Forest Research Institute

Drying Behaviour of Bawzagaing (*Leucaena leucocephala*) and Eucalypt (*Eucalyptus camaldulensis*)

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December, 2009

ဘောစကိုင်းသစ်နှင့် ယူကလစ်သစ်တို့၏ အခြောက်ခံမှုကို လေ့လာခြင်း

အောင်စိုး၊ လက်ထောက်သုတေသနအရာရှိ
စုစုလှိုင်၊ သုတေသနလက်ထောက် (၃)
သစ်တောသုတေသနဌာန

စာတမ်းအကျဉ်း

လွန်ခဲ့သောနှစ်ပေါင်း နှစ်ဆယ်သုံးဆယ်မှစတင်၍ အပူပိုင်းဒေသနိုင်ငံများတွင် ပြုန်းတီးနေသော သစ်တောများကို ပြန်လည်တည်ထောင်ရန်အတွက် အကြီးမြန်သစ်ပင် အမျိုးမျိုးကို ကျယ်ပြန့်စွာ စိုက်ပျိုးလာခဲ့ပါသည်။ ကမ္ဘာတဝန်းတွင် သဘာဝတောများနှင့် သစ်တောစိုက်ခင်းများမှ သစ်ကုဗမီတာပေါင်း ၃.၇ ဘီလီယံခန့် နှစ်စဉ် ထုတ်ယူသုံးစွဲ နေကြပါသည်။ ၁၉၉၀ ခုနှစ်တွင် သစ်ခွဲသားကုဗမီတာပေါင်း ၄၅၆ သန်း သုံးစွဲခဲ့ရာမှ ၂၀၁၀ ခုနှစ်တွင် သစ်ခွဲသားကုဗမီတာပေါင်း ၇၄၅ သန်းခန့် တိုးမြင့်သုံးစွဲနိုင်ကြောင်း ခန့်မှန်းထား ပါသည်။ ဘောစကိုင်း (*Leucaena* leucocephala) ၁၂ ပင်နှင့် ယူကလစ် (*Eucalyptus camaldulensis*) (၃) ပင် တို့ကို ရေဆင်း၊ သစ်တောသုတေသနဌာနဝင်း အတွင်းမှ စုဆောင်းခဲ့ပါသည်။ စုဆောင်းထားရှိသော သစ်လုံးများကို ပျဉ်းမနားမြို့ရှိ ရွှေသပြေသစ်အခြေခံစက်ရုံနှင့် သစ်တောသုတေသနဌာနရှိ သစ်စက်တို့တွင် ခွဲစိပ်ခဲ့ပါသည်။ သစ်ခွဲသားများသည် ၃ ၁ လက်မ နှင့် ဖြက်အရွယ်အစား အမျိုးမျိုးရှိကြပါသည်။ ဤစာတမ်းတွင် ဘောစကိုင်းသစ်နှင့် ယူကလစ်သစ်တို့၏ သဘာဝလေဖြင့် အခြောက်ခံခြင်းနှင့် ရေနွေးငွေ့ပေါင်းဖိုဖြင့် အခြောက်ခံခြင်းတို့ကို လေ့လာထားပါသည်။ ရေဆင်း၊ နေပြည်တော်၌ နွေရာသီနှင့် ဆောင်းရာသီတို့တွင် စမ်းသပ်ချက်များအရ (၁) လက်မဒုရှိ ဘောစကိုင်းသစ်နှင့် ယူကလစ်သစ်များကို အစိုဓါတ်ပါဝင်မှုနှုန်း ၁၀ရာခိုင်နှုန်းနှင့် ၁၂ရာခိုင်နှုန်းအောက် ရရှိရန် လေဖြင့် အခြောက်ခံနိုင်ကြောင်း တွေ့ရှိရပါသည်။ ရေနွေးငွေ့ပေါင်းဖိုဖြင့် အခြောက်ခံရာတွင် ဘောစကိုင်းသစ်သည် နာရီ (၉၀) အတွင်း အစိုဓါတ် (၁၀) ရာခိုင်နှုန်းသို့ လျှော့ချနိုင်ပြီး ယူကလစ်သစ်သည် (၉) ရက်အတွင်း အစိုဓါတ် (၁၀) ရာခိုင်နှုန်းသို့ လျှော့ချနိုင်ကြောင်း တွေ့ရှိခဲ့ပါသည်။

Drying Behaviour of Bawzagaing (*Leucaena leucocephala*) and Eucalypt (*Eucalyptus camaldulensis*)

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Abstract

Many species of fast growing trees has been planted wide area of tropical countries for reforestation of devastated forest in last 20 to 30 years. In present time the used of these are limited fuels and wood tip for pulp. The more valuable uses than wood tips are required by these countries to strengthen the people's will to reforest and to built-up the sustainable forest management of tropical forests. The research for wood quality and developing new product from these trees, are carried out by the universities and national research institutes in some of these tropical countries. Wood is the most important regrowing raw material in the world due to its wide range of applications. Wood is used as an energy source, as raw material for paper processing and as construction material in the building and furniture industry. 3.7 billion m^3 of natural and replanted forest are felled world-wide every year. The annual sawn wood consumption, is expected to increase from 456 million m^3 in 1990 to 745 million m^3 2010. Twelve Bawzagaing (*L.leucocephala*) trees and three Eucalyptus (*E.camaldulensis*) trees of different sizes from the Forest Research Institute campus were selected for this study. Bawzagaing logs were swan into 1-inch thick board of different widths at the Shwe Tha Pye Wood Based Industry in Pyinmana whereas Eucalypts logs were sawn at the Forest Research Institute sawmill. Bawzagaing and Eucalyptus lumber of 1-inch (25 mm) thick can be air-dried without occurring objectionable drying defects during the winter and summer time in Yezin, Nay Pyi Taw, to attain moisture contents below 10 percent and 12 percent. One inch (25 mm) thick Bawzagaing and Eucalyptus lumber can be kiln-dried without occurring objectionable drying defects to attain 10 percent moisture content within 90 hours and around 9 days.

Keywords. Bawzagaing (*L. leucocephala*) and Eucalyptus (*E.camaldulensis*), air drying, kiln drying, drying defects

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1. Introduction

Many species of fast growing trees has been planted wide area of tropical countries for reforestation of devastated forest in last 20 to 30 years. In present time the used of these are limited fuels and wood tip for pulp. The more valuable uses than wood tips are required by these countries to strengthen the people's will to reforest and to built-up the sustainable forest management of tropical forests. The research for wood quality and developing new products from these trees, are carried out by the universities and national research institutes in some of these tropical countries (Yoji Kikata et.al, 1997).

Wood is the most important regrowing raw material in the world due to its wide range of applications. Wood is used as an energy source, as raw material for paper processing and as construction material in the building and furniture industry. 3.7 billion m^3 of natural and replanted forest are felled world-wide every year. The annual sawn wood consumption, is expected to increase from 456 million m^3 in 1990 to 745 million m^3 2010 (Ing and Muhlbauer, 2003).

Bawzagaing (*Leucaena leucocephala*) has it origins in Central America and Yucatan Peninsula of Mexico where its fodder value was organized over 400 years ago by the Spanish conquistadors who carried Bawzagaing feed and seed on their galleons to the Philippines to feed their stock. Bawzagaing is native throughout the west Indies from Bahamas and Cuba to Trinidad and Tobago, and from southern America, Naturalized north ward to southern Texas California and Southern Florida, and southward to Brazil and Chile: also naturalized in Hawaii and the old world tropics. It has spread pantropically due to its value, particularly for forage, but also for wood, green manure and shade (Aganga & Tshwenyane, 2000). Ninty acres of Bawzagaing were planted for fuel wood at Shweminwun unclassed forest near Shwedah Village, Yemathin Township by Forest Department of Myanmar in 1984. (Record from F.D, Yemathin Township)

Eucalypt (*Eucalyptus camaldulensis*) Syn. *E.rostrata* Schlecht. belongs to the family Myrtaceae and is a native of Australia where it is one of the most widespread species of the genus *Eucalyptus* confining mainly to river banks and damp depressions. It is a medium-sized tree attaining a height of about 114 feet with a diameter of 6 feet 7 inches, but some times reaching a height up to 148 feet. It frequently has a short bole and heavy, wide spread crown.

An economical and sustainable alternative to the often illegally cut tropical wood species can be seen in fast growing eucalyptus species. Originally coming from Australia, Tasmania, Papua New Guines and part of Indonesia and the Philippines. Eucalyptus was first introduced to Brazil in 1904. Today Brazil processes about 3 million hectares respectively 27% of all reforested eucalypt plantation world-wide, which makes it the world largest producer of eucalypt wood. More than 720 different eucalypt species are described, with about 250 of them being used in the wood working industry. The most common eucalypt species grown in Brazilian plantation. Special attention in currently paid to Eucalypt grandis due to its characteristics similarly to mahogany (Ing & Miihlbauer, 2003).

The aims of this study are;

- To conduct air-drying tests and kiln-drying tests on Bawzagaing and Eucalyptus lumber in order to know the drying behaviour of these species.
- To carry out the “Quick Drying Tests” on Bawzagaing and Eucalyptus lumber in order to get the proposed kiln schedules for these two species.

2. Literature review

2.1. Bawzagaing

Bawzagaing a widely planted multipurpose tree from tropical America introduced to most of the tropics. Forms monotypic stands in dry lowland area of oceanic islands and regenerated freely in most of the tropics. Deciduous trees usually growing to 9m and in some places up to 18 m high. Bawzagaing has moderate tolerance for shade as it can regenerate under its own canopy. It is used as a shade plant in coffee, rubber, cacao and cinchona plantations, for reforestation, windbreaks and firebreaks. Necklaces are made with the seeds. Bawzagaing and other woody invaders of lowland dry vegetation of oceanic islands probably have same, as yet undetermined, competitive advantage over native species lack the characteristics necessary to cope with high levels of human disturbance (Aganga & Tshwenyane, 2007).

Mexico and Central America is the native range of lead tree of *Leucaena leucocephala*. Lead tree was most likely distributed by man because of its many uses. This multipurpose tree is used for fuel wood, lumber, animal fodder and green manure. There are no known mechanical controls for lead tree. Continuous cutting will eventually kill longer trees. Frequent mowing or grazing will kill smaller plants (Langelant & Craddock Burks,1998).

2.2. Eucalypt

The largest planted genus, Eucalyptus had major areas in India (30%) and Brazil (26%) followed by China (7%), South Africa (5%), Vietnam (5%), Uruguay (3%), Pegu (3%), Argentina (2%) and others. Eucalyptus plantations in Africa countries like Morocco, Madagascar, Ethiopia, Rwanda, Sudan each had significant area (750000 ha) grown mainly for fuel wood and other non- industrial purpose. The Brazilian furniture industry consumes about 45 million $m^3$of sawn wood per year which is mainly supplied by deforestation of the tropical rainforest. At the same time, fast growing eucalypt species are produced on almost 3 million ha for the production of wood pulp and charcoal. Meanwhile, several Brazilian companies try to substitute the expensive natural woods by hardwood from eucalypt trees for the production of high quality sawn wood. Most of the eucalyptus plantation of Peru and Uruguay were also for industrial purposes. Eucalyptus plantation in India, Vietnam and Pakistan met both industrial and non-industrial needs (Anon, 2000).

Eucalypt plantations were first introduced in Myanmar in 1922, on trial basis and for amenity planting. During the year 1922-29, about 600 acres of seven eucalyptus species had been planted as trial plantation. The species were, *E.rostrata* (E.*camaldulensis*), *E.amygdalina*, *E.maculata*, *E.resinifera*, *E.tereticoris*, *E.citriodora* and *E.saligna*. From these trial plantings, the following results were recorded. Among the seven species, *E.camaldulensis* was the best found. Two years old stump of *E.camaldulensis* gave 50% survival. Plantation of eucalyptus species were stopped from 1922 to 1966 because of the high establishment cost, low survival rate and the sufficiency of fuel wood (Ohn Lwin,1993).

The Forest Department had planted seven eucalyptus species in trial plantation during 1967 to 1969. The trial species were *E.camaldulensis*, *E.grandis*, *E.robusta*, *E.tereticoris*, *E.citriodora*, *E. saligna* and *E.globus*. Among the seven species *E.camaldulensi*s for its adaptability to survive severe climatic and edaphic conditions, ease of establishment and wide ranging usefulness, was selected for large scale planting since 1970. About 45523 acres (18423 ha) of Eucalyptus had been planted in Myanmar by 1989 (Forest Department, 1997).

The anatomical structure, physical and mechanical properties of plantation grown *Eucalyptus camaldulensis* Dehn. of Myanmar are described and recorded from observations and tests made on specimens from a tree collected from Kyaukpadaung, Manadalay Division. This is the first recorded instance in which investigation on plantation timber of the species in Myanmar has been made (Ral Lian Sum & Win Kyi, 1975). It was noted that, *E.camaldulensis* is slightly heavier and has less shrinkage than In (*Dipterocarpus tuberculatus*). It was also reported that, *E.camaldulensis* is slightly

stronger than In, Kanyin-byu (*Dipterocarpus alatus*) and Kyun (*Tectona grandis*) and is slightly lower in strength than Thitya (*Shorea oblongiflolia*) and Ingyin (*Pentaeme siamensis*). However, it is inferior to Padauk (*Pterocarpus microcarpus*) and Pyinkado (*Xylia xylocarpa).*

Green eucalypt wood has moisture content between 60 and 100% which has to be reduced to moisture contents between 8 and 12% before it can be manufactured to high quality products in the furniture industry. This low moisture content is not only required for a higher resistance against pest and to improve the mechanical properties but also for a high deformation resistance of the final products. Since wood is a hygroscopic material, it adapts its moisture content to the surrounding air conditions. A changing wood moisture content is result is swelling respectively shrinking and consequently in deformations. In this respect especially eucalypt wood is extremely prone to deformations due to a high anisotropy factor, a high wood density variation within the log and a severe spiral growth. Furthermore, the fast growing eucalypts are often characterized by high growth stresses which results in checking during felling and forced drying. Eucalypts are also highly susceptible to cell collapse when using an inadequate drying process. These unfavorable wood properties can only partially be equalized by an adequate sawing and drying technique. A drying process that prevents quality losses and allows the production of eucalypt wood with a stable average moisture content and on uniform moisture distribution in both the single board and in the whole timber load (Ing & Muhlbauer, 2003). This means that suitable processing of the eucalypt wood is essential for the production of high quality products for national and international markets.

According to Vermaas (1990) eucalypt wood generally dries slowly. Typical features are collapse, surface checking, high shrinkage, steep moisture gradients and pronounced drying stresses. Checking has always been a major cause of timber degradation during drying, especially in the case of hardwoods. Most eucalypt species have mean basic densities of 500-800 kgm^{-3} (Campbell and Hartley, 1984). They are relatively impermeable and difficult to season. At moisture contents above the fibre-saturation point they show an increasing tendency to check and collapse with rise in temperatures. In kiln drying green timber 25 mm thick or more; the drying temperatures should not exceed about $45^{\circ}C$ during the early stages and the relative humidity should be kept high, otherwise surface checking or internal checking (honeycombing) may develop. Despite this, with care and technical skill, seasoned timber of high quality can be produced commercially from a wide range of eucalypts.

It was also noticed that in Australia, special drying techniques are used to dry Eucalyptus lumber, where it has been found that a relationship apparently exists between

the moisture content (MC) of the core of sawn section and collapse. It was also succeeded that steaming process before air-drying or kiln-drying has been done.

The main uses for the wood of planted *Eucalyptus camaldulensis* have been for poles, posts, firewood, and charcoal. In Argentina, Israel, Mexico, Spain and Thailand it is used for hardboard and particleboard, and in Myanmar, California, India, Morocco, Portugal and Spain it is used for paper pulp. It is sawn into boards, though sometimes of not very good quality, and is used for fruit cases in Argentina and Turkey (Ken Eldridge et.al, 1997).

3. Materials and Methods

Twelve Bawzagaing trees and three *E.camaldulensis* trees of different sizes from the Forest Research Institute campus were selected for this study. Girth at breast height and stem length of each and every tree were measured and recorded before felling the trees. Then each stem was cut into 9-foot bolt and mid girth of each bolt were also measured and recorded. Bawzagaing logs were sawn into 1-inch thick board of different widths at the Shwe Tha Pye Wood Based Industry in Pyinmana whereas Eucalypts logs were sawn at the Forest Research Institute sawmill.

Finally, the boards from each species were equally divided into two groups. The boards consisted in Group I were for air drying tests and those in Group II were for kiln drying tests.

3.1. Air Drying Test

Bawzagaing and Eucalyptus boards for air drying test were stacked properly in the air drying shed at FRI, Yezin. The length of the piles is from east to west in order to attain the maximum air-flow through the lumber pile. The length and width of each lumber pile were 9 feet and 4 feet respectively.

Three sample boards were placed in each lumber pile in order to estimate the drying rate and to examine the drying defects. Each and every sample board was weighed once a week and the current moisture content were estimated.

Stacking and piling of lumber, selecting and weighing of sample boards and estimating the weekly moisture content of the sample boards were done properly according to the standard producers given in “Air Drying of Lumber” (Reitz and Page, 1971). To know the drying defects occurred in the tested boards, each and every board will examined carefully at the end of the air drying tests.

3.2. Kiln Drying Tests

To estimate the first kiln drying schedule for each species, "The Quick Drying Test" (Terazawa, 1965, 1976) was carried out.

Eight sample blocks of size (100 x 25 x 200 mm^3) for each species were cut from the corresponding boards which are free from knots and decay. Four surfaces (excluding too ends) of every sample were planned by planning machine. Unlike the ordinary drying test, coating on ends was omitted.

Then, sample blocks were dried in an oven at a temperature of 103 ± 2°C. Two drying defects, check and deformation occurred in each of the tested blocks were examined carefully at one hour interval.

At the end of the drying test, i.e. after attaining the oven-dry weight, each block was cut at the center, in order to observe the degree of honeycombing and cross-sectional deformation.

The results obtained from "Quick Drying Tests" for each species are given in Table (3) together with the schedule codes. And the corresponding proposed kiln schedules for each species are given in Table (5) and (6).

Based on the grades of drying defects occurred, proposed kiln drying schedules for each species were determined.

Finally, the tested boards of each species were kiln-dried in a steam kiln of capacity 25 ft^3 (0.7 m^3), (Irvington moore, Forest Products Division of Jacksonville, FL, USA), following the corresponding kiln schedule which were determined by the "Quick Drying Test". Kiln drying tests were conducted in the Wood Drying Laboratory, FRI.

4. Results and Discussion

4.1. Air Drying Test

4.1.1 Bawzagaing

The average initial moisture content, the average final moisture content together with the weekly average moisture content of the test sample boards are given in Table (1). Air drying test was started in the second week of May, 2008 and terminated in the first week of December 2008.

To observe the drying rates and seasonal variation of moisture content, air drying curve is shown in figure (1). According to table (1), the average initial moisture content

of Bawzagaing sample boards is found to be 28.2%. And the corresponding average final moisture content attained at the end of the test was found to be 9.7%. In drying of lumber, the temperature and relative humidity of a region is decisive for the rate of drying. So, monthly weather data on temperature, relative humidity and rainfall are given in Table (4) in order to reveal the climatic condition of Yezin region. These data were obtained from a weather station in the Forest Research Institute campus.

At the end of the air drying tests, each boards were examined carefully in order to know the drying defects occurred. No surface check, no end checks and no signs of warping and distortion were found in Bawzagaing boards. No discoloration and no signs of decay were also seen. At the last week of January 2009, about one-fourth of the Bawzagaing boards were found to be attacked by insects. In this study, each tested boards was found to be free from warping. This advantage was gained because of the following performances done in sawing logs, stacking and piling of boards.

(1) The tested boards have uniform thickness (1 inch - 25 mm), which is a desirable quality for stacking.

(2) The tested boards were stacked immediately after sawing the logs. Because the drying process starts when a log is sawed into lumber, and soon after stacking, shrinkage of the boards begins.

(3) The tiers of stickers and other supporting members, such as foundation cross beams and bolsters, were placed in good alignment.

(4) Over-loads were placed properly on top of the pile soon after stacking the boards. They were placed in the same alignment with the stickers.

Based on the results gained from this air drying test, it can be seen that Bawzagaing lumber of 1-inch (25 mm) thick can be air-dried without occurring objectionable drying defects, during the winter and summer time in Yezin, Nay Pyi Taw, to attain a final moisture content below 10 percent.

4.1.2. Eucalypt

The average initial moisture content, the average final moisture content together with the weekly average moisture content of the tested sample boards are given in Table (2). Air drying test was started in the second week of October, 2008 and terminated in the first week of March, 2009.

To observe the drying rates and seasonal variation of moisture content, air drying curve is shown in figure (2). According to table (2), the average initial moisture content

of the sample boards of Eucalyptus is found to be 33.1% and the corresponding average final moisture content attained at the end of the test was found to be 11.6%.

Monthly weather data on temperature, relative humidity and rainfall are given in Table (4) in order to reveal the climatic condition of Yezin region. These data were obtained from a weather station in the Forest Research Institute Campus.

At the end of the air-drying process, a significant increased in length and depth of surface checks were observed. Beside this, an extreme development of hair check at the board surface was observed during this process. The end checks at the base of tree were significantly higher than at the top logs. Warp such as twist and bow caused by shrinkage, and end check were also found on some boards. As a consequence of drying process cup was build-up and crook increased significantly.

4.2 Kiln Drying Test

4.2.1. Bawzagaing

The results obtained from "Quick Drying Test" for Bawzagaing sample boards are given in Table (3) together with the schedule code and the corresponding proposed kiln schedule is given in Table (5).

To observe the drying rate, kiln drying curve for Bawzagaing is also shown in Figure (3). According to Figure (3), it can be seen that 1-inch (25mm) thick lumber of Bawzagaing can attain an average final moisture content 10.2 % within 90 hours.

According to the kiln drying curve shown in Figure (3), the drying rate of Bawzagaing was found to be slow after attaining MC around 30%. The desired final moisture content of the Bawzagaing boards was 10%. At the end of the test, equalizing treatment and conditioning treatment were also carried out. No drying defects such as surface check, end check and warping were found. No fungus attack and insect attack were also seen.

4.2.2. Eucalypt

The results obtained from "Quick Drying Test" for Eucalyptus are given in Table (3) together with the schedule code and the corresponding proposed kiln schedule for Eucalyptus is given in Table (6).

To observe the drying rate, kiln drying curve is also shown in Figure (4). According to Figure (4), it can be seen that 1-inch (25mm) thick Eucalyptus lumber can

attain an average final moisture content of 12% within 222 hours. According to the kiln drying curve shown in Figure (4), the drying rate of *Eucalyptus camaldulensis* was found to be 2 % decrease per 12 hours. The desired final moisture content of the boards of Eucalyptus was 10%. At the end of the test, equalizing and conditioning treatments were done when the MC of the driest sample board was 2% below the desired final MC. A few end checks and splits were occurred. Cupping was also observed because of less lumber thickness and more lumber width.

5. Conclusion

The following conclusions can be drawn from this study.

(1) Bawzagaing lumber of 1-inch (25 mm) thick can be air-dried without occurring objectionable drying defects during the winter and summer time in Yezin, Nay Pyi Taw, to attain a final moisture content below 10 percent.

(2) One inch (25 mm) thick Bawzagaing lumber can be kiln-dried without occurring objectionable drying defects to attain 10 percent moisture content within 90 hours.

(3) Eucalyptus lumber of 1-inch (25 mm) thick can be air-dried during the winter and summer time in Yezin, Nay Pyi Taw, to attain 12 percent moisture content. A few end checks and several surface checks were occurred at the early stage of air drying.

(4) One inch (25 mm) thick Eucalypts lumber can be kiln-dried to attain 10 percent moisture content around 9 days. A few end checks and splits were occurred. And few cupping was also observed.

(5) Eucalyptus wood has to be dried **very carefully under controlled conditions** to prevent drying defects.

Table (1)- Air Drying of Bawzagaing

Sr.No	Date	Week	Average moisture content of sample boards (%)
1	13-5-08	0	28.2
2	20-5-08	1	24.8
3	27-5-08	2	21.9
4	3-6-08	3	19.6
5	10-6-08	4	18.5
6	17-6-08	5	17.6
7	24-6-08	6	16.7
8	1-7-08	7	17.6
9	8-7-08	8	17.4
10	15-7-08	9	17.4
11	22-7-08	10	17.2
12	29-7-08	11	17.2
13	5-8-08	12	16.1
14	12-8-08	13	15.7
15	19-8-08	14	15.5
16	26-8-08	15	16.3
17	2-9-08	16	15.2
18	9-9-08	17	14.9
19	16-9-08	18	13.8
20	23-9-08	19	13.6
21	30-9-08	20	13.7
22	7-10-08	21	12.7
23	14-10-08	22	11.4
24	21-10-08	23	12.2
25	28-10-08	24	11.5
26	4-11-08	25	10.9
27	11-11-08	26	10.6
28	18-11-08	27	10.0
29	25-11-08	28	10.0
30	2-12-08	29	9.7

Table (2)- Air Drying of *Eucalyptus camaldulensis*

Sr.No	Date	Week	Average moisture content of sample boards (%)
1	24-10-08	0	33.1
2	31-10-08	1	31.6
3	7-11-08	2	29.7
4	14-11-08	3	26.5
5	21-11-08	4	24.9
6	28-11-08	5	22.7
7	5-12-08	6	20.8
8	12-12-08	7	19.6
9	19-12-08	8	19.0
10	26-12-08	9	17.9
11	2-1-09	10	16.7
12	9-1-09	11	16.0
13	16-1-09	12	15.4
14	23-1-09	13	14.9
15	30-1-09	14	13.7
16	6-2-09	15	13.3
17	13-2-09	16	13.1
18	20-2-09	17	12.1
19	27-2-09	18	12.7
20	6-3-09	19	12.7
21	13-3-09	20	12.0
22	20-3-09	21	11.6

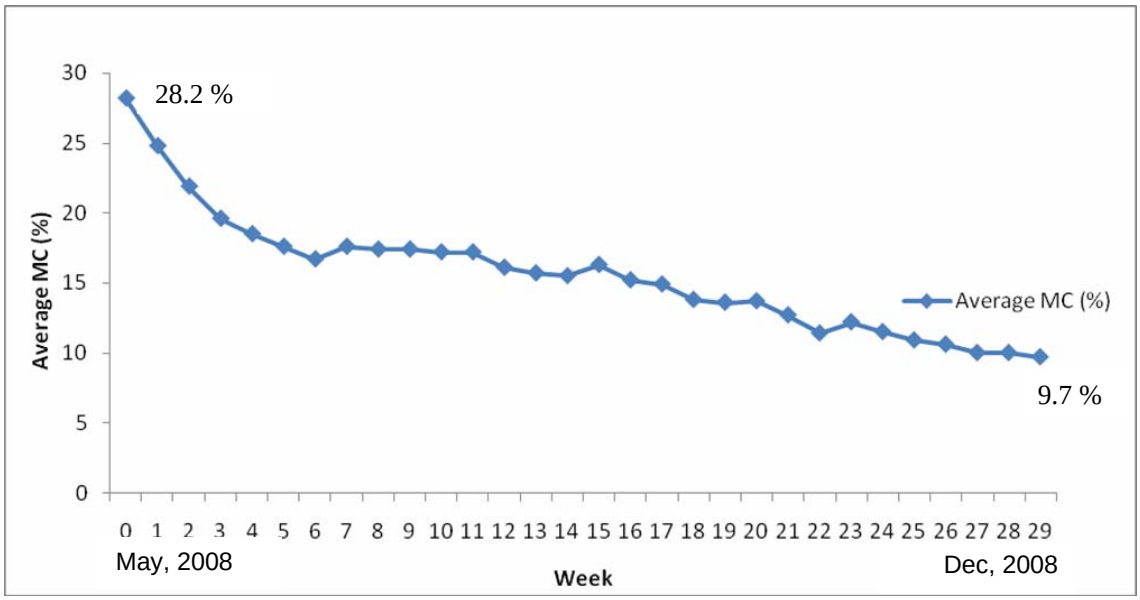

Fig (1) – Air drying curves of Bawzagaing

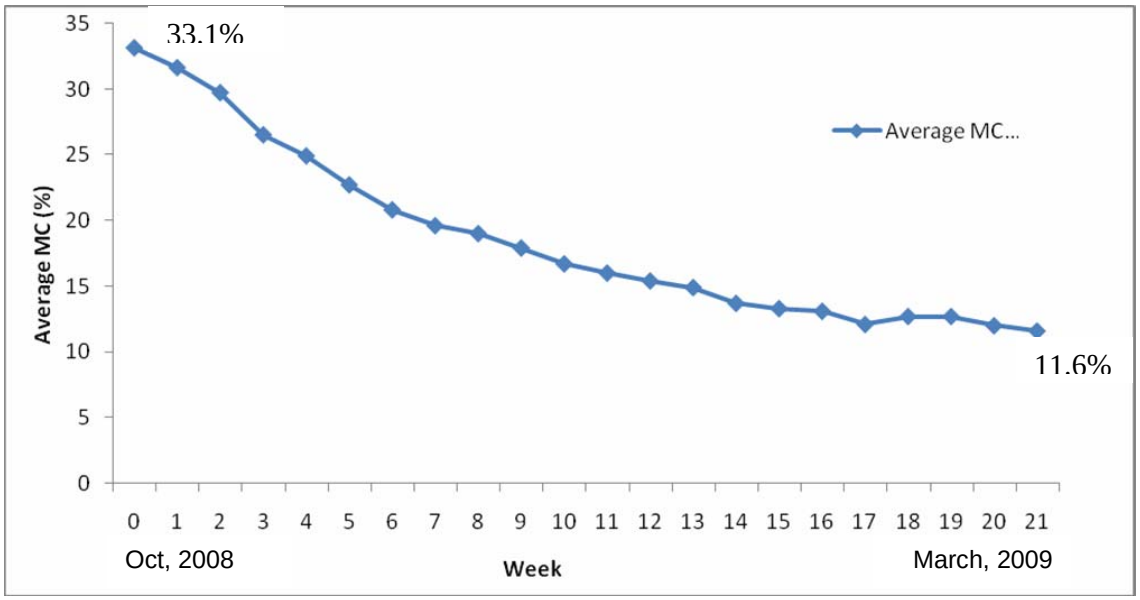

Fig (2) – Air drying curves of *Eucalyptus camaldulensis*

Table (3) – Results of Quick Drying Test

Species	Grading of defects			Estimated Condition			Initial moisture content (%)	Estimated Drying Time (days)	Schedule Code *
	Initial Check	Defor-mation	Internal Check	Initial DBT (˚C)	Initial WBD (˚C)	Final DBT (˚C)			
Bawzagaing	3	1	1	60	4	85	56.33	3 - 4	D_{42}/W_{33}
Eucalypt	6	3	6	50	2	89	55.20	9 - 10	D_{21}/W_{13}

* D = indicate the code number of patternized temperature schedule

W = indicate patternized wet bulb depression schedule

WBT = Web Bulb Temperature

DBT = Dry Bulb Temperature

WBD = Web Bulb Depression (DBT –WBT)

(Source: Terazawa,et.al.,1965)

Table (4) – Monthly Temperature and Rainfall (FRI, Yezin)

Month	Temperature (˚C)			Av.RH (%)	Rainfall	
	AV.	Min.	Max.		No of Days	Precipitation (mm)
May,08	24.8	17.2	32.5	48.4	10	147.83
June, 08	25.4	17.7	33.0	52.2	11	274.32
July, 08	26.4	19.4	33.4	52.7	18	266.70
Aug,08	27.5	22.3	33.4	53.6	7	134.11
Sep, 08	27.8	22.1	33.4	53.6	7	105.16
Oct,08	27.4	22.0	32.8	52.0	7	183.90
Nov, 08	25.9	20.0	31.8	47.6	-	-
Dec, 08	24.3	17.9	30.8	43.8	-	-
Jan,09	24.0	17.5	30.4	44.4	-	-
Feb,09	24.3	17.8	30.8	44.3	-	-
March,09	24.5	17.4	31.7	46.1	1	7.62

Source: Natural Resources Division, FRI, Yezin.

Table (5) – Kiln Drying Schedule of Bawzagaing (Thickness 25 mm)

Moisture Content (%)	Dry Bulb Temperature (°C)	Wet Bulb Depression (°C)	Relative Humidity (%)
Above 50	60	4	82
45 ~50	60	5	77
40 ~ 45	60	7	69
35 ~ 40	60	9	62
30 ~ 35	65	12	54
25 ~ 30	70	16	45
20 ~ 25	75	21	35
15 ~ 20	80	30	22
10 ~ 15	85	30	23

Table (6) –Kiln Drying Schedule of *Eucalyptus camaldulensis* (Thickness 25 mm)

Moisture Content (%)	Dry Bulb Temperature (°C)	Wet Bulb Depression (°C)	Relative Humidity (%)
Above 45	50	2	89
40 ~ 45	50	2.5	87
35 ~ 40	50	3	85
30 ~ 35	50	5	75
25 ~ 30	55	7	68
20 ~ 25	60	10	59
15 ~ 20	65	16	43
10 ~ 15	75	25	28

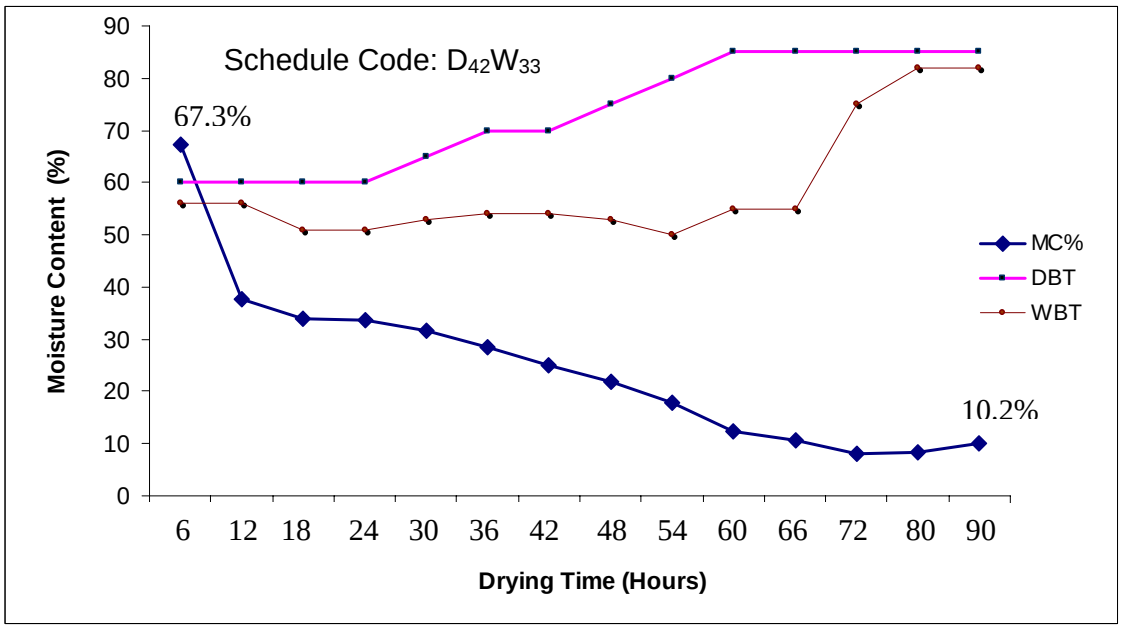

Fig (3) -Kiln drying process of Bawzagaing

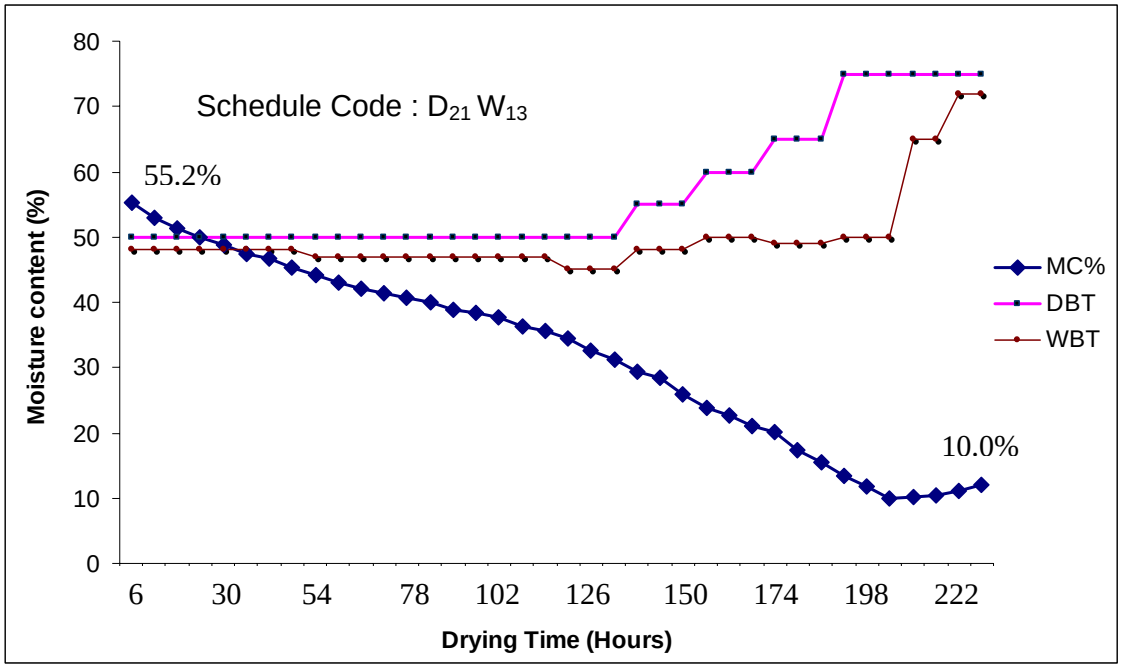

Fig (4)- Kiln drying process of *Eucalyptus camaldulensis*

Acknowledgements

I am grateful to Dr. Nyi Nyi Kyaw, Director, Forest Research Institute for the permission to undertake this research. I am grateful to Prof. U Win Kyi (Retired Rector) University of Forestry for his invaluable advice while I am preparing this paper. Last but not the least I would like to express my thank to the staff members of FRI.

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