Journal of Engineering and Applied Sciences 11 (8): 1784-1787, 2016
ISSN: 1816-949X

Moisture Content Assessment of Heat Treated Malaysian Timber: The Case of Keruing (*Dipterocarpus* sp.) And Light Red Meranti (*Shorea* sp.)

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Abstract: In order to improve a timber natural quality and equip the timber with new upgraded properties, the timber must be treated. One of the methods of treatment which is environmental friendly is heat treatment. The high level of temperature used in this treatment will modify the properties of timber by using high temperature instead of using chemical preservatives as common practice. This study presents the effect of heat treatment on physical properties which is moisture content for two types of Malaysia hardwood timber namely keruing and light red meranti. Ceramic fiber had been used as material to design an electronic furnace was used as an oven for the heat treatment process. The result shows a reduction in moisture content for both species after heat treatment and the difference is significant. Lower in moisture content indicates a positive indicator which theoretically leading to the increment of movement stability and maximise the strength because mechanical properties is increasing when moisture content is low.

Key words: Malaysian timber, heat treatment, moisture content, hardware, practice

INTRODUCTION

The reasons why timber been selected to build a structure for many centuries is because of its durability and comes from natural sources which makes timber as a unique material. Timber is still relevant as a structural material as the number of its demand keep increasing. Based on Malaysian Timber Industry Board (MTIB), the graph of Malaysia major export of timber showed increment year by year. Due to this demand, the quality control of the timber properties is important. In order to ensure that timber can be used safely in many structural forms, the properties of timber is the most important factor to be considered. It is one of the oldest building materials been used to build man's shelters. However, there is a limit on timber usage based on its properties and characteristics. For above ground uses, a timber species rated with moderately durable or better can be used and those species that rated as very durable or better are suitable for above ground and also for ground contact use. This limit has defined timbers as a material that not under all conditions is an appropriate building material. The naturally durable timber is limited and considered expensive. Therefore the use of non-natural durable timber is the alternative. However, this timber needs to be modified or treated to help improve its durability properties. The most commonly method of treatment for timber is by using chemical preservatives such as Copper Chromium Arsenic (CCA). There are many issues arise related to CCA due to the usage of chemical preservatives during treatment process that are toxic. CCA can give a threat to the health of human. EC Scientific Committee on Toxicity, Eco-toxicity and the Environment (CSTEE) had announced that CCA is both genotoxic and carcinogenic which means CCA may give a risk of cancer especially in lung, bladder, kidney and liver.

As Malaysia still treating the timber by using this method, alternative treatment method need to be explored and made available in this country to overcome this issue. One of the possible methods of treatment is heat treatment which using high level of temperature heat rather than chemicals. This method of treatment will alter the substrate of a timber species by using high level of temperature not by using chemical preservatives. Heat treatment is the most environmental friendly way to treat a timber species that will be an alternative way to replace CCA.

When timber is treated with heat treatment (the temperature is between approximately 150 and 220°C), the main purpose is to achieve new material properties rather than to dry the wood. The main aim of this treatment is to increase the biological durability and enhance dimensional stability which can be achieved. The durability and dimensional stability were strongly related to moisture content as both of these behavior will change with the different level of moisture content. The

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temperature above 150°C applied in this treatment will lead to permanent changes of the timber properties and durability (Sundqvist, 2004) exposed spruce with heat treatment and reported that heat treatment can reduce the mechanical properties and may form inner cracks.

As stated in (Esteves and Pereira, 2008), keruing and light red meranti are listed as timbers which required treatment to improve its properties and durability before can be used in the industry. The objective of this paper is to assess the effect on one of timber physical properties; the moisture content of these two Malaysian hardwood timbers; Keruing (*Dipterocarpus* sp.) and Light Red Meranti (*Shorea* sp.) treated by heat at temperature level of 150, 170, 190 and 210°C within 1 h duration.

MATERIALS AND METHODS

This study utilized the solid hardwood timber namely Keruing (*Dipterocarpus* sp.) and Light Red Meranti (*Shorea* sp.). The timber been treated by four different heat temperature level; 150, 170, 190 and 210°C within one hour duration. The 15 samples of green (wet) timbers with Moisture Content (MC) >19% and size of 50×90×1800 mm were prepared respectively for each of the mentioned heat treatment temperatures. All samples were weighted prior to the test.

Those samples were stored in the conditioning room for 2 week prior to the heat treatment process. The conditioning room has 65% of relative humidity with temperature level of 24°C. After conditioning process, the reading of moisture content had been taken by using moisture meter. The readings were taken as the data for moisture content reading before heat treatment. Heat treatment was then executed on the samples after the conditioning process which was conducted at Margin Heat Treatment and NDT Services Sdn Bhd, Shah Alam. A special electrical furnace made up from ceramic fiber acted as an oven was designed and prepared according to the size and numbers of the samples as shown in Fig. 1.

About 15 samples for each temperature set up were put into the electrical furnace in arrangement of what shown in Fig. 2. The heat treatment was performed within one hour duration in an oven which connected to the induction heating machine used to control the heat applied to the timber.

After the heat treatment had been done, each sample from both species was cut from the three part of mid span of specimen for moisture content testing. Moisture content of timber is amount of water inside of timber which been expressed in percentage. The oven-drying method has been the most universally accepted method

Fig. 1: Specially designed electrical furnace made up from ceramic fiber

Fig. 2: Arrangement of samples inside the electrical furnace

for determining moisture content of timber but it is slow and requires cutting the wood. Specimens for determining moisture content were prepared with specimen dimension of 25 mm thick, 50 mm wide and 90 mm long. The procedure of testing for the moisture content is in accordance to Malaysian Standard, MS 544:2001, "Method for Determination of Moisture Content of Timber" by using formula in Eq. 1:

$$mc = (m_i - m_{od})/m_{od} \times 100\% \quad (1)$$

Where:

m_i = Initial mass (g) of the test specimens

m_{od} = Mass (g) of oven-dry test specimens

The specimens were weighing as soon as it cut by using weight scale where all of them been cleaned by a brush to remove the dust or residue that may affect the weight of the specimen. The weight then be recorded before been placed in an oven for drying as shown in Fig. 3. The oven temperature was maintained at

Fig. 3: Sample placed in oven

105+2°C. The weight then been recorded again once all of the specimens been removed from the oven after 24 h.

RESULTS AND DISCUSSION

Table 1 shows the result on moisture content on hardwood keruing before and after heat treatment. The moisture content for wet and dry timber is in the range provided by MS 544 as for timber before treatment, the moisture content is (>19%) which shown that the timbers are in green condition which means timber is in wet condition. The moisture content seems to reduce once treated by heat and the percentage of reduction does increase with an increase in temperatures. Reduction in moisture content after been treated is caused by reduction of timber's hydroxyl where the heat had reduce the timber water uptake that lead to increment of movement stability both of swelling and shrinkage which is a positive indication.

To verify if there is significant difference in the moisture content before and after heat treatment, t-test was performed with the hypothesis as shown:

- H_0: No significant difference between before and after heat treatment
- H_1: There is significant difference between before and after heat treatment

The t-test analysis by Excel in Table 2 shows that the t-stat = 19.03>t-critical two-tail = 3.18. While the significance p = 0.000317 is smaller than the p = 0.05 which means the null hypothesis is rejected. Therefore, it is convincing enough to say that the moisture content before and after heat treatment differs significantly.

Table 1: Moisture content value before and after heat treatment for hardwood timber keruing

Temperature of heat treatment (°C)	Average moisture content (%)	Percentage of reduction (%) before heat treatment	After heat treatment
150	21.50	9.59	55.39
170	20.75	8.82	57.49
190	22.13	7.65	65.43
210	20.85	6.75	67.63

Table 2: t-test analysis of difference in moisture content before and after heat treatment for keruing

	Average moisture content (%)		
Temperature of heat treatment (°C)	Before heat treatment	After heat treatment	Percentage of reduction (%)
150	21.73	9.71	55.32
170	20.37	8.32	59.16
190	21.51	7.21	66.48
210	22.55	4.75	78.94

Table 3: Density value before and after heat treatment for hardwood timber light red meranti

Results	Variable 1	Variable 2
Mean	21.3075	8.2025
Variance	0.411225	1.573825
Observations	4	4

Pearson correlation = 0.05507664; Hypothesized mean difference = 0; df = 3; t-stat = 19.03260484; p(T≤t) one-tail = 0.00015836; t-critical one-tail = 2.353363435; p(T≤t) two-tail = 0.000316721; t-critical two-tail = 3.182446305

Table 4: Test analysis of difference in moisture content before and after heat treatment for light red meranti

Results	Variable 1	Variable 2
Mean	21.54	7.4975
Variance	0.808666667	4.401025
Observations	4	4

Pearson correlation = -0.584550372; Hypothesized mean difference = 0; df = 3; t-stat = 10.31364697; P(T≤t) one-tail = 0.00097207; t-critical one-tail = 2.353363435; P(T≤t) two-tail = 0.001944141; t-critical two-tail = 3.182446305

The same condition goes to hardwood light red meranti which has reduction of moisture content after heat treatment as shown in Table 3. Based on t-test, it can be concluded that the difference of moisture content before and after heat treatment of light red meranti is significant, as shown by the t-test analysis of Excel in Table 4 as the t-stat = 10.31 is smaller than t-critical two-tail = 3.18 with significance value of p = 0.00194 is smaller than p = 0.05 which means the null hypothesis is rejected.

Reduction in moisture content indicates the positive impact to the timber. Other than improving its movement stability where the shrinkage and swelling will be reduced, the timber with low moisture content will lead to reduction in fungus attack and decay inception. Both of these reasons are good to the timber to be a good material in industry. Other than that reduction of moisture content also will lead to increment in strength as dried timber with

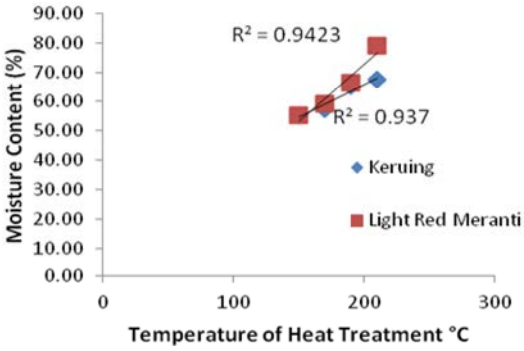

Fig. 4: Moisture content (%) versus temperature of heat treatment (°C)

moisture content smaller than 19% will have improvement in their mechanical properties (Korkut *et al*., 2009).

The correlation between moisture content and level of temperature of heat treatment also had been studied. A correlation coefficient nearing 1 recommends a strong positive relationship. A relatively strong relationship can be observed as the correlation between moisture content and temperature of heat treatment for keruing and light red meranti where R^2 are 0.937 and 0.9420, respectively as shown in Fig. 4. It shown clearly that heat treatment had caused a high reduction in moisture content that may lead to another improvement for both keruing and light red meranti properties.

CONCLUSION

From this study, it can be concluded that heat treatment had reduced the level of moisture content for both species of timber; keruing and light red meranti. Both of these timber species had an increment of moisture content reduction with increment of heat temperature level. Treatment on Malaysian hardwood timber is vital and heat treatment is another alternative way. Moisture content of Malaysian hardwood timber seem to decrease caused by heat treatment where the difference of before and after heat treatment is significant. There is also a good correlation between moisture content and temperature of heat treatment. Reduction in moisture content indicates the increment of movement stability and strength. It is a good indicator that heat treatment is an alternative treatment that can help improving Malaysian hardwood timbers properties in environmental friendly way.

ACKNOWLEDGEMENT

This research is financially supported by the Public Works Department Malaysia and Universiti Teknologi Mara (UiTM) whom both are greatly acknowledged.

REFERENCES

Esteves, B. and H. Pereira, 2008. Wood modification by heat treatment: A review. Bio Resour., 4: 370-404.

Korkut, S., H. Alma and Y.K. Elyildirim, 2009. The effects of heat treatment on physical and technological properties and surface roughness of European Hophornbeam (*Ostrya carpinifolia* Scop.) wood. Afr. J. Biotechnol., 8: 5316-5327.

Sundqvist, B., 2004. Colour changes and acid formation in wood during heating. Ph.D. Thesis. Lulea University of Technology.